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Name of Work: "Construction of Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage system, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."

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Certified that Bid document contains pages 01 to 565 pages Only

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 agencies / contractors of repute in two bid system (Eligibility cum Technical bid & Financial Bid) for the following work: -

NIT No.	30/Composite/CO/2025-26	
Name of work	"Construction of Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage system, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."	
Location	IIT Campus, (GSMST site) Kanpur	
Estimated cost put to bid	Civil & PHE works: - Firefighting works: - ETP & STP works: - Electrical & ELV works: - HVAC works: - Total :-	Rs. 40,82,80, 801.60 Rs. 1,24,32,997.20 Rs. 2,60,24,085.59 Rs. 6,28,57,908.52 Rs. 89,15,869.29 Rs. 51,85,11,662.00
Earnest Money	Rs. 61.85 Lacs	
Period of Completion	09 Months	
Last date & time of online submission of 'Eligibility and Financial Bids'	21.07.2025 & 17:00 Hours	
EMD Submission hard copies	23.07.2025 upto 12:00 Hours	
Time and date of opening of eligibility documents	23.07.2025 upto 12:30 Hours	
Pre-Bid Conference	08.07.2025 at 12:00 Noon at SE, IWD office	

INDIAN INSTITUTE OF TECHNOLOGY KANPUR
INSTITUTE WORKS DEPARTMENT
CENTRAL OFFICE

Notice Inviting e-Tender 30 /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 agencies / contractors of repute in two bid system (Eligibility cum Technical bid & Financial Bid) for the following work: -

SI No	Name of work	Estimated Cost (without GST)	Earnest money	Period of completion
1.	"Construction of Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage system, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."	Civil & PHE works:- Rs. 4082.81 Lacs Firefighting works:- Rs. 124.33 Lacs ETP & STP works:- Rs. 260.24 Lacs Electrical & ELV works :- Rs. 628.58 Lacs HVAC works:- Rs. 89.16 Lacs Total :- Rs. 5185.12 Lacs	Rs. 61.85 Lacs	09 Months

Last date & time of submission of bid on 21.07.2025 Up to 17:00 Hrs 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/2025-26/115

Dated:28.06.2025

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.2074.05 lacs

Or

Two similar works each costing not less than Rs. 3111.10 lacs

Or

One similar works each costing not less than Rs. 4148.10 lacs

Similar work shall mean works of **"Construction of RCC framed structure Building with water supply & Sanitary Installations, external sewerage systems, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) works. "**

Note:

1. 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.

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 are 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 1555.53** 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. **2074.05** Lacs or Net Worth certificate of minimum Rs. **518.51** 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 in the office of the SE, IWD, IITK.

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 08.07.25** 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 quarries/ 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 quarries/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	Affidavit as per provision of CPWD-6 (Form 'F') .
13	Declaration about Site Inspection (Form 'G') .
14	Memorandum Of Understanding [M.O.U] Between associate agency of E & M works and main contractor (Form 'H') .
15	Willingness Certificate by Associate agency (E & M works) (Form 'I') .
16	Enlistment order for CPWD enlisted contractors.
17	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 Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installation, external sewage, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur. "

1. The work is estimated to cost **Rs. 51,85,11,662.00/-**. This estimate, however, is given merely as a rough guide.
2. The time allowed for carrying out of the work will be **09 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 **09 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 61.85 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 23.07.2025.**
 - 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 12:30 Noon on 23.07.2025.

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 Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installation, external sewage, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."
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 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 C:- General Guidelines, Particular specifications for Fire fighting works.

PART D:- General Guidelines, Particular specifications for ETP & STP works.

PART E:- General Guidelines, Particular specifications for Electrical & ELV works.

PART F:- General Guidelines, Particular specifications for HVAC works.

PART G: - List of Tender Drawings. **Link provided at Index pages.**

PART H:- Schedule of financial quote shall be uploaded separately.

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 below:

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 40% value of the Electrical Works

OR

(ii) Two similar works each of 60% value of the Electrical Works

OR

(iii) One similar work each of 80% value of the Electrical Works

Similar works means SITC of internal ELECTRICAL Works with LT panels/cables etc.

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.

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.

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 Engineer in charge of major component. The duly signed copy of the contract agreement shall be handed over to PMC for the smooth execution of works.

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 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 (a) **The composite work shall be treated as complete when all the components of the works are completed. 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.**

21.1.11 (b) Final bill of whole work shall be finalized and paid by the EE of major component.

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 Superintending Engineer, IWD, IIT Kanpur (U.P).website:www.iitk.ac.in/iwd/tenderhall.htm,<https://eprocure.gov.in/eprocure/app>.

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
	"Construction of Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage system, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."	Rs.51,85,11,662.00/-	9 Months
	Total	Rs.51,85,11,662.00/-	

2. **The work is situated inside IIT campus Kanpur, (UP) Pin: 208016.**
3. The scope of works includes complete execution of work, foundation superstructure, Finishing, Internal, External Electrification and ELV work, plumbing, firefighting, Fire alarm System, 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 Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installation, external sewage, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."** on percentage basis. 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) The architectural and engineering design and drawings for the work have been prepared and attached with bid document.
- (v) The 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, 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 fibre 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.
- (vi) Contractor has to complete the buildings in all respects and make them habitable and hand over to Engineer-in-charge.
- (vii) 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.
- (viii) 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.
- (ix) **Electrical & Mechanical works:** Details of E & M works are given in PART C to PART F of the tender document.
- (x) Samples of the materials of approved make or otherwise shall be got approved from the Engineer-in-charge before use in the work.
- (xi) 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 Installation works. The Contractor shall be bound to abide by all the clauses of all statutory and other approvals.

(xii) **Provisional Fire NOC will be applied & obtained by the IIT Kanpur. The final Fire NOC for the whole GSMST Project IIT Kanpur shall be obtained by the contractor before completion & handing over the work to the GSMST.** The agencies are advised to quote their rates accordingly.

(xiii) 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 / Tender drawings for all related civil, plumbing, Firefighting, electrical, ELV and HVAC services, duly supported with design as required by Engineer-in-charge without any extra cost.
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.

(xiv) 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.

(xv) **Tender Drawings:** The Tender 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 Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage systems, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."** 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.
- 2.5 "Architect"** shall mean every partner of the firm **M/s HOSMAC INDIA PVT LTD**, Mumbai duly appointed by the Institute for the work and in the event of ceasing to be the Architects, such other firms or persons as may be appointed by the Institute.
- 2.6 "Project Management Consultant (PMC)"** shall mean every partner of the firm **M/s TATA consulting Engineers Limited (TCE)** as duly appointed by the Institute for rendering project management services to supervise, the daily ongoing works, daily recording, checking & certify all the measurements, daily checking of quality of ongoing works and preparing the records of all tests on testing registers for smooth completion of the quality work, prepare & certify the bills of the contractor for payment in time, ensuring the safety at site submitting the monthly progress report including recording of hindrances on hindrance register to the Institute for the record and in the event of ceasing to be the PMC, such other firms or persons as may be appointed by the Institute.
- 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.

Three similar works each costing not less than Rs.2074.05 lacs

Or

Two similar works each costing not less than Rs. 3111.10 lacs

Or

One similar works each costing not less than Rs. 4148.10 lacs

AND

One complete work costing not less than Rs 2074.05 lacs with Central Government department / Central autonomous body / central public sector undertaking.

Similar work shall mean "Construction of RCC framed structure Building with water supply & Sanitary Installations, external sewerage systems, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) works. " executed under the said agreement.

Note:

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.

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 1555.53 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. 2074.05** lacs or Net Worth Certificate of minimum Rs. 518.51 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:

Bidding Capacity = {[AxNx1.5]-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 work 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-C1**).
- (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 26 AS (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

Attributes	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 Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage system, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."

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 I** 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 commen ce ment as per contract	Stipulate d date of completi on	Actual date of completi on	Litigation/ arbitration cases pending /in progress with	Name and address /teleph one numbe r of officer	Whet her the work was done on back to back basis Yes/N o
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 damps 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
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,	10

	cable termination earthing pits, earthing of transformer/DG sets		
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

Registration No.

- 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"

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 'G'

Declaration about Site Inspection

(By Bidder)

To

The Executive Engineer,

IWD, IIT,

Kanpur

Subject: "Construction of Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installation, external sewage, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."

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 'H'

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 Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage system, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."

[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 (IITK) 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 & Mechanical works. As per agreement shall be the responsibility of the associated contractor.
- 3- The site staff required for the Electrical & Mechanical 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

FORM 'I'

WILLINGNESS CERTIFICATE BY ASSOCIATE AGENCY (E & M works)

Name of work:- "Construction of Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage system, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."

I will execute the work as per specifications and conditions for the agreement and as per direction of the Engineer-in- charge. 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 IITK 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

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 Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage system, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."**

- (i) Last date and time of technical and financial bid for online submission of e-tenders is up to 17:00 Hrs. on 21.07.2025.
- (ii) Time and Date of opening of technical bid in presence of tenders who may be present on 12:30 Hrs. on 23.07.2025 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 61.85 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. 30/Computer/CO/2020 (hereinafter referred to as "**Tender/Bid**") and intends to award, under laid down organization procedures, contract(s) for Procurement of hardware for the Institute of Technology 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:-



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

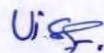
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with any other contract for any other stores, such outstanding payment could also be utilized to recover the aforesaid sum and interest.

- (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.



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.



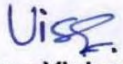
3. In case of a joint venture, all the partners of the joint venture should sign the Integrity Pact. In case of sub-contracting, the principal contractor shall be solely responsible for the adherence to the provisions of IP by the sub-contractor(s).
4. Issues like Warranty/Guarantee etc. shall be outside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


 Name: **Vishwa Ranjan**
 Designation: **Registrar**
 Address: **IIT Kanpur**
 (Authorized Signatory)
 विश्व रंजन / Vishwa Ranjan
 कुलसचिव / Registrar
 भारतीय प्रौद्योगिकी संस्थान कानपुर
 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.



PROFORMA OF SCHEDULES (A to F)

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

(For Civil /E & M Works)

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
NIL				

SCHEDULE 'C'

Tools and plants to be hired by the contractor as per Appendix-I.

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 Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage system, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."		
Estimated cost of the work:	Civil Items of Work-	Rs. 40,82,80,793.67 (without GST)
	Firefighting Items of work-	Rs. 1,24,32,997.20 (without GST)
	STP & ETP Items of Work-	Rs. 2,60,24,085.59 (without GST)
	Electrical Items of Work-	Rs. 6,28,57,889.51 (without GST)
	HVAC Items of Work-	Rs. 89,15,869.08(without GST)
Earnest money	Rs. 61.85 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	As per CPWD specifications 2019 (Civil works)/ As per CPWD specifications 2013 (E & M works)
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%
2 (iv)	Standard Schedule of Rates: Civil Items of Work: E & M Items of works:	DSR-2023 & Market Rates DSR-2022 & Market Rates
2 (v)	Department	IWD, IIT Kanpur
2 (vi)	Standard CPWD contract Form:	GCC 2023, CPWD form-7 as modified & corrected up to the last date of submission of bid (Whether correction vide latest circulars are in corporate or not in this document). The following condition pertains to GST of clause 33 & 34 of General Condition of contract and corresponding Amendments should be read as follows: a. The Quoted rates should be exclusive of GST. b. The GST as applicable shall be paid extra.
Clause 1	a) Time allowed for submission of Performance Guarantee, applicable labour licenses, registration with EPFO, ESIC and BOCW Welfare Board or proof of applying thereof from the date of issue of	10 Days

	letter of acceptance from the date of issue of letter of acceptance. b) Maximum allowable extension with late fee @0.1% per day of performance guarantee amount beyond the period as provided in (i) above	5 Days	
Clause 1A	The Defect liability period shall be Three years from the date of handing over of the assigned works to the user/Institute	Applicable.	
Clause 2	Authority for fixing Compensation under Clause 2	Dy. Director, IIT Kanpur	
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 9 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)	Dy. Director/ Director IIT 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	
Milestones 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	Completion of RCC work of foundation up to plinth level including grade slabs	3.5 Months	1.0
3	Completion of RCC work in Superstructure	4.5 Months	0.5
4	Completion of all masonry work (Block/Brick work, Plastering)	5.5 Months	0.5
5	Completion of Cladding work, Wood & PVC Work, Steel Work, Flooring, Roofing, False Ceiling, Plaster & Paint, Aluminum Work, Waterproofing, Structural Glazing, finishing works including all other misc. internal & external works pertaining to buildings as mentioned in the scope of work to make the buildings functional in all respects.	6.5 Months	0.5
6	SITC of Sanitary Installation, Water Suply, Drainage, Low Side Internal Fire Fighting Work	7.0 Months	0.5
7	Internal Electrical Work for STP, ETP & Pump Room, OWC, BMW, Fire Station, MGPS Plant Room, Common Toilet, Security Cabins	7.5 Months	0.5
8	Low Side Equipment, Ducting, Air Distribuiton Product, Standby Equipments, Special Purpose Equipments	7.5 Months	0.5
9	ELV- FAS, CCTV, SIGNAGES, BMS, PAS, DATA & NETWORK, PS SYSTEM	7.5 Months	0.25

10	CIVIL WORKS FOR MEP SERVICES	8.0 Months	0.5
11	External Lighting Work, , UPS distribution system, Substation, External Hydrant work, External Drainage, and Completion of all external works which are in the scope of the contract	8.5 Months	0.25
12	Completion of Road Work including Hardscape	8.5 Months	0.5
13	Completion of work : Completion of all Structure as per the contract in all respects. Handing over of buildings along with schedule of fittings / fixtures. Submission of approved completion certificate of the project including all NOCs from Fire Dept, Pollution Control Board, Labour Officer etc , all statutory post-construction clearances, submission of as-built drawings.	9 Months	0.5
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.	350 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 & page no 71 & 72	
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
Clause 11	Specification to be followed for execution of work:	
For Civil items of work	CPWD Specification vol.1 and vol.2, 2019),	
For Firefighting, STP & ETP, Electrical & ELV and HVAC items of works	As per Component PART-C, D, E and PART-F	
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)
Clause 16		Competent Authority for deciding reduced rates
For Civil items of work		Superintending Engineer, IWD IIT Kanpur
For E & M Items of works		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
19K		Applicable
Clause 25		
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	1	10 years respectively	Project Manager cum Planning	Rs. 60,000/- (Rupees Sixty Thousand only) per month, per person
2.	Graduate Engineer or Diploma Engineer	1+1+1	5 or 10 respectively	Project site Engineer/quality/billing Engineer	Rs. 40,000/- (Rupees Forty Thousand only) per month, per person
3	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	Ten year in major construction project	Safety Engineer	Rs. 60,000/- (Rupees Sixty 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

Appendix-I

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)	01 Nos.
	Equipment for Concrete work	
2	Fully Automatic batching plant of 30 cum/hour as per direction of Engineer-in-Charge	01 Nos.
3	Concrete pump	01 Nos
4	Concrete transit mixer	02 Nos.
5	Concrete mixer (diesel)	01 Nos.
6	Concrete mixer (electrical)	01 Nos.
7	Needle vibrator (electrical)	02 Nos.
8	Needle vibrator (petrol)	02 Nos.
9	Surface and Plate vibrator	02 Nos.
	Equipment for Building work	
10	Bar bending Machine	02 Nos.
11	Bar cutting machine	02 Nos.
12	Drilling machine	02 Nos.
13	Welding machine i/c transformer	02 Nos.
14	Cube testing machines automatic (Digital 100 MT)	01 Nos.
15	M.S Shuttering/ Wooden	Minimum 500 m ²
16	M.S. pipes/telescopic props and other accessories.	As per requirement
17	Steel scaffolding system (cup lock type)	As per requirement
18	Grinding/polishing machines)	As per requirement
	Equipment for transportation	
19	Tippers	As per requirement of the project and milestones.
20	Trucks	As per requirement of the project and

		milestones.
	Pneumatic equipment	
21	Air compressors (diesel)	As per requirement of the project and milestones.
	Dewatering equipment	As per requirement of project.
	Power equipment	
22	Diesel generator (to meet requirement at site for uninterrupted work)	01 No. of required capacity
	Survey equipment's	
23	Total Work Station	01 Nos.
24	Vernier Calipers	02 Nos.
25	Weighing Machine	02 Nos.
26	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 Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage systems, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."**

- 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 **09 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. Stainless Steel Railing (Grade-304)
- Approval 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.

B. Sampling of Materials:

- B1. 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.
- B2. 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.
- B3. 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.
- B4. 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.
- B5. All materials brought by the contractor for use in the work shall be got checked from the PMC / Engineer-in-Charge or his authorized representative of the work on receipt of the same at site before use.
- B6. 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.
- B7. The Stone aggregates and sand shall be brought from any quarries subjected to the said materials confirm CPWD specifications.
7. 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 PMC/ Engineer - in-Charge of work and which shall be duly signed by the contractor or his authorized representative.
- 5 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.
- 6 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.
- 7 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.
- 8 Cement issued shall be for consumption at site only. No cement for factory made

items and those not manufactured at site shall be issued.

- 9 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 PMC on behalf of Engineer-in-Charge. All test register are to be maintained by the PMC with duly Signature & seal on daily basis.
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 authenticated by PMC and submitted to Engineer-in-Charge.
4. PMC shall be responsible for safe custody of all the test registers to be maintained at site.
5. Submission of copy of test reports of materials with each alternate running account bill and final bill shall be mandatory. These test reports should be duly checked and signed by PMC on behalf of 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 by the PMC.
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 / PMC 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 500 bags of cements shall be constructed by the contractor at site of work and/or 02 Nos sillos 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.

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 bars	One sample for each 50 tons or part thereof	One sample for each 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 liveable 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.

10 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.

11 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.

12 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.

13 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.
- 14 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.
- 15 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.
- 16 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.
- 17 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.
- 18 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.
- 19 It shall be ensured by the contractor that no electric live wire is left exposed or unattended to avoid any accidents in this regard.
- 20 The structural and architectural drawings shall at all times be properly co-related 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.
- 21 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.
- 22 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.
- 23 All RCC work in Structural members shall be of M25/M30/M40 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.
- 24 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.

1.0 PROGRAM CHART

- 1.1 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".
- 1.2 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.
- 1.3 The approval by the Engineer-in-charge of such program shall not relieve the contractor of any of the obligations under the contract.
- 1.4 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.
- 1.5 The program chart should include the following: -
 - 1.5.1 Descriptive note explaining sequence of various activities.
 - 1.5.2 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.
 - 1.5.3 Program for procurement of materials by the contractor.
 - 1.5.4 Program for arranging and deployment of manpower both skilled and unskilled so as to achieve targeted progress.
 - 1.5.5 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.
 - 1.5.6 Program for achieving milestones.

2.0 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.

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

4.0 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.

5.0 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.

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

7.0 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.

8.0 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.

9.0 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.

10.0 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.

11.0 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 safety himself that the information available thereof is complete and unambiguous.

12.0 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.

13.0 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.

14.0 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.

15.0 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.

16.0 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.

17.0 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.

18.0 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.

19.0 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.

20.0 POUR CARD, CHECK-LIST FOR EXECUTION OF WORK

20.1 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 PMC /Engineer-in-Charge and should be used at site.

20.2 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 pipelines, 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.

21.0 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.

22.0 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.

23.0 **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 **PMC** / Engineer-in-Charge & proceed further. Any discrepancy between architectural drawings and actual layout at site shall be brought to the notice of the **PMC**/ 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.

24.0 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.

25.0. 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.

26.0 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.

27.0 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, revines, 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.

28.0 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.

29.0 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.

30.0 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.

31.0 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.

32.0 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.

33.0 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 PMC /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.

34.0 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.

35.0 Inspection of work

The PMC Engineers will assist the IITK Engineers during the 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.

36.0 **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 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, along with documentary evidences as required by the Engineer-in-Charge/PMC. 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.

37.0 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.

38.0. 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.

39.0 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).

40.0 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.

41.0 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.

42.0 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.

43.0 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.

44.0 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.

The contractor shall ensure the following:

- i. 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.
- ii. Covering stockpiles of dusty material with impervious sheeting.
- iii. Covering dusty load on vehicles by impervious sheeting before they leave the site.
- iv. Transferring, handling / storing dry loose materials like bulk cement and dry pulverized flyash inside a totally enclosed system.
- v. 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.
- vi. Clear vegetation only from areas where work will start right a way.
- vii. 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).
- viii. 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.
- ix. 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.

- x. 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.
- xi. 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.
- xii. 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.
- xiii. 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.
- xiv. A soil Erosion and Sedimentation Control Plan (ESCP) should be prepared prior to construction and should be applied effectively.
- xv. 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.
- xvi. 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).

- xvii. 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 17 above unless specifically mentioned otherwise.

45.0 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. 70 (i) to 70 (xv) above.

46.0 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 through PMC 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.

47.0 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 GSMST 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 through **PMC** on monthly basis for record purpose.

SCOPE OF WORK

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 tanks, Roads, Pathways, STP & ETP, external fire hydrant work external lighting work, 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 includes Construction of Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installation, external sewage, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) as per approved drawings / specifications and as directed by Engineer-in-Charge.

1.11 Execution of rainwater harvesting tank for collection of roof top water including laying of pipelines and construction of substructure / superstructures as per GFC drawings is within the scope of work.

1.12 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.

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

1.14 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 PMC and IITK 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.

1.15 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)

1.16 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.

1.17 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.

1.18 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.

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

1.20 **External Bulk Services:** Execution upto completion of 1. Water supply, 2.

Sewerage system, 3. Storm water drains, 4. Roads, 5. Paths, 6. Rain Water Harvesting tank, 7. UG Tank, Cabling etc. all complete as per GFC drawings, are in the scope of work.

1.21 Execution of Internal Electrification, Fire Alarm System, Fire-fighting system, CCTV, Point wiring, 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.

1.22 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.

1.23 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.

1.24 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 PMC and IITK officers.

1.25 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 provide all required details in obtaining the Provisional Fire NOC from fire department. Final approvals/NOC/permissions of the whole GSMST project etc. shall be obtained by the contractor. The contractor is advised to quote the rate accordingly, 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, 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 as per GFC drawings.
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 site from outside. No payment / fees on this account shall be entertained by the department.

1.7 The contractor may encounter 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 M25/M30/M40 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 M25,M30 & M40 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) IIT Roorkee
- (iv) HBTU Kanpur

The various ingredients for mix design / laboratory tests shall be sent to the test houses through the PMC/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.

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 $T_{ck} = F_{ck} + 1.65 s$.

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 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 PMC/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 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 Form work/Shuttering

Shuttering / Form Work - Formworks material should be in steel with rubberized joints. Centering and shuttering including strutting, propping etc. and removal of form work including cost of de-shuttering and de-centering at all levels, for all heights and depths. The work shall be done in accordance with CPWD Specifications - 2019 - Vol. I & Vol. II with up to date correction slips. Steel shuttering and 12 mm thick BWP grade film faced plywood shuttering to be used by contractor as per direction of engineer in charge.

All shuttering should be new/fresh.

- i. Minimum size of shuttering plates shall be 600mm x 900mm except for the case when closing pieces required to complete the shuttering panels. Dented, broken, cracked, twisted or rusted shuttering plates shall not be allowed to be used on the work.
- ii. The shuttering plates shall be cleaned properly with electrically driven sanders to remove any cement slurry or cement mortar or rust. Proper shuttering oil or de-shuttering compound shall be applied on the surface of the shutter plates in the requisite quantity before assembly of steel reinforcement.
- iii. The joint filler shall be resilient closed cell expanded polythene and non- tainting as manufactured by Supreme Industries Ltd or equivalent.
- iv. Providing joint filler of required thickness in position to substrate using either double sided foam adhesive tape or neoprene synthetic rubber adhesive. When forming expansion joint with the Board in in-situ concrete, joint sealing slots can be readily formed in the following matter-
- v. Before installing, simply cut off a strip of the required depth. Then install the filler flush with the finished surface. Prior to sealing, the top strip can then be pulled easily from the joint to provide an uncontaminated sealing slot ready for preparation and sealing.
- vi. Shuttering surface before concreting should be free from any defect/ deposits and fully cleaned so as to give perfectly straight smooth concrete surface. Shuttering surface should be therefore checked for any damage to its surface and excessive roughness before use.
- vii. Form work including centering, shuttering, propping, staging shall be strong enough to withstand the dead and live loads and forces caused by ramming and vibrations of concrete and other incidental loads, imposed upon it during and after casting of concrete. It shall be made sufficiently rigid by using adequate number of ties and braces, screw jacks or hard board wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete.

- viii. The agency shall provide and fix the Exposed shuttering in suspended floors, roofs, Landings, balconies ,and access platforms with water proof ply 12 mm thick or wherever exposed quality of R.C.C is mentioned or desired by the Engineer-in-charge. The ply shuttering used for Exposed quality shall be used maximum for 2 castings.

Form work shall be properly designed for self-weight, weight of reinforcement, weight of fresh concrete, and in addition, the various live loads likely to be imposed during the construction process (such as workmen, materials and equipment). In case the height of centering exceeds 3.50 meters, the prop may be provided in multi-stages. Extra for additional height in centering, shuttering wherever required with adequate bracing , propping etc including cost of de shuttering at all levels , over a height of 3.5 m for every additional height of 1m nothing extra shall be paid

- i. Form 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.
- ii. Camber: Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per meter (1 to 250) or as directed by the Engineer-in-charge, so as to offset the subsequent Deflection, for cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the Engineer-in-charge.
- iii. Tolerance in Finished Concrete - The formwork shall be so made as to produce a finished concrete true to shape, lines, level, plumb and dimensions as shown in the drawings subject to the following tolerance unless otherwise specified in this specification or drawings.

Variation from Plumb	+/-6 mm	Up to 3 m Height
Variation from the plumb of conspicuous liner	+/-6 mm	Up to 6 m Height
Variation in the size of wall openings	(+)-15mm (-) 6mm	

COLUMN/ FINS: SLAB, BEAM & GIRDER FORMS:

Variation from the level or from the specified grid for beam soffit before removal of shores,

In any 6/3m span	+/-6mm
In 10m span	+/-10mm

All the tolerances mentioned above shall apply to concrete dimensions only, and not to positioning of vertical steel or dowels. The tolerances given above are specified for local aberration in the finished concrete surface and should not be taken as tolerance for the entire structure taken as whole for the setting and alignment of formwork. Any error, within the above tolerance limits, or any other if noticed in any of the structure after part or portion stripping of forms, shall be corrected in the subsequent work to bring back the structure to its true line, level and alignment.

Workmanship

- i. Erection of form work may be from pre-molded, prefabricated, pre-assembled plates or forms reasonable enough to transport and erect at site to correct line and level as set out at site. Supports shall be firm and maintained in position by nails, cross bracings, tie rods, locking bolts and nuts. It shall be rigid and stiff so as to retain its shape during and after concreting. The tie rods shall be terminated at least 40mm inside the finished surface. Joints shall be water-tight, and no cement slurry shall be allowed to slip through. In joints foamed tapes shall be used. Prefabricated or site forms shall be assembled, to de-shutter without any jerk to the green concrete. For this double wedge shall be used. Wedges shall be nailed, the heads reasonably left out, allowing easy removal while de-shuttering .
- ii. Prefabricated or on-site fabricated forms shall be of enough thickness and with the required supporting runners in either direction. Supporting runners shall be standardized in size for easy replacement and universal use at site. Props shall be of steel only. Size and verticality shall be approved by the Engineer-in-charge. Its spacing shall be as per design. It shall be vertical and plumbed. Base shall be a proper steel plate or timber plank, for equal distribution of load. In repeated use, panels shall be clearly marked for using at defined locations. Successive lift shall be tightened with previous lift by fixing foamed strips at joints to avoid grout leakage.
- iii. In fill pieces and panels shall be well dressed, levelled and jointed with main formwork so as to achieve smooth, even natural finish. Props, Soldiers,

walling's, Shores, bearers, Clamps, wall & ties etc. shall be at required spacings. Props, shores shall be securely braced with firm bearing.

- iv. Provide and fix or fix only inserts pockets, to correct line and level and with enough rigidity to keep in position while concrete placing is in progress along with vibration.
- v. Sloping, brackets, chajjas etc shall be well secured and firmly restrained. Adequate access and working platform shall be arranged with required safety to avoid reinforcement displacement, damage to shuttering and easy movement of concrete gang.
- vi. Props and scaffolds are to be erected to correct plumb, line, level and with required tie. Load carrying capacity of props shall be as per table of manufacturer.
- vii. Props and scaffolds shall not be loaded more than allowed by manufacturer of Props /scaffolds. Heavy, medium and light duty props shall not be mixed up. Beams and slabs shall have camber of 4 mm per meter or as directed by the Engineer-in-charge.
- viii. All angles and corners shall be sharp and well defined. In places where concrete edges are permanently exposed and require no further treatment; they shall be chamfered in a triangle of 25×25mm.
- ix. Props of steel shall be provided with adequate horizontal and cross - bracing. Steel props shall use steel pipes and steel couplers use of timber is not permitted.

At the design and erection stage, the following additional points shall be considered and incorporated into the Shutters-

- i. Openings for cleaning prior to start of concreting.
- ii. Pouring points shall avoid high drops and provide easy access to vibrator needles. Surfaces shall be treated with mould releasing oil or emulsion as approved by the Engineer-in-charge prior to reinforcement laying. The following point shall be observed very carefully:
 - i. Joints of moulds shall be water-tight & should be checked from bottom to make sure, that no light is visible.
 - ii. Props shall be on solid base, plumbed, in one straight line, and braced horizontally and cross.
 - iii. Tie bars in beams, walls and columns shall be at the correct place and fully tight.
 - iv. Wedges shall be fully secured and nailed with head left out for easy removal.
 - v. All saw dust, dirt, shaving and any other unwanted materials shall be cleaned and hosed out.

- vi. Provision shall be made for watching form work while concreting and any other platform needed for movement of workers without any disturbance to reinforcement.

Opening/inserts: All required openings and pockets shall be provided as detailed in the drawing. The contractor shall provide for the required material, labour for fixing and supporting during concreting, in his quoted price. It is imperative that all openings and pockets shall be de-shuttered with care and all corners of openings shall be preserved. All openings/pockets shall be in a correct line and level. After concreting, the openings shall be secured by proper covering against any accident and guard rail and warning notice, if any will be incorporated. In case of multi-storey building, any upper floor shall be suitably supported on at least one floor below the same or as approved by the Engineer-in-charge. The concreting of upper floor shall be done only after lower floors have attained the strength.

Camber: Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per metre (1 to 250) or as directed by the Engineer-in-charge, so as to offset the subsequent deflection, For cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the Engineer-in-Charge. In case of slab/ raft etc. chairs of dia minimum 12mm dia to 25mm of required length in double mesh portion should be provided @ 1 no. per sq.m.as directed by the Engineer-in-charge. The dia of chair should be such that they do not bend or buckle under the weight of reinforcement and other incidental load during construction. Bar bending schedule to be prepared and provided by the Contractor, as per structural drawings

- i. Clear overhead space, hoisting hooks, exhaust fan opening, etc. are to be provided, as required for proper commission of lifts, as per manufacturer's specifications and approved shop drawings
- ii. Form work shall be placed and removed as per time line provided in CPWD-specifications.
- iii. Plaster drip course of size 25mm × 12mm in plastered surface or moulding to be provided for all R.C.C. projections/ chajjas, etc.

Formwork design shall consider the following:

- i. Dimensional tolerance
- ii. Demountable without shock, disturbance or damage to concrete

- iii. All construction joints in beams and slabs shall be provided as shown in drawings.
- iv. Ties shall be provided where required
- v. Props / supports of extra ceiling height shall be specially designed.
Formwork: - Form work shall be placed and removed as per timeline provided in CPWD specifications

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 25 tons 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 then 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%

6.3.14 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.

6.3.15 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 MASONRY WORK:

The masonry work shall be done as per CPWD Specifications 2019, Volume-I & II with revisions/ amendments / correction slips up to last date of bid submission (including extensions if any). In case of conflict or contradiction between detailing shown in drawings and specification mentioned hereinunder this subhead, the specification mentioned herein under this subhead will be followed.

7.1 Chicken mesh 85gsm or fibre mesh of good quality to be provided in plaster at the junction of Masonry and RCC or CC Member/band.

7.2 For masonry work above plinth level, RCC band at sill level and lintel level shall be provided. This thickness of the band shall be 100 mm or as approved by the Engineer-in-Charge.

7.3 All opening on masonry wall shall be provided with RCC lintels, RCC bands / lintel over top of parapet wall at corridors, balconies etc. with specified grade of concrete as shown in the drawing or as approved by Engineer-in-Charge.

7.4 FPS bricks (Local Ist Class) in cement mortar 1:6 (1 Cement: 6 Coarse Sand) shall be used in brick work in foundation up to plinth level, wet areas and other masonry work shown in drawings. All the walls of corridors shall be full brick wall or with 200mm thick AAC blocks.

7.5 AAC blocks masonry shall be of Grade I and of oven dry density 551-650 kg/cum with polymer modified adhesive mortar above plinth level except wet areas. The

polymer modified adhesive (of make Pidilite, Ardex Endura, Weber) mortar shall be provided @ 30 kg per cum. AAC Block confirming the IS Code – 2185 (Part-3) 1984 (Reaffirmed 2005) shall be used.

- a) Dimensions & Tolerances: Autoclave Aerated Concrete Block shall be made in sizes and shapes to fit different needs.
- b) The maximum variation in the length of the Autoclave Aerated Concrete Block shall not be more than plus/minus 5mm and maximum variation in the height and width of Autoclave Aerated Concrete Block, not more than plus/minus 3mm.
- c) The faces of Autoclave Aerated Concrete Block shall be flat & Rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angle to the face of the Blocks. The Autoclave Aerated Concrete Block with special faces shall be manufactured and supplied if so required.
- d) The autoclaved Autoclave Aerated Concrete Block shall be classified in two grades according to their compressive strength as indicated in table below:

S. N.	Density in Oven dryCondition(Kg/m3)	Compressive Strength (N/mm2)		Thermal Conductivity in air dry condition (W/m.k)
		Grade I	Grade II	
1	451 to 550	2.00	1.50	0.21
2	551 to 650	4.00	3.00	0.24
3	651 to 750	5.00	4.00	0.30
4	751 to 850	6.00	5.00	0.37
5	851 to 1000	7.00	6.00	0.42

- e) All Autoclave Aerated Concrete Block shall be sound, free of cracks or other defects which interfere with the proper placing of block units impair the strength or performance of the construction. Where block units are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks or other imperfections except that if not more than 5% of a consignment contains slight cracks or small chippings not larger than 25mm, this shall not be deemed grounds for rejection.
- f) Block Density – The Block density shall conform to the requirements specified in above table, when tested accordance with IS 6441 (Part-1) - 1972.

- g) Compressive Strength – The min. compressive strength being the average of twelve block units shall be as prescribed in above table, when tested accordance with IS 6441 (Part-5) -1972.
- h) Thermal Conductivity – The thermal conductivity shall not exceed the values specified in above table when tested accordance with IS 3346 -1980.
- i) Drying Shrinkage – The drying shrinkage shall be not more than 0.05% for grade –1 block and 0.10% for grade-2 block when tested accordance with IS 6441 (Part-2) -1972.
- j) Number of tests: A sample of 24 blocks shall be selected at random. All the 24 Blocks shall be checked for dimensions and inspected for visual defects. Out of the 24 blocks, 12 blocks shall be subjected to the test for compressive strength, 3 blocks to the test for density, 3 blocks to the test for thermal conductivity and 3 blocks to the test for drying shrinkage. The remaining 3 blocks shall be reserved for re-test for drying shrinkage if a need arises.
- k) The samples of AAC blocks (each sample consisting of 6 specimen) shall be chosen randomly from the lot procured and tested for various parameters specified as above. One samples shall be tested for every 200 cum or part thereof. However, minimum one sample shall be tested from each lot received at site if the quantity procured in the lot is less than 200 cum. If required, Engineer-in-Charge or his authorized representative shall inspect the factory during production of the material for this work and also collect samples (of materials used for making AAC blocks and precast AAC blocks) from the factory itself. The contractor shall consider this contingency also while placing the order with one of the approved firms. Nothing extra shall be payable on this account.
- l) Criteria for conformity: The number of blocks with dimensions outside the tolerance limit and or with visual defects, among those inspected, shall not be more than two. For density, the mean value shall be within the range as specified in above Table. For compressive strength, the mean value, say X shall be determined. The test results shall be grouped into groups of 4, individual values of ranges shall be determined, the average range a calculated from these values and shall satisfy the following condition: $X - 0.6 R > \text{minimum value specified in above Table}$. For thermal conductivity, the mean value shall be equal to or less than the value specified in above Table. For drying shrinkage, all the test specimens shall satisfy the requirements of the test. If one or more specimens fail to satisfy the requirements, the remaining 3 blocks shall be subjected to these tests. All these blocks shall satisfy the requirements.
- m) Manufacturer's Certificate: The manufacturer shall satisfy himself that the masonry units conform to the requirements of this specification and, if requested, shall supply a certificate to this effect to the purchaser or his representative.

- n) Marking: Each lot of concrete masonry units manufactured in accordance with this specification shall preferably be marked with information-
 - o The identification of the manufacture
 - o The grade and block density of the unit
 - o The month and year of manufacturing

8.0 WOODWORK:

The woodwork in general shall be carried out as per CPWD Specifications 2019, Volume-I & II with revisions/ amendments / correction slips up to last date of bid submission (including extensions if any). In case of conflict or contradiction between detailing shown in drawings and specification mentioned herein under this subhead, the specification mentioned herein under this subhead will be followed. The detailing shown in door and window drawings are suggestive only. Before taking up any procurement/construction activity, shop drawings (for fixing of all kinds of doors, showing all hardwares) shall be prepared (based on specification laid herein) and submitted by contractor for obtaining approval from Engineer-in-Charge.

- 8.1 The samples of species of timber to be used shall be deposited by the contractor with the Engineer- in-Charge before commencement of the work. The contractor shall produce cash vouchers and certificates from standard kiln seasoning plant operator about the timber to be used on the work having been kiln seasoned by them, failing which it would not be accepted as kiln seasoned. Specified timber shall be of good quality and well-seasoned. It shall have uniform colour, reasonably straight grains and shall be free from dead knots, cracks and sapwood.
- 8.2 Woodwork shall not be painted, oiled or otherwise treated before it has been approved by the Engineer-in-Charge. All portion of timber including architrave abutting against masonry concrete stone or embedded in ground shall be painted with approved wood preservative or with boiling coal tar.
- 8.3 Door/window schedules is provided with the tender document which shall be followed invariably.

If any door type or tag is not mentioned in drawings or door & window schedule, decision shall be given by Engineer in charge based on door suggested in door & window schedule for similar functional area. Before taking up any procurement/construction activity, shop drawings (for fixing of all kinds of doors, showing all hardwares) shall be prepared and submitted for obtaining approval from Engineer-in-Charge.

- 8.4 Flush Door Shutters - Flush door shutters shall be of 35 mm thick or of thickness as specified/required/decided (in door & window schedule or in drawings) and conforming to IS: 2202 (Part I) decorative type, core of block board construction with frame of 1st class hard wood and well-matched teak 3 ply veneering with vertical grains or cross bands and face veneers on both faces of shutters. Stainless Steel butt hinges with necessary screws shall be used for fixing. Lipping with 2nd class teak wood battens of 25 mm minimum depth on all edges of flush door shutters shall be provided. Rebate shall be cut (in frames/shutters) as specified and instructed by Engineer-in-charge. Vision panel of required and specified shape e.g., rectangular, square, circular etc. shall be provided.
- 8.5 Laminates- Flush doors shall be provided with 1.5 mm thick Decorative high pressure laminated sheet (on both side) of plain / wood grain in gloss / matt/ suede finish with high density protective surface layer and reverse side of adhesive bonding quality conforming to IS: 2046 Type S, including adhesive of approved quality. The laminates shall be resistant to fungal attack at the end of 28 days of incubation when tested as per ASTM: G 21 - 2015 test method.
- 8.6 Melamine Polish (Pidilite, Asian, Dulux make) shall be done (in 3 or more coats to achieve superior finish) on all teak wood & decorative veneered surfaces.
- 8.7 Doors frames (Aluminium Door frames): All the door frames (non-fire rated) shall be made Aluminium of suitable section, (with Anodic coating in required shade and colour of not less than 25 microns), All provision should be mortised, drilled, and tapped for receiving appropriate hardware. The frames shall have inbuilt grooved sealing system and site fitted with PVC seal as standard. Frames should be provided with back plate for anchor fasteners for installation on a finished plastered wall opening.
- 8.8 Glazed Doors: All the glazed doors (non-fire rated) shall be made in Aluminium door frames, shutters of suitable section, (with Anodic coating in required shade and colour of not less than 25 microns), Clear float glass with necessary fittings and fixtures of stainless steel (SS 304) required to make the door operational and function smoothly, complete as per directions of Engineer-in-charge (necessary shop drawings should be prepared by the contractor and work shall be executed after obtaining approval from Engineer-in-charge). The thickness of glazing should not be less than 5 mm.
- 8.9 All fittings and fixtures shall be as per hardware schedule for doors / windows (mentioned in tender document) and got approved from the Engineer-in-Charge before procurement well in advance and the approved samples shall be kept at site till completion of the work.

8.10 **HARDWARE FOR DOORS /WINDOWS:**

- a) BUTT HINGES: 5 Knuckle, 2 bearing butt hinges size 4" x 3" x 3mm, in SS 304 and in satin stainless steel as per EN 1935, CE Marked suitable for door weights up to 120kgs (DORMA 3090F, HORMANN, GEZE OR HAFELE)
- b) VISION PANEL: Unless otherwise specified, toughened glass of 6 mm thickness.
- c) DOOR LOCK: Mortice cylindrical lock - Mortice sash lock (Euro profile) Non-handed & field reversible latch 5 pin Euro profile cylinder 60 mm Finish (of make DORMA Cylindrical lock CK701 KS SSS Entrance Function or equivalent make.
- d) D TYPE PULL HANDLED type 300mm long CTC, 22mm Dia Pair of pull handle in SS 304 B/B fixing of make- Dorma TGD1300x 22S, Hormann PD12, Geze 98163036. or approved equivalent.
- e) Tower Bolt: Stainless steel (Grade 304) tower bolts size 250 x10 mm (Hafele, Dorma, Geze or approved equivalent) with necessary SS screws etc complete.

9.0 **ALUMINIUM WORK:**

- (a) Before taking up any procurement/construction activity, shop drawings (for fixing of all kind of Aluminium Works, showing all hardware) shall be prepared and submitted for obtaining approval from Engineer-in-Charge.
- (b) Minimum weight of aluminium section for door, windows and ventilators shall be as per relevant standards.
- (c) Kiln seasoned hard wood shall be filled inside door frames on hinged side and top of frames wherever hydraulic door closers are to be provided.
- (d) Frames shall be fixed with dash fastener of minimum size 10 x 100 mm as per approved shop drawings.
- (e) Gap between aluminium frame / uPVC window and adjacent RCC / masonry work shall be filled by providing weather silicon sealant over backer rod of approved quality as per direction of Engineer-in-Charge.
- (f) The material for the work shall be procured from the approved manufacturer as per preferred make list for materials in this contract agreement. The Contractor shall procure and submit samples of various materials to be used in the work for the approval of Engineer-in-Charge and no work shall commence before such samples are approved. Samples of un-anodized as well as polyester powder coated aluminium sections, microwave cured EPDM gaskets, glass, stainless steel screws, anchor fasteners, hardware and any other material or components requiring approval of samples, in opinion of Engineer-in-Charge, shall be submitted for the approval as mentioned above. The above samples shall be retained as standards of materials and workmanship.

- (g) Aluminium sections to be used for various works shall be appropriate to meet technical, structural, functional and aesthetic considerations. Aluminium work for doors, windows, ventilators and partitions etc. shall be with extruded built up standard tubular sections/ appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/ neoprene gasket etc. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / panelling, C.P. brass / stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. Anodic coating of required colour & shade (with minimum thickness of Anodic coating 25 micron) section shall be used. Hinges/ pivots, provision for fixing of fittings, EPDM rubber / neoprene gasket shall be provided wherever required. The polyester powder coating shall be carried out in a factory / workshop approved by engineer-in-charge.
- (h) Glass in Windows/Ventilators: Glazing in aluminium windows, ventilators and partition etc. shall be with 5 mm thick clear float glass including providing EPDM gasket, etc. as per specifications, drawings and direction of Engineer-in-charge complete.
- (i) Hydraulic floor spring: It shall be double action hydraulic floor spring (Approved make- DormaTS80, Geze TS550NV, Hormann) conforming to IS : 6315, having brand logo embossed on the body/ plate with double spring mechanism and door weight up to 125 kg, for doors, cover plates with brass pivot and single piece M.S. sheet outer box with slide plate etc.
- (j) Mortice Latch & lock: It shall be of Brass 100 mm mortice latch and lock with 6 levers without pair of handles (best make of approved quality) for aluminium doors.
- (k) Fabrication: The factory for fabrication and coating of aluminium windows/doors/frameworks shall be got approved from Engineer-in-charge. The fabrication unit should have experience of having done similar work of similar cost in 7 years prior to date of submission of proposal by contractor.
- (l) All joints shall be accurately fabricated and be hairline in appearance. The finished surface shall be free from visible defects. All the aluminium windows/ventilators/doors shall be factory made and shall be brought to site for assembly and fixing.
- (m) All hardware used shall conform to the relevant specifications mentioned in door window hardware schedule and as per samples approved by the Engineer-in-Charge. Design, quality, type, number and fixing of hardware shall be generally in accordance with shop drawings and as approved by the Engineer-in-Charge before use.
- (n) All doors, windows, ventilators and glazing etc. shall be made watertight with microwave cured EPDM gaskets and weather silicone sealants to the satisfaction of the Engineer-in-Charge.

(o) FIXING OF ALUMINIUM FRAMEWORK

- i. The screws used for fixing fixed aluminium frames of the aluminium windows to masonry walls / RCC members and aluminium members to other aluminium members shall be of stainless steel of approved make and quality and of stainless-steel grade 304. Threads of machine screws used shall conform to requirement of I.S. 4218.
- ii. For the aluminium windows, the gap between the aluminium frames and the R.C.C / Masonry and also any gaps in the various sections shall be filled with weather silicone sealant DC 795 of Dow Corning or equivalent in the required bite size, to ensure water tightness including providing and fixing backer rod, wherever required. The weather silicone sealant shall be of such approved colour and composition that it would not stain or streak the masonry / R.C.C. work. It should not sag or flow and shall not set hard or dry out under any conditions of weather and shall be tooled properly. The weather silicone sealant shall be used as per the manufacturer's specifications and shall be of approved colour and shade. Any excess sealant shall be removed / cleared.
- iii. Fixing of glass panes shall be designed in such a way that replacing damaged / broken glass panes is easily possible without having to remove or damage any members or interior finishing materials.

(p) PROTECTIONS AND CLEANING

- a) All glass panes shall be retained within aluminium framing by use of exterior grade microwave cured EPDM gaskets. Use of glazing or caulking compounds around the perimeter of glass will not be permitted. There shall be no whistling or rattling. Before installation of glass, Contractor shall ensure the following:

- All glazing rebates shall be square, to plumb, true to plane, dry and free from dust.
- Glass edge shall be clean and cut to exact size and grounded

- b) Glass of specified thickness in doors, windows, ventilators and fixed glazing etc. shall be of approved make and standard quality conforming to C.P.W.D. Specifications

(q) GUARANTEE FOR ALUMINUM WORK

- i. The contractor shall guarantee about proper design and performance of aluminium work for a period of 10 years from the date of completion of work.
- ii. The design and installation shall be to the best international standards and shall specially take account of wind and seismic loads, storms, thermal stresses, building movements and the like.
- iii. The 10-year guarantee shall be furnished in non-judicial stamp paper of value Rs.100/- or more, in prescribed Performa for performance of glazed units, anodizing, EPDM/silicon gaskets and sealants. The guarantees shall be submitted

before final payment and shall not in any way limit any other rights to correct which the Engineer-in-charge may have under the Contract.

10.0 FLOORING, MARBLE, CLADDING WORK:

All flooring work and cladding work in Granite, Tile, Marble, Stones, Wooden, PVC, Vinyl etc. in general shall be carried out as per CPWD Specifications 2019, Volume-I & II with revisions/ amendments / correction slips up to last date of bid submission (including extensions if any). The tiles / stones shall be as specified in the schedule of finishes and architectural drawings provided with tender document. The tiles / stones shall be of approved colours and shades and will be laid in pattern as per approved architectural drawings or shop drawings. Nothing extra shall be paid for laying tiles / different stones in specific design/pattern. The tiles shall be of first quality of approved make and nothing extra shall be paid for use of cut/sawn tiles in the work. Schedule of finishes mentioned in tender documents shall be followed in case of deviation/different detailing is shown in Architectural Drawings. Before taking up any procurement/construction activity, shop drawings shall be prepared and submitted for obtaining approval from Engineer-in-Charge.

- 10.1 Proper gradient shall be given to flooring for toilets, verandah, kitchen, courtyard, corridors 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.
- 10.2 Samples of flooring material are to be deposited well in advance to the Engineer-in-Charge for approval. Approved samples should be kept at site with the Engineer-in-Charge and the same shall not be removed except with the written permission of Engineer-in-Charge.

The samples shall be submitted along with the following details:

 - a) Three representative samples for each type of flooring/cladding specified.
 - b) Details of physical characteristics such as dimensional tolerances (within the specified limits), water absorption, compressive strength, Mohs Hardness, Specific gravity with reference to IS or International standards.
 - c) Source of supply and confirmation of availability in full quantity and uniformity of colour, tone and textures.
 - d) Company profile of Suppliers.
- 10.3 The Engineer-in-Charge or his representative may, if required, visit the source of supply of the various materials (Granite/Stones/Marble/Tiles/Cladding etc.) to assess the quality as well as availability of the material in the required quantities.
- 10.4 The entire supply for each type of granite/stone slabs shall be procured from one location (in one quarry), and supplied preferably, in one lot to keep variations to the minimum. The Contractor shall also segregate and sort the slabs according to colour, shade, texture and size of grains etc. to keep variation(s) in stones used

- at any one floor to the minimum. Any slab with variation in the colour, shade, texture and size of grains etc., not acceptable to the Engineer-in-Charge, shall not be used in the work and shall be removed and replaced by the Contractor. Nothing extra shall be payable on these accounts. Also, no claim of any kind shall be entertained from the Contractor on this account.
- 10.5 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 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. 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.
- 10.6 The (Granite/Stones/Marble/Tiles/Cladding etc.) shall be transported to site well packed in Boxes or otherwise. These shall be handled carefully to prevent any damage. Granite stone slabs shall be individually packed in cardboard paper. The various types of stones and tiles procured shall be free of any surface defect or any edge damage. The damaged (Stones/Marble/Tiles/Cladding etc.) 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. The stone slabs shall not be waxed or touched up with dyes / colours
- 10.7 The following tolerances shall be allowed in the dimension of granite stone slab:
- a) Length $\pm$ 1mm
 - b) Width $\pm$ 1mm
 - c) Thickness - 1mm
 - d) Angularity at corners $\pm$ 0.25%
- The stone (slab and tiles) not meeting the above tolerance limits shall be rejected and not permitted to be used in the work. Nothing extra shall be payable on this account.
- 10.8 Stones slabs shall have uniform thicknesses within the tolerance limits and linear items like treads, sills and jambs, coping, risers, urinal partitions, kitchen / wash basin platforms, vanity counters, facias and other similar locations etc. shall have edge polished calibrated thickness i.e. exposed edges shall have edge polished uniform thickness throughout the length of the work.
- 10.9 The flooring work shall be carried out as per the architectural drawings in design and pattern (geometric, abstract etc.) and in linear and / or curvilinear portions and in combination with stones of different colour and shade and ceramic tiles etc. For the flooring portions curved in plan, the stone slabs (at the edge) shall be cut to the required profile and shape as per the architectural drawings. Nothing extra shall be payable on this account and any consequent wastages and incidental charges on such accounts shall be deemed to be included in the cost.

- 10.10 The granite slabs used for providing and fixing in the sills, soffits and jambs of doors, windows, ventilators and similar locations shall be in single piece unless otherwise directed by the Engineer- in-Charge. Wherever stone slab other than in single piece is allowed to be fixed, the joints shall be provided as per the architectural drawings and as per the directions of the Engineer-in-Charge. In the cabin areas, the joints in sills shall preferably be provided in line with the partition wall. Depending on the number of joints, as far as possible, the stone slabs shall be procured and fixed in slabs of equal lengths as per the architectural drawings and as directed by Engineer-in-Charge.
- 10.11 The specifications for dressing, laying, curing, finishing etc. for the granite stone flooring shall be same as that of works for the Marble flooring, skirting and risers of steps under Flooring Sub Head of the CPWD Specifications. The wall lining / veneer work with granite stone shall be as per the CPWD Specifications for Marble work Sub Head.
- 10.12 All the tiles (flooring/wall lining/Skirting/dado) shall be fixed with quick set tile adhesive (of make Pidilite, Ardex, Endura, Weber) of minimum thickness of 6 mm. Also joints of flooring tiles having 3mm width shall be grouted using epoxy grout (of Pidilite, Ardex, Endura, Weber) mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardener and 0.20 kg of resin per kg).
- 10.13 Wet stone/granite wall cladding (in interior) shall be fixed in average 20 mm thick cement mortar in 1:3 (1 cement: 3 coarse sand), with copper pins 7.5 cm long, 6 mm diameter for securing adjacent stones in stone wall lining.
- 10.14 Unless specified otherwise, all stone/granite/marble in flooring shall be laid on 20 mm (average) thick base of cement mortar 1:4 (1 cement : 4 coarse sand) and jointed with cement slurry and pointing with white cement slurry admixed with pigment of matching shade.
- 10.15 Unless otherwise specified, all stone/granite/marble in skirting/wall lining/dado shall be fixed on 20 mm (average) thick base of cement mortar 1:3 (1 cement : 3 coarse sand) and jointed with cement slurry and pointing with white cement slurry admixed with pigment of matching shade.
- 10.16 For flooring work, the joints between the different types of flooring shall be located as per the architectural drawings. Also, the Contractor shall maintain the uniform level of the finished flooring of the different types unless specifically mentioned on the architectural drawings.
- 10.17 All the tiled/ granite 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.
- 10.18 One piece Granite / Kota stone for treads / risers in staircase shall be used including rounding of nose.
- 10.19 POP protection layer shall be laid on all finished floors for protection from damage during execution of other items of work in that area which shall be removed and cleaned just before handing over of the premises.

- 10.20 For the skirting in the enclosures with curvilinear profiles, the (Stones/Marble/Tiles/Cladding etc.) 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 masonry works required for such fixing is deemed to be included in the cost of masonry.
- 10.21 Granite stone tiles and slabs shall be pre polished (mirror polished), eggshell polished, flame finished or given any other surface treatment as specified in finishing schedule or architectural drawings and as directed by the Engineer-in-Charge.
- 10.22 Machine polishing and cutting to required size shall be done with water (as lubricant) only. Sawing shall also be done preferably with water as lubricant but as a special case, the Engineer-in-Charge may permit, at his discretion, oil or kerosene as lubricant subject to all kerosene or oil in the body and surface of tiles / slabs being thoroughly dried in ovens. Tiles / slabs with stains or patches due to the use of oil or otherwise, either before or after installation, shall be rejected and shall be replaced by the Contractor at his own cost.
- 10.23 The exposed cut edges of the Kota Stone slab in risers and treads along its width (sides of the risers and treads of the steps i.e. along the shorter dimensions of the Kota stone slab for the risers and treads) shall be polished in a workman like manner. The top exposed edge of the Kota stone skirting shall also be polished in a workman like manner.
- 10.24 Nosing / edge moulding shall be provided to the front edge of the Kota stone slab treads along its length i.e. along the longer dimensions of the Kota stone slab, as per the architectural drawings.
- 10.25 Tactile tile such as directional warning or hazardous (for vision impaired persons as per standards) shall be of size 300x300x15 mm {10 mm base + (5mm $\pm$ 0.5mm) thick raised portion} having water absorption less than 0.5% and conforming to IS: 15622 of approved make in all colours (preferably yellow) and shades for indoor floors, should be laid on 20mm thick base of cement mortar 1:4 (1cement : 4 coarse sand) in all shapes & patterns including grouting the joints with white cement mixed with matching pigments etc. as per harmonized guidelines and space standards for barrier free built environments for persons with disability and elderly persons issued by Ministry of Urban Development, Govt. of India.
- 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.
- 11.0 **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 ready made 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

12.0 ROOFING WORK:

All roofing work in general shall be carried out as per CPWD Specifications 2019, Volume-I & II with revisions/ amendments / correction slips up to last date of bid submission (including extensions if any). Schedule of finishes mentioned in tender documents shall be followed in case of deviation / different detailing is shown in Drawings. Before taking up any procurement / construction activity, shop drawings shall be prepared and submitted for obtaining approval from Engineer-in- Charge.

- 12.1 Khurras shall be of 45x45 cm with average minimum thickness of 5 cm cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) over P.V.C. sheet 1mx1mx400micron, finished with 12mm cement plaster 1:3 (1 cement : 3 coarse sand) and a coat of neat cement, rounding the edges.
- 12.2 At inlet mouth of rain water pipe, cast iron grating 15 cm diameter and weighing not less than 440 grams shall be provided.
- 12.3 Rainwater Pipes - All the RWP pipes shall be PVC Pipes (including with required fittings and clamps) exposed on walls / in the shafts to be executed as per CPWD specification 2009.

13.0 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.

- 13.1 All External face shall be finished with 18 mm thick cement plaster in two coats under layer 12 mm thick cement plaster 1:5 (1 cement : 5 coarse sand) and a top layer 6 mm thick cement plaster 1:3 (1 cement : 3 coarse sand) finished with rough sponge.
- 13.2 All Internal brick wall, AAC wall & slab/beam & column shall be finished with 12mm thick 1:4 (1 cement : 4 Coarse Sand).
- 13.3 All junctions of concrete and masonry work and other locations shall be provided with approved galvanized chicken wire mesh (24-gauge 12 mm sizes) fixing in position with galvanized wire nails as per specifications or providing grooves of required size at the junctions, all complete as per directed by Engineer-in-charge.
- 13.4 Necessary drip course shall be provided in Chajja, Balcony, Projecting Roof, Beams etc.
- 13.5 Application of paints shall be done with mechanical equipment. Mechanical sanding machine (for scrubbing & preparation of surface) shall be used by the contractor.

- 13.6 In case of painting over old work / new work, the contractor shall give proper notice to the Engineer-in-charge after the surface is prepared & before applying of primer coat / paint. The Engineer-in-charge shall either approve the surface thus prepared or ask the contractor to rectify the defects pointed. Only after approval by Engineer-in-charge, the priming / painting coat shall be applied.
- 13.7 Anti-Bacterial Paint: Low VOC, highly washable, water based, abrasion resistant (over 4000 cycles) sanitizing and anti-bacterial coating Ultra satin (D-11205) shall be applied as per finishing schedule to all kind of surface and enhancing protection against bacteria for Hygienic environment and conforming to JIS Z 2801:2100 test Protocols for Anti-Bacterial Coatings test. The material should be reactive curing acrylic resin water-based coating. One coat of water based acrylic primer shall be applied before application of two coats of water based anti-bacterial coating. (Approved make: OIKOS/Liquide Plastic/Construction Speciality).
- 13.8 All the steel work shall be applied two or more coats of synthetic enamel paint over a coat of suitable primer of approved brand and manufacture with ready mixed red oxide zinc chromatic on steel / iron works having VOC content less than 250 grams/litre.
- 13.9 Water repellent coat: 2 to 3 coats of Silicone based water repellent, anti-algal paint of approved shade, complete as per manufacturer's specifications, shall be applied on stone cladding.
- 13.10 **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.
- 13.11 **Internal Painting**
All internal RCC surfaces shall be painted as per schedule of finishes, with Ist quality acrylic distemper 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.
- 13.11.1 **Base Preparation:** Base Preparation by grinding/rubbing/sand papering to remove mortar dropping and other foreign materials from the RCC surface.
- 13.11.2 Applying one or more coat cement primer of approval brand and manufacturer over cleaned base of concrete surface.
- 13.11.3 Applying white cement based putty of average 1.0 mm thick to make the surface smooth and plain.
- 13.11.4 Applying Ist quality acrylic distemper paint of interior grade having VOC content less than 50 gram/litre of required shade & colour in two or more coats on new work over white cement based putty.
All service shaft shall be finished with two or more cement paint over water thinnable cement primer as per specifications.

13.12 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.

14.0 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.

15.0 STAINLESS STEEL WORK:

Unless otherwise specified, stainless steel generally shall be of Grade (SS 304) or 1.4401 (SS316).Stainless Steel (SS) grade 316 shall be used for exposed / exterior work whereas grade SS 304 shall be used for interior works. Lower grades shall not be used. Before taking up any procurement/construction activity, shop drawings shall be prepared and submitted for obtaining approval from Engineer-in-Charge.

Stainless steel railing shall be provided with SS 304 grade stainless steel of 50 mm dia. of 18 gauge handrail with adequate rods parallel to handrail, balusters, flanges, end caps, newel posts with caps etc. complete as per approved drawings and direction of Engineer-in-charge.

Surface finish of all the stainless-steel materials will be in 240 grit satin finish / matt finish. All stainless-steel material will have to be coated by a solution of Inox to avoid finger in prints and avoidance of settlement of environment / atmospheric dust. Stainless steel railing, both sides in staircase and external ramp with double handrail shall be used for barrier free accessibility requirements with adequate SS balusters, runners etc as per approved architectural drawing. Fixing shall be done by stainless steel expansion bolts of approved size and make as per Engineer-in- Charge and welding to be done by using organ welding rods and the surface being duly finished and cleaned by K2 passivation, which is nitric acid plus florid acid solution treatment by which the chances of corrosion will be eliminated, and any burn out makes on the metal will also be eliminated.

16.0 MS STRUCTURAL STEEL WORK:-

- 16.1 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.
- 16.2 The work includes labour, fabrication, delivery, assembly, erection, lifting, painting, finishing, supervision and Non-destructive testing of welded steel work etc. complete.
- 16.3 All other incidental works not specified herein mentioned but necessary for the satisfactory completion of the works, shall be deemed to be included.
- 16.4 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.
- 16.5 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.
- 16.6 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.
 - 16.6.1 Doors, Windows ventilators fitting and fixtures
 - 16.6.2 Doors, Frames and shutters:
Door frame and shutters shall be provided as per GFC drawings.
 - 16.6.3 All Window and ventilators shall be provided as per GFC drawings.
 - 16.6.4 Provision of wire mess shutters made of SS Tabular frames with Stainless steel 304 grade mosquito proof wire mesh as per GFC Drawings and schedule of Finishes.

17.0 FIRE CHECK/RATED DOOR:

CPWD Specification 2019 Vol. I & II with revisions/ amendments / correction slips up to last date of bid submission (including extensions, if any), National

- Building Code (NBC) 2016 and manufacturer's specification will be followed. Fire Check doors shall be provided in buildings wherever necessary and required as per National Building Code 2016, as per door & window schedule and as per architectural drawing provided with tender document. Unless otherwise specified elsewhere in tender document, all fire doors should be fire rated for 120 minute and doors of fire exit corridor should meet the requirement of fire exit corridor specified in NBC 2016. In general, all the services/electrical rooms/shafts shall be provided with Metal Fire Check/rated doors whereas all the lobbies, entry/exit to corridors shall be provided with the Glazed fire check/rated doors. Rooms opening in fire exit corridors may be provided with wooden fire check/rated doors. In case of any deviation is found between general principle mentioned herein and Fire check doors shown in architectural drawings (or mentioned door & window schedule), the former i.e. general principle (mentioned herein) will be followed. If any door type or tag is not mentioned in drawings or door & window schedule, decision shall be given by Engineer in charge based on principles mentioned herein. Before taking up any procurement/construction activity, shop drawings (for fixing of all kind of doors, showing all hardware) shall be prepared and submitted for obtaining approval from Engineer-in-Charge.
- 17.1 The Fire check/rated Door should not collapse during the rated period of the fire under specified fire conditions. The fire door should not allow the passage of hot gases or the flames through the rebate or the gap between the door frame and shutter. The integrity or smoke sealing function is achieved by Fire Door by incorporating an "Intumescent Seal". This Intumescent Seal in the form of a strip, which under fire conditions expands many times its original size and forms a hard char which has high insulation properties and does not permit the smoke or flames to escape through the gap between the shutter and frame.
- 17.2 Observation, if any, made by the fire officer on the fire check/rated doors, shall be incorporated suitably. Nothing extra shall be paid on this account.
- 17.3 Execution of Fire Check Doors shall be carried out through the Specialized Agencies having sufficient work experience in the same field and shall be got approved from the Engineer-in- Charge well in advance. Specialized firm shall furnish all materials, labour, accessories, equipment, tool and plant and incidentals required for providing and installing the fire check/rated doors. Contractor has to select one specialized agency from list of preferred makes/brands and specialized agencies.
- 17.4 Fire resistance and smoke check doors shall be made of proper sizes and section as per the available opening at the site. The details shown on the drawings indicate generally the sizes of components parts and general standards. These may be varied slightly to suit the standard adopted by the Manufactures. Before proceeding with manufacturing, the contractor shall prepare and submit complete manufacture and installation drawing for approval of the Engineer-in-Charge and no work shall be performed until the approval of these drawings is obtained.

- 17.5 The term "Fire Rating" referred in tender documents means fire rating of complete assembly of fire check door e.g. frames, shutter, Vision Panel, Glass, Hinges and other hardware. Doors will be approved only after door passes the required tests from fire testing lab approved by the Engineer-in- Charge. Cost of sample door and testing shall be borne by contractor.
- 17.6 Doors shall be fabricated to size in factory. Fabricated material shall be protected against any damage during transportation. 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 units/members. Arrangements shall be made for expeditious replacement of damage units or members. Materials found acceptable on inspection shall be repacked in crates and stored safely.
- 17.7 Just prior to installation, the doors shall be uncartered and stacked on edge on level bars and supported evenly. The frame shall be fixed into position true to line and level using adequate number of fastener of approved size and manufacture and in an approved manner. The holes in concrete/masonry member for housing anchor bolts shall be drilled with an electric drilling machine only.
- 17.8 Stainless steel ball bearing hinges, panic bars, door trims, fire rated hydraulic door closers, handles, tower bolts, lock and other fittings shall be as per hardware schedule for doors & windows provided in tender document and shall be got approved from Engineer-in-Charge. All Hardware's should have a minimum 02 Years of manufacturer warrantee from the date of supply. Hardwares should pass European certificate "CE" of conformity / UL certified with required fire ratings and relevant documents to this effect shall be produced at the time of approval of samples.
- 17.9 The design of fire check/rated doors and material to be used in their construction have to be such that the doors shall be capable of providing an effective barrier of desired rating accredits labs as per ISO/IEC 17025 for testing and calibration scopes shall be eligible.
- 17.10 Metal Fire Check/Rated Doors-
- a) Metal Fire door shall be from ISO 9001:2015 certified manufacturer. The door must have been manufactured with galvanised - GI sheet of GPSP Grade as per IS 277. All Fire doors must satisfy the requirement of latest NBC 2016 Part 4 for Fire & Life Safety guidelines. The Prototype sample of the door must carry a prior test evidence as per IS 3614 part-2 / BS 476 Part 20 & 22. The manufacturer must submit the copy of test evidence prior to start of production. The offered test certificate should either carries it's Validity or certificate must not be older than 5 years from CBRI / NABL Accredited Lab. All doors should be finished with Powder coating (minimum 60 micron) in desired regular RAL Shades.
- b) Door frame shall be Single rebate profile of section 125 x 55 mm made out of minimum 1.20mm thick galvanised steel sheet with a factory pre-punched groove so as to accommodate fire seal size (minimum 10x4mm). Frames should be mitred, butt jointed and field assembled with bolting system for proper strength. Frames shall have in built grooved sealing system and shall be site fitted

with fire rated EPDM gasket as standard. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Frames should be provided with back plate for anchor fasteners for installation on a finished plastered wall opening.

- c) Door leaf should be minimum 46mm thick fully flush double skin door. Door leaf must be manufactured from minimum 1.2 mm (18 gauge) thick galvanised steel sheet. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core. For Double leaf doors astragal has to be provided on meeting stile for both active and inactive leaf. Vision panels wherever required should be provided with specified shape and sizes of glass (bidirectional interlayered glass of required thickness).

17.11 **FIRE RATED HARDWARE FOR FIRE CHECK DOORS:**

All hardware for fire check/rated doors shall also be fire rated and shall have certification from UL/CE.

- a) DOOR CLOSER: Extruded aluminium body Heavy duty Fire Rated Door Closers with full body cover. The Door Closers should be spring adjustable type 2-6, Non-handed with back check, and tested along with the fire doors from CBRI Roorkee as per BS476 Part-22 and IS 3614 Part-2. The door closer shall have 10 years mechanical warranty from the manufacturer and complies with EN 1154-for 50000 cycles + A1: 2002 CE Certified.(DormaTS89,Hormann HDC35,Geze TS5000, Hafele DCL-97).
- b) BUTT HINGES: 5 Knuckle, 2 bearing butt hinges size 4" x 3" x 3mm, in SS 304 and in satin stainless steel as per EN 1935, CE Marked suitable for door weights up to 120kgs (DORMA3090F, HORMANN,GEZE OR HAFELE).
- c) VISION PANEL: Unless otherwise specified, bidirectional interlayered glass of 15 mm thickness shall be used.
- d) GRAVITY COORDINATOR: Door coordinator /sequencer for the double leaf doors of make– Dorma SR390, Hormann, Geze 013525, and Hafele.
- e) PANIC BAR-SINGLE POINT: Panic bar / latch (Single point) suitable for single / active leaf of door of approve make -Hafele-903.10.625, Dorma-PHCR, Geze-8026301 or Hormann XDB5760SV.
- f) PANIC BAR-TWO POINT OR DOUBLE POINT: Panic bar / latch (Two point or Double point) with vertical rod and top and bottom latch suitable for double doors or inactive leaf of door of approve make-Hafele-903.10.625, Dorma-PHCR, Geze-8026302 or HormannXDB5120SV.
- g) EXTERNAL TRIM: External trim on back side of the Panic Latch of approve make-Hafele-901.02.401,Dorma-PHCR-2905,Geze-8026306 or Hormann
- h) ELECTROMAGNETIC HOLD OPEN-Electro Magnetic hold open device for holding the door in open condition EM with armature plate with 24v DC approve make-Dorma EM 500G, Geze, Hafele.
- i) EM LOCK FOR HOLD OPEN DOOR- Holding force of 1200 lbs EM Lock with 1200 ALH and EM1200 2ALH with armature receiving plate, surface mounted 12/24

- vDC including armature plate holder approve make - Dorma, Geze, Hormann and Hafele.
- j) DOOR LOCK: 55mm backset, 20mm square fore-end prepared for euro profile cylinder including strike plate. and EPC 70mm Length both side key operation & Escutcheons in SSS Finish (of make DORMA 288a, Hormann, Geze).
 - k) FLUSH BOLT: DORMA lever action flush bolt with 19mm projecting bolt (LENGTH 172 mm OR 300 MM AS PER DIRECTION OF ENGINEER IN CHARGE) in satin chrome of make-Dorma, Hormann, Geze.
 - l) FLOOR SOCKET: Spring loaded dust excluding floor socket with fixing accessories, in satin Chrome finish of make-Dorma, Hormann, Geze.
 - m) DOOR BOTTOM SEAL : Automatic Door Bottom Seal, Heavy Duty, Face Mounted Version, spring loaded to lift clear of the floor as soon as the door leaf is opened, suitable to be used on Fire and smoke check doors, Seal Material = Silicon, Finish = Anodized Satin Clear, Length =48"IN SATIN CLEAR FINISH (of make-Dorma, Hormann, Geze)
 - n) DELTA SEAL : Delta Seal for acoustic, fire and smoke protection, suitable for wooden and steel frames, self-adhesive, Finish = Black, Length = 1 x 2000mm, Height- 2 x 2750mm IN BLACK FINISH of make-Dorma, Hormann, Geze.
 - o) PA BRACKET: Parallel arm bracket suitable for surface mounted door closer for fixing of door closer in Silver finish of make-Dorma, Hormann, Geze.
 - p) ARMOR PLATE: Armour plate with smoothened edges and rounded corners flush face fixing screws height 1000mm and thickness 1.2 mm in SS 304 grade in satin stainless steel. Length=5mm short of the shutter width (of make DORMA, Hormann, GEZE).
 - q) PUSH PLATE: Push plate with smoothened edges and rounded corners flush face fixing screws size 150 x 400 x 1.2 mm in SS 304 grade in satin stainless steel (of make Hormann, Dorma, Geze).
 - r) SIGN PLATES: Male/Female/Disable sign plate for WC application with fixing screws size 150x150x1.2 mm, rounded corners in SS 304 satin stainless steel finish with marking in black (of make Hormann, Dorma, Geze).
 - s) MOP PLATE: Mop plate with smoothened edges and rounded corners flush face fixing screws height 150mm and thickness 0.9mm in SS 304 grade in satin stainless steel. Length=5mm short of the shutter width. Max door width =1200mm (of make DORMA, Hormann, GEZE).
 - t) KICK PLATE: Kick plate with smoothened edges and rounded corners flush face fixing screws height 300mm and thickness 1.2 mm in SS 304 grade in satin stainless steel. Length=5mm short of the shutter width (of make DORMA, Hormann, GEZE).

u) PULL HANDLE:

- i. D type 300mm long CTC, 22mm Dia Pair of pull handle in SS 304 B/B fixing of make – Dorma TGD1300, Hormann PD12, Geze 98163036.

- ii. Offset type D handle of 450mm long CTC, 25mm Dia pair of handle in SS 304 B/B fixing of make- Dorma TGDI, Hormann, Geze 98163179.
- iii. FLUSH PULL HANDLE: Stainless steel Flush Pull handle with fixing of screw at flush with surface of doors approve make-Dorma, Hormann, Geze.
- iv. Pull Handle: 25mm dia, 300 mm long in cranked / square shape stainless steel (Grade 304) satin finish pull handle (Hafele 903.05.700, Dorma 9125409, Geze 8133006 or equivalent make) with necessary screws etc.
- v) Door Stoppers: Stainless Steel (grade 304) wall mounted or hanging floor door stoppers (Hormann, Dorma, Geze) in stainless steel satin finish with necessary SS screws etc.
- w) Sliding Door Bolt: 250x16mm Stainless steel (Grade 304) satin finish sliding door bolts of superior quality with necessary SS screws etc.
- x) Mortice Latch: Brushed finished 100mm mortice latch in stainless steel satin/polished finish with euro deadlock (Coin release) (Hafele-903.92.586, Dorma-XLH5071, Geze-8012101) with rose rings and pair of stainless steel (grade 304) lever handles with necessary SS screws etc.
- y) Tower Bolt: Stainless steel (Grade 304) tower bolts (Hafele 903.05.700, Dorma 9125409, Geze 8133006) with necessary SS screws etc complete.

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.

18.0 WINDOWS & VENTILATORS:

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

- 18.1 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.
- 18.2 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.
- 18.3 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.
- 18.4 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.
- 18.5 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.
- 18.6 Installation:
- 18.6.1 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.
- 18.6.2 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.
- 18.6.3 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.
- 18.6.4 The fasteners distance shall be 150-200 mm from the edge of the frame and at maximum interval of 600 mm.
- 18.6.5 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.
- 18.6.6 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.
- 18.6.7 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.
- 18.6.8 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.
- 18.6.9 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	Tensile Breaking Stress for welded corner		

	a) For the tensile bending test	EN -514	Shall not be <25 N/mm ²
	b) For the compression bending test		Shall not be <35 N/mm ²
6	Heat Reversion Test	EN -479	Shall not be >2.0%
7	Surface Spread of flame	BS:476- Part 7	Classification 1

18.6.10 **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.

18.6.11 **Reinforcement**

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.

Mild steel section reinforcement made from roll forming process and shall be not dip zinc galvanized in accordance with IS 277 with a minimum coating mass of 120 gm/sqm.

The reinforcement of uPVC window/door shall cater the strength and serviceability requirements.

Shape and thickness of the reinforcement should be as per uPVC profile manufacturer recommendation and fixed to ensure adequate fastener retention.

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.

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

18.6.12 **Glazing / Wiremesh**

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.

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.

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.

The plastic spacer shall be used to provide support to the glass in sash/frame

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.

- 18.6.13 Glazing gasket & Weather pile strip/Wool pile 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.

Weather pile strip/ Wool pile shall be used in uPVC sliding door and window to reduce air filtration and water penetration.

- 18.6.14 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

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.

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.

18.6.15 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.

18.6.16 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	of height upto 1.2 m	of height upto 1.8 doors of height upto 2.5m	f height above 1.8 m doors of height above 2.5m
thickness (mainprofiles)	Minimum 1.7 m	Minimum 1.7 mm	Minimum 2.1 mm	Minimum 2.5 mm
2 Track Frame	X	& above)x (40& above)	& above)x (40& above)	& above)x (40& above)
2.5 Track Frame	X	& above)x (40& above)	& above)x (40& above)	
3 Track Frame	X	& above)x (40& above)	& above)x (40& above)	& above)x (45& above)
Sliding window sash	X	& above)x (50& above)	& above)x (55& above)	& above)x (55& above)
Sliding door sash	X		& above)x (74& above)	& above)x (85& above)
Sliding Fly screen window sash	X	& above)x (40& above)	& above)x (50& above)	
Interlock/Inline Sash Adaptor	X	er system supplier	er system supplier	er system supplier
Glazing Bead for sliding	X	er system supplier	er system supplier	er system supplier

X- Not recommended / suggested.

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.

In a window / door no two profiles from different series shall be combined.

For combination of windows and doors individual item specification shall be followed. Different windows shall be combined using suitable coupling profile.

18.6.17	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.
18.6.18	Joining Methodology for two different units: couplers shall be used to combine two different frame, vertically or horizontally.
18.6.19	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.

19.0 GLAZING WORK

Glazing in doors, windows, ventilators shutters etc shall be with 5 mm thick with EPDM rubber gasket, silicon structural sealant and weather proofing sealant complete as per the direction of Engineer-in-Charge and GFC drawings.

19.1 Installation:-

The glass shall be cut exact size 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.

19.2 **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.

20.0 WATER PROOFING WORKS

General

20.1 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.

20.2 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.

20.3 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.

20.4 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.

20.5 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.

20.6 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.

20.7 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.

For waterproofing of works below plinth level, complete envelope/box shall be ensured with Pre- applied HDPE waterproofing membrane and Post-applied Self-Adhesive Modified Bituminous Waterproofing membrane.

20.8 Basically in all the buildings all the RCC works below plinth level (foundations, columns, slabs, shear walls, retaining walls, beams, lift well etc.), RCC work in Terrace slab (Columns above it, if any), retaining walls (with or

- without weep holes), reservoir, U.G. Tanks, water retaining/carrying structures, sewage & water treatment plant etc.) shall be given waterproofing treatment by adding the cementitious integral crystalline admixture of make KRYTONE, PENETRON, XYPEX or equivalent @0.80% (minimum) to the weight of cement content per cubic meter of concrete) or higher as recommended by the manufacturer's specification in reinforced cement concrete at site of work. The material shall meet the requirements as specified in ACI-212-3R-2010 i.e., by reducing permeability of concrete by more than 90%, compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure. The crystalline admixture shall be capable of self-healing of cracks up to a width of 0.50mm. The intension is to use integral cementitious crystalline admixture to all RCC works requiring the water proofing treatment. The product performance shall carry guarantee for 10 years against any leakage.
- 20.9 Pre-applied waterproofing membrane of 1.2 mm thick flexible sheets of make Pidilite, Grace, BAS For equivalent, consisting of HDPE carrier sheet coated with a pressure-sensitive adhesive and trafficable, weather and dirt resistant non-absorbent coating shall be used for waterproofing treatment below horizontal surface of foundations or underground structures exposed to soil (e.g. grade slab, raft, footing, lift pit base, UG tank, etc.). Sheet shall be durable and robust, manufactured using only virgin HDPE. The membrane shall form a continuous and permanent adhesive bond to poured concrete to prevent lateral water migration at the interface of the membrane and structural concrete. Continuity between adjacent sheets shall be assured using only adhesive to adhesive sealing, using either manufactured ZipLap™ at side laps, or multiple adhesive layer tape at end laps or cut edges. Pre-applied membranes shall be smooth faced to avoid clogging or contamination and easy to clean prior to concreting to ensure intimate bonding to concrete. The membrane shall be capable of UV exposure without additional protection for a maximum of 45 days prior to concrete pouring. Third party test report from NABL accredited approved laboratory along with MTC of product should be submitted. Test report should not be older than 5 years. All detailing components of the system has to be compatible with the proposed waterproofing membrane and has to be manufactured and supplied by the manufacturer of waterproofing membrane. The Membrane shall confirm to following properties (minimum)- i) Pass for Lateral water migration resistance in both directions at 70 m (7 bar) of hydrostatic head pressure as per ASTM D 5385 modified. ii) Peel Strength to Poured-in-Place Concrete after 7 days of water immersion should be >880N/m as per ASTM D 903. iii) Lap peel adhesion of 1408 N/m at 22°C as per ASTM D1876. iv) Peel Strength to Poured-in-Place Concrete of >880N/m – ASTM D 903. v) Elongation of at least 400 % as per ASTM D412. vi) Tensile strength of more than 27.6 Mpa as ASTM D412. vii) Puncture Resistance of more than 890 N as per ASTM E154.

All systems to be installed as per manufacturer's specification and executed by manufacturer's certified applicators (in house team) after successful mock-up at site etc.

- 20.10 Post-applied Self-Adhesive Modified Bituminous Waterproofing membrane of 1.5 mm thickness of make Pidilite, Grace, BASF or equivalent shall be used for waterproofing treatment on vertical sides of foundation system or underground structures exposed to soil (e.g., lift pit walls, retaining walls without weep holes, walls in continuation with the foundations, UG tank etc.). The water proofing treatment shall be as per manufacturer's specification and applications shall be by the manufacturer 's certified applicators. The system shall be a self-adhesive, cold applied flexible water proofing membrane comprising of self-adhesive rubberized asphalt with cross laminated HDPE film with a unique solar reflective film on top surface. The membrane shall have pre-marked overlaps of 50mm and shall be applied on the uniform concrete surface and shall have expanded polystyrene protection including a coat of bitumen solution primer on RCC surface. The membrane have following typical property values: i) Minimum thickness of 1.5 mm with HDPE thickness of minimum 0.2 mm as per ASTM D3767. ii) Hydrostatic Head Resistance of more than 70 m, as per ASTM D5385 test carried out on an overlap crossing a post formed crack. iii) Water Vapour Transmission Rate: 0.06g/m²/day as per ASTM E96. iv)) Elongation of at least 200 % as per ASTM D412. vi) Tensile strength of more than 482 psi as ASTM D412. vii) Puncture Resistance of more than 280 N as per ASTM E154.

- 20.11 Waterproofing cum insulation on terrace slabs shall be with an average 90 mm thick spray applied CFC & HCFC free polyurethane foam of Pidilite, BASF or equivalent, conforming to CPWD GHAR, IGBC, & GRIHA standards. The material shall have a core density of 50-60 kg /m³ (as per ASTM 1622), thermal conductivity of 0.023 W/m.k at 25°C mean temperature (as per ASTM C518/91), U-value of 0.28 W/m²K as per ECBC standards for cold climate type, tensile strength of >400 kPa (as per ASTM D 1623/78), compressive strength >300 kPa (as per ASTM D 1621), closed cell content having apparent VOI of 96-98% (as per ASTM D 2856) and fire resistance property confirming to Class B2 as per DIN 4102. Before applying polyurethane foam, cracks shall be repaired by cutting V groove in 25x25 mm size and filling the same with polymer modified mortar(1:3 Cement Mortar having polymer @10% by weight of cement). Base coat of highly elastomeric two component polyurethane based waterproofing coating (elongation of 600% and tensile strength of 6Mpa) shall be applied at 1.5 kg/Sqm at the corners above the mother slab for a length of 150mm horizontally and 150mm vertically. Top of the polyurethane foam shall be applied with highly elastomeric two component polyurethane based waterproofing coating (elongation of 600%, tensile strength of 6MPa as per ASTM D 412) at 1.5 kg/Sqm. 150 gsm Geotextile (non-woven polyester) over the entire membrane maintaining proper overlaps shall be applied. A filler board of 10mm thickness for construction joints shall be placed vertically to form a rectangular bay not exceed 12sqm. The treatment should be followed by protective layer of average 75 mm

thick concrete screed (grade M-15) including control joints of 3M X 4M size and making angle fillet of 50mmX50mm using concrete at the corners. Exposed filler boards shall be cut by mechanical means and groove shall be filled with Polysulphide Sealant. The width of sealant fill shall not exceed 10mm. All systems shall be installed by authorised applicators (in house team of manufacturer) as per manufacturer's recommendations and includes all lead and lift for all materials and labour.

20.12

Water proofing treatment to vertical and horizontal surfaces in all internal wet areas of building (e.g.Toilets/Kitchens/AHU/balconies etc.) shall consist application of water based, anti-root, low VOC, single component, pure PU Polyurethane elastomer water proofing membrane of make PIDILITE, GRACE, BASF or equivalent with 1.5 mm DFT, having solid % value > 90, tensile strength > 2 mpa, Elongation > 550%, shore 'A' hardness 60 ± 5 with a 150 gsm polyester geotextile membrane. The system includes base preparation of cleaning, brushing and removal of flaky materials, grouting the porous area with cementitious grout, proper covering between slab and wall junctions and priming the surface as per manufacturer's specification. The coating shall be continued to the entire horizontal area and should be terminated at 300mm above the floor finish level complete as per manufacturer's specification. The treated horizontal surface shall be provided 40 mm (minimum) concrete screed (Grade M-15). The Vertical surface shall be provided with 15 mm thick Protective mortar of (1 Cement: 4 Coarse Sand) mixed with integral waterproofing compound of approved make as per manufacturer's specifications. All systems shall be installed by authorised applicators (In house team of manufacturer) as per manufacturer's recommendations and includes all lead and lift for all materials and labour. rading 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.

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 within 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 the 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.

21.0 ROAD WORK:

- 21.1 All roads will be either bitumen or cement concrete roads (as per drawings), executed as per MORTH specifications (fifth edition), 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 laid over sub grade duly prepared with power roller of required thickness as per design. Irrespective of whether shown in drawings or mentioned in tender document, all the drainage, signages (Informative, Mandatory, Regulatory etc.) other works associated with road works shall be provided as per relevant standards and specification MORTH Specifications for Road and bridge work (Fifth Revision). The edges of roads should be at least 20 cm above the adjoining ground level. The work shall be carried out using MORTH Specifications for Road and bridge work (Fifth Revision).
- 21.2 As far as possible cross drainage should be taken under the road and at right angle to it. NP-3 pipes of dia not less than 300 mm and as per design requirement shall be provided at an interval of not more than 60 meter with a longitudinal slope as per design slope. At the head of cross drain catch pits of adequate size to collect stones, soil and rubbish and to prevent scour has to be provided. The floor of the catch pit should be deeper than the sill of pipe culvert by at least 0.3 meter.
- 21.3 Control of seepage flow below road: whenever seepage flow is expected /likely to exist, or seepage zone is at depth less than 0.9 m from sub grade level, longitudinal perforated pipe drain of adequate dia of PVC in trench filled with filtered material and geo textile shall be constructed to intercept the seepage flow. Necessary arrangement to collect the water from perforated pipe drain and diverting by using pipes of PVC/RCC NP-3 of adequate dia shall be made.
- 21.4 Sub grade: It shall be prepared and consolidated with power road roller of 8 to 12 tonne capacity after excavating earth to an average of 22.5 cm depth, dressing to camber and consolidating with road roller including making well the undulations etc. and re-rolling the sub grade and disposal of surplus earth.
- 21.5 Granular Sub-Base: Construction of granular sub-base shall be, by providing close graded Material conforming to specifications, mixing in a mechanical mix plant at OMC, carriage of mixed material by tippers to work site, for all leads & lifts, spreading in uniform layers of specified thickness with motor grader on

- prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per specifications and directions of Engineer-in-Charge. With material conforming to Grade-I (size range 75 mm to 0.075 mm) having CBR Value-30.
- 21.6 Wet Mix Macadam: It shall consist providing, laying, spreading and compacting graded stone aggregate (size range 53 mm to 0.075 mm) to wet mix macadam (WMM) specification including premixing the material with water at OMC in mechanical mix plant, carriage of mixed material by tipper to site, for all leads & lifts, laying in uniform layers with mechanical paver finisher in sub- base / base course on well prepared surface and compacting with vibratory roller of 8 to 10 tonne capacity to achieve the desired density.
- 21.7 Cement Concrete Pavement: Design mix cement concrete of M-30 grade shall be laid as per drawings, in roads/ taxi tracks/ runways, using coarse sand and graded stone aggregate of 40 mm nominal size in appropriate proportions as per approved & specified design criteria, providing dowel bars with sleeve/ tie bars wherever required, laying at site, spreading and compacting mechanically by using needle and surface vibrators, levelling to required slope/ camber, finishing with required texture, including steel form work with sturdy M.S. channel sections, curing, making provision for contraction/ expansion, construction & longitudinal joints (10 mm wide x 50 mm deep) by groove cutting machine, providing and filling joints with approved joint filler and sealants.
- 21.8 Factory made kerb stone: It shall be of M-25 grade cement shall be provided at or near ground level in position to the required line, level and curvature jointed with cement mortar 1:3 (1cement: 3 coarse sand) as per drawings including making joints with or without grooves (thickness of joints except at sharp curve shall not to more than 5mm) including making drainage opening wherever required complete etc.
- 21.9 Tactile tile: Such as directional, warning or hazardous (for vision impaired persons as per standards) of size 300x300x9mm, having water absorption less than 0.5% and conforming to IS: 15622, of approved make in all colours (preferably yellow) and shades for footpath should be laid on 20mm thick base of cement mortar 1:4 (1cement : 4 coarse sand) in all shapes & patterns including grouting the joints with white cement mixed with matching pigments etc.
- 21.10 Coloured, preferably yellow PU - Tactile Studs Warning/Positional) with 1 stem having stem dia of 6.0 mm & stem length between 20 - 25 mm, as ground surface indicators shall be provided for the visually impaired persons, on the pedestrian pathway as per manufacturers design / specification and as per harmonised guidelines.
- 21.11 Coloured, preferably yellow PU - Tactile strips (Guiding) with 3 stems having stem dia of 6.0 mm & stem length between 20 - 25 mm, as ground surface indicators shall be provided for the visually impaired persons on the pedestrian pathway as per manufacturers design / specification and as per harmonised guidelines.

- 21.12 Interlocking Paver Block: It shall be 60mm thick factory-made cement concrete paver block of approved shape and colour of M-30 grade by block making machine with vibratory compaction laid in required pattern and including over 50mm thick compacted bed of coarse sand, filling the joints with fine sand etc.
- 21.13 Gang saw cut 30 mm thick or of thickness specified in drawings, mirror polished pre moulded and pre polished machine cut granite stone of required size and shape of approved shade, colour and texture in footpath, flooring in road side plazas and similar locations as per landscape drawings, shall be laid over 20mm thick base of cement mortar 1:4 (1 cement: 4 coarse sand) including grouting the joints with white cement mixed with matching pigment, epoxy touch ups etc.
- 21.14 Gang saw cut 30 mm thick or of thickness specified in drawings, Flamed granite pre moulded machine cut granite stone of required size and shape of approved shade, colour and texture in footpath, flooring in road side plazas and similar locations as per landscape drawings, shall be laid over 20mm thick base of cement mortar 1:4 (1 cement: 4 coarse sand) including grouting the joints with white cement mixed with matching pigment, epoxy touch ups etc.
- 21.15 RCC Perforated Drain Covers: Factory made precast RCC perforated or non-perforated drain covers having concrete of strength not less than M-25, of required sizes for road side drains/underground utility shaft or duct, shall be provided. These should be properly reinforced to carry the desired load.
- 21.16 Drain Cell shall be of 20mm thickness (Weight Over 2Kg/sqmt) consisting of High strength Polypropylene module having size of 500mm x 250mm and 20mm height with interlocking tabs. The Drain Cell to have compressive strength of over 120 tons/sqmt and weight of more than 2kg/sqmt. Drain Cell to be laid by interlocking individual modules their by covering the entire area. Drain Cell to be covered with Geotextile 150 GSM with 200mm overlap before laying planting soil. Laying to be done as per manufacturer instructions.
- 21.17 CC Grass Pavers block: It shall be made of M-30 grade cement concrete by block making machine with vibratory compaction. Each grass paver should be of 330mm x 330 mm and 80 mm in thickness consisting steel reinforcement of 6 mm MS bar. The Grass Paver to have interlock system to lock each other. The Grass Paver should have compressive strength of minimum 150 tons/sqmt, capable to take the load of the Four wheeler (HMT/LMT). The panel should have high level of porosity greater than 90%, porous for Grass, shrubs and low planters. Laying to be done in required pattern on 50 mm sand bed over well compacted subbase/WBM as per manufacturer specifications.
- 21.18 Road Surface marking: it shall be done with two or more coats to give uniform finish with ready mixed road marking paint conforming to IS: 164, on white/yellow shade, including cleaning the surface of all dirt, scales, oil, grease and foreign material etc.
- 21.19 Retro Reflective Overhead Signage Boards: It shall consist manufacturing, supplying and fixing made up of 2 mm thick aluminium sheet, face to be fully covered with high intensity and encapsulated lens type heat activated retro reflective sheeting conforming to type - III of ASTM- D-4956-01 as approved by

Engineer-in-charge, letters, borders etc. as per IRC : 67-2001 in silver white with blue colour back ground and with high intensity grade, pasted on substrate by pressure sensitive adhesive backing which shall be activated by applying pressure conforming to class II of ASTM-D-4956-01 and fixing the same to the plate of structural frame work by means of suitable sized aluminium alloys, rivets or bolts & nuts @ 300 mm centre to centre all along the periphery as well as in two vertical rows along with theft resistant measures, including the cost of painting with two or more coats of epoxy paint in grey colour on the back side of aluminium sheet including appropriate priming coat. The process includes rounding off the corners, lowering down the structural frame work from the gantry, fixing and erecting the same in position all complete as per drawings, specification.

22.0 SIGNAGES:

Signages inside/outside building shall be as per NBC 2016 guidelines and of approved design and make with LED backlit. Each rooms shall be provided with Name Boards, Numbering of rooms, Signages etc. The contractor shall prepare the detailed shop drawing in compliance to the NBC 2016 guidelines and disable friendly building norms of MoHUA.

- 22.1 Name Boards for buildings shall be of approved design and make (like suitable gauge, 2 feet height SS 304 lettering) with LED backlit.
- 22.2 Signage works include providing and fixing Building Entrance signage / Tactile Layout / Emergency Evacuation Layout on the wall or with any other required structure, with provision of multilingual text integral with 4mm thick blue Acrylic base plate with min 0.5 mm Aluminium sheet at the back with Upper Case San Serif words made of white acrylic non-glare cut out letters of height 15mm, raised above base plate by not less than 0.8mm and the equivalent word/s written in Hindi / any language as required with same specifications with Grade 1 Braille to be integral with the sign face and should be raised 0.5mm above Acrylic base plate. Each signboard to be fixed strictly as per the Harmonised Guidelines & Space Standards for Barrier Free Built Environment for persons with Disability, issued By MOUD, Govt. of India, and as per approved drawings and complete as per the directions of Engineer - In - Charge. Size of the Signboards shall be proportional to the layout plan of the particular building, Min Size of the above signboards shall not be less than 1200mm X 750 mm.
- 22.3 Identification signage (e.g. Room Names / Rooms Number / Toilet facility / Drinking Water / Staircase / Entry / Exit / Lift etc.) of the size 150 mm X 230 mm or 200 X 200 mm).
- 22.4 Floor Directories (Signboard Placed near the Lift / Staircase / Entry to the particular Floor indicating the facilities on that floor which are normally also called as Directional Signages) shall be of minimum size not less than 450 mm X 450 mm.

22.5 Emergency Exit Sign Boards (Generally used Text as "In Case of Emergency, Do Not Use The Lift", "Emergency Exit" etc.)

23.0 MISCELLANEOUS-

23.01 Anti- termite treatment - Providing and injecting chemical emulsion for post construction anti-termite treatment along the external wall up to depth of 300mm as per CPWD specifications.

23.02 Anti-Termite Chemical Treatment: Post Constructional anti-termite treatment shall be with Chloropyriphos/ lindane emulsifiable concentrate 20% with 1% concentration as per CPWD specification.

23.03 Damp Proof Course: Damp proof course shall be with 40 mm thick cement concrete 1:2:4 (1cement:2 coarse sand :4 graded stone aggregate 12.5mm nominal size) mixed with waterproofing compound painted at top with a coat of residual petroleum bitumen of grade VG-10 of approved quality at 1.7 kg/sqm.

23.04 Plinth Protection: Plinth Protection (1000mm wide) shall be with 50mm thick cement concrete 1:3:6 (1cement: 3 coarse sand : 6 graded stone aggregate 20mm nominal size) over 75mm of brick ballast 40 mm nominal size with brick edging.

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.

Sl. No.	Material description	Manufacturer / Brand Name
1.	Ready Mix Concrete	Ultratech Concrete, ACC Ready Mix and RMC India
2.	Cement (PPC/OPC)	ACC, Ultratech, Vikram, Shree Cement, Abuja, JK Cement, Century Cement, Jaypee Cement & Prism Cement.
3.	White Cement	Birla White, J.K. White
4.	Reinforcement Steel	SAIL, Tata Steel Ltd, RINL, Jindal Steel & Power Ltd. and JSW Steel Ltd
5.	Water proofing compounds, admixtures, plasticizer, super plasticizer, curing compounds	Fosroc, ROFF/Dr. Fixit (Pidilite Industries), STP Ltd., Sika, BASF, Ardex Endura & Perma Construction Aids Pvt. Ltd.
6.	Integral water proofing compound with cement (for plaster & mortar)	Fosroc: Conplast 421, Dr. Fixit : LW+, Sika: Sikacim, Asian Paint: SmartCare Vitalia & equivalent product of BASF, STP Ltd., Ardex Endura, Perma Construction Aids Pvt. Ltd.
7.	Water proofing compound for bathroom/ toilet /balcony & other wet area	Fosroc: Bush Bond, STP Ltd.: Shalcrete, CICO: Tapecrete, Dr. Fixit : Pidifine 2K, Sika : Topseal 107, Asian Paints: Damp Block 2K & equivalent
8.	Crystalline water proofing compound	Product of BASF, Ardex Endura, Perma Construction Aids Pvt. Ltd. Fosroc: Bushbond TGP, Dr. Fixit : Dr. Fixit Krystalline, Sika: Sika 101h, Asian Paints: SmartCare & equivalent product of BASF, Ardex Endura, STP Ltd., Perma Construction Aids Pvt.
9.	Grouts, Tile Adhesive	Laticrete, STP Ltd., Kajaria, BASF, Perma, Ardex Endura, JK White & Ferrous Crete.
10.	Structural steel	SAIL, Tata Steel, Rashtriya Ispat Nigam Ltd. (RINL), JSW Steel Ltd., Jindal Steel & Power Ltd.
11.	Polycarbonate sheet	GE Plastic, LEXAN & MG Polyplast
12.	Profile steel sheet	Ezydeck of TATA, Lloyd Superdeck, JSW, Jindal
13.	Particle board	Action TESA, Merino, Archidply & Orion Doors
14.	Laminates	Action TESA, Greenlam, Century Ply, Merino, Archidply, Virgo & Orion doors

15.	Flush door shutters	Duro, Century, Durian, Archidply, Green Ply, JAYNA (Jain Wood Industries), Jain Doors Pvt. Ltd., GREENPANEL & Orion Doors Note: Only ISI marked flush door shutters to be used.
16.	Fire rated doors	Signum fire protection, Shakti Metdoor, NAVAIR, Promat, Thrislington, Sukri & Bhawani. If fire rated glass is integral part of fire rated door than it should be of one of the following makes: Pyroguard, Saint Gobain, Asahi India, Pilkington & Schott
17.	False ceiling system	Armstrong, USG Boral, Saint Gobain, Aerolite, Interarch, Hi- steel of PR Ceiling Products
18.	Plywood / Veneer	Greenply, Century, Merino, Durian, Archidply, GREENPANEL & Orion Doors.
19.	Melamine polish	Asian Paints melamine gold, Wudfin of Pidilite & Timbertone of ICI dulux.
20.	Floor spring & door closer	Godrej, Dormakaba, Dorset & Kich
21.	Aluminum section	Hindalco, Jindal & Indian Aluminium Co.
22.	Anodized aluminum hardware (Heavy Duty)	Kilon, Alualpha, Classic & Ebco.
23.	Clear / Float/Frosted/Toughen Glass/ Refractive glass	Saint Gobain, AIS & Modiguard
24.	Stainless steel railing, Accessories etc.	JINDAL, Dormakaba, Kich, GEZE, Godrej & Hardwyn
25.	SS fittings for doors & window	Jindal, Dormakaba, Kich, Dorset, Godrej, Ozone & Define
26.	Silicon based water re-pellant /weather sealant	GE Plastics, STP Ltd., Dow Corning, Waker, BASF & Pidilite (Dr. Fixit/ Roff
27.	Poly-Sulphide Sealant	Fosroc, STP Ltd., Pidilite (Dr. Fixit/Roff), Sika & BASF
28.	Mosaic tiles/Chequered Tiles	Ultra Tiles, NITCO, Hyper, Mayur & Pavcon,
29.	Glazed Ceramic Tiles	Kajaria, NITCO, Orient Bell, Johnson, Somany, RAK & Varmora
30.	Vitrified Tiles (Antiskid /Matt /Glazed)	Kajaria, NITCO, Orient Bell, Johnson, Somany, RAK, Varmora & Restile
31.	Paver block & Kerbstone	Pavcon, Hyper, Mayur, KK, Power, Sharda & Navya
32.	Cement Based wallputty	Asian Paints, Birla Wall Care, JK, White & Berger
33.	Oil bound washable distemper / dry distemper	Asian Paints (Professional Acrylic Distemper), Nerolac: Beauty Acrylic Distemper, Berger: Bison Acrylic Distemper & Dulux ICI: Maxilite

34.	1st quality acrylic distemper (washable/ ready mix / Low VOC)	Asian Paints (Tractor Aqua Lock Paint), Berger: Commando or equivalent paints of Nerolac & ICI-Dulux
35.	Acrylic emulsion paints	Asian Paints: (Professional Premium Interior, Emulsion Paint), Nerolac: Beauty Gold, Berger: Rangoli Total Care & ICI Dulux: Super Cover, Indigo
36.	Plastic emulsion paint	Asian Paints: (Apolite Heavy Duty Premium Emulsion Paint), Nerolac: Impression, Berger: Easy Clean & ICI Dulux: 3 in 1
37.	Premium acrylic emulsion paints (Interior)	Asian Paints: (Royale Luxury Emulsion), Nerolac: Impression, Berger: Silk & ICI Dulux: Velvet Touch, Indigo
38.	Textured exterior paint	Asian Paints, Nerolac, Berger Paints, Ultratech Paints & Luxure
39.	Acrylic smooth exterior paint	Asian Paints: (Apex/Professional Premium Exterior Emulsion), Nerolac: XL, Berger: Weather Coat & ICI Dulux: Weather Shield, Indigo
40.	Premium acrylic smooth exterior paint with silicone additive	Asian Paints: Apex Ultima, Nerolac: XL total, Berger: Weather Coat all Guard & ICI Dulux : Weather Shield Max
41.	Synthetic Enamel Paint	Asian Paints: Apolite Premium Gloss Enamel, Nerolac: Synthetic Hi gloss, Berger: Luxol Hi gloss & ICI Dulux: Gloss Synthetic enamel.
42.	Cement Primer	Nerolac, Berger (BP white), STP Ltd., Asian (Decoprime WT) & ICI (White primer).
43.	Steel primer (Red Oxide Zinc Chromate Primer)	Asian Paints, Nerolac, Berger & ICI
44.	Wood primer	Asian Paints (wood primer - White/Pink), Burger, ICI & Nerolac
45.	Epoxy paint	Asian Paints, STP Ltd., Nerolac, Berger, ICI, Kansai, & Akzo Nobel
46.	Fire paint	Asian paint, STP Ltd., Akzo Nobel, PROMAT, & JOTUN
47.	GI/MS Pipe	Tata, Jindal (Hisar) & Prakash Surya

48.	GI Fittings	Unik, AVR & Zoloto
49.	HDPE Pipes	Reliance, Jain Pipes, ORIPLAST & Supreme
50.	DI Pipes & fittings	Electrosteel, Jindal, TATA DUCTURA, Kapil Ansh & Kesoram
51.	UPVC pipe and fittings	Astral, Supreme, Prince, M/s Skipper Ltd, Ashirwad & Prayag Polymers Pvt. Ltd
52.	SW Pipes (BIS approved)	Anand, Parry & Perfect
53.	Centrifugally Cast (Spun) Iron Pipes & Fittings /Hub less pipes& fittings	NECO, BIC, Kapilansh, SKF, Raj Pattern Makers & Founders Pvt. Ltd. or any other ISI marked make
54.	CI Manhole covers, frames & GI Gratings	NECO, BIC, SKF & Kapilansh,
55.	SFRC Manhole covers & gratings	K K Jain & Pragati
56.	CP brass fittings (Superior range)	Jaquar, Grohe & Roka.
57.	CP brass fittings (Normal Range)	ESSCO (by Jaquar), Parryware, CERA, Kerovit (Kajaria), Johnson & Prayag Polymers Pvt. Ltd.
58.	Sanitary ware, fittings & accessories	Kerovit (Kajaria), CERA, Jaquar, Parryware, Hindware & Prayag Polymers Pvt. Ltd.
59.	Mirror glass	Atul, Modi Guard & Golden Fish
60.	CPVC Pipe & fitting	Astral, Superme, Prince, M/s Skipper Ltd., Ashirwad & Prayag Polymers Pvt. Ltd.
61.	Stainless steel sink	Neelkanth, Niralli, Jyna & Prayag Polymers Pvt. Ltd.
62.	FRP doors shutters & frame	Jayna, Fiberways, Jain Doors Pvt. Ltd. & Selected Product Co,
63.	Extruded polystyrene insulation board	Dowcorning, Supreme, Texas & Analco
64.	Gypsum plaster	Ferrous Crete, Gyproc Saint Gobain, Ultra Tech & J K White

65.	Floor hardener	Ironite, Perma, STP Ltd., Ferrok & Hardonate
66.	Modular ExpansionJoint	Herculus, Sanfield India Ltd & Vexcolt
67.	Glass Wool	Dow Corning, UP Twiga & Isover
68.	uPVCdoor/window/ventilator	Fenesta, Komerling, Rheau, Veka, Duroplast, Aluplast & Advika Profiles Pvt. Ltd. (Fabric- ation and installation will be done by profile
69.	uPVC doors and win-dow hardware	Manufacturer or his authorized fabricator). Roto, Dorset, DNV Accado & Kinlong
70.	AAC block Adhesive	UltraTech, Perma, Ardex Endura & Ferrous Crete
71.	PVC Water Tank	Syntex & Vectus
72.	AAC Block	MAX Blocks, UltraTech, HIL & BILTECH ACE & Gravit
73.	Modular Kitchen	Everyday/Hettich/Steel Art Brand Baskets of AISI 304(18/8); Hettich/Hafele Brand Auto closing, Concealed Hinges; DMS/ Dynasty/ Indoline brand shutter
74.	Aluminum shuttering	Knest, S-form, Durand Forms (India) Pvt. Ltd. & Mivan
75.	MS Tubular windows & Pressed Steel door frames	Jangid Engineering Works, AGFUV, Sen Harvic, Navair Delhi & Sukriti Delhi
76.	Dash fasteners /Anchors	Hilti, Bosch & Fischer

PHE - (Low side - CP & Sanitary Installations, Water supply and Drainage)

Sanitary Fittings and Fixtures:

All Sanitary installation work 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. All Sanitary Ware & C.P Brass Fittings shall be low flow rate fixtures to confirm the GRIHA-3 Standards. Water closets with cistern shall be provided. Wash basin shall be under Pedestal as shown in drawings. Single lever basin mixer shall be provided with all wash basins. Urinal shall be provided with automatic sensor based flushing system. List of preferred Make & Model no of sanitary fixtures & C.P brass fittings are:

CP & SANITARY OF QUANTITY_SUPER SPECIALITY BLDS					
SR.NO	DESCRIPTION	JAGUAR	ROCA	CERA	AMERICAN STD
1.0	Wash down wall mounting EWC-P	KUS-WHT-35851S300UF	RS342617000	CHANEL Cat. No. S1013210	CL26225-6DACTCB
2.0	Water Closet (Squatting Orissa Type Pan)	ORISSA PAN TYPE		CERA EWCs - S3010105	
3.0	White glazed vitreous Under counter Wash Basin	OPS-WHT-15801	RS325993000	CORNET 550 x 400 x 225 mm Cat. No. S2040103 Wash basin Cat. No. S2090103 Half Pedestal	CL0741PL1- 1MA00
4.0	stainless steel sink C.I. Painted brackets painted, 40mm dia. C.P. waste Coupling,	NIRALI-ORRA BIG		DALLAS Single bowl sink	
5.0	f white vitreous china flat back sensor operated (battery operated) automatic concealed flush valve urinal	URS-WHT-13255	RS35945H000	CORE Cat. No. S4025101	CCAS6591-3100410C0 (BACK INLET)

6.0	Drinking water cooler	Blue Star Stainless Steel PC480 80 L Water Cooler(Metallic)	Voltas - Silver Stainless Steel Water Cooler Voltas 40/80, Storage Capacity: 80 L		
7.0	9 Litre capacity Inline wall mounted RO water unit for drinking water	Blue Star IM3WSAM01 9 L RO Water Purifier (Black)	KENT Grand Star RO Water Purifier (11070)	Pureit Classic 9 Litres Water Purifier	
8.0	Handicaped wall mounting EWC-P	DIS-WHT-93201	RS342617 000	CAMPBELL Cat. No. S1021109	CL26225- 6DACTCB
	SANITARY VALVES & ACESSORIES				
9.0	Sink mixer	OPP-15173BPM	RT5A7A90 CA1	F9030453	CCAS0320-1010410F0
10.0	pillar cock (Quarter turn type)	OPP-15001PM	RT5A7A90 CA1	F1014101	FFAST601-101500BF0
11.0	wall mixer 2 in 1 system Single Lever thermostatic Diverter with spout with telephone shower	OPP-15125PM	RT5A2I90 C00	Exposed part F1014474 Concealed Part F4065101	FFAS0411-709500BF0
12.0	SHWER HEAD	OHS-1719	RT18700A 1	F7010212AB	FFASS057-000500BC0
13.0	HAND SHOWER	HSH-1739	RT5A0120 C0N	F7010605AB	F46014- CHADYHS
14.0	U-Shaped wall mounted grab bar	WAC-SAP-BG0800CS		Hand Rail Cat. No. B2210108	FFAS9402-000040BC0
15.0	Shaped wall mounted grab bar	WAC-SAP-BAI090CS		Cat. No. B2210103	FFAS9405-000040BC0, FFAS9404-000040BC0,
16.0	wall mounted grab bar	WAC-SAP-BR0600CS		Cat. No. B2210106	FFAS9406-000040BC0

17.0	15 mm C.P. brass bib cocks	OPP-15037PM	RT5A7990 CA1	F1014151	FFAST602 000500BF0
18.0	wall mounted type CP paper holder	AKP-35751P	RA816713 001	F5004109	FFAS1489- 908500BF0
19.0	2 way bib cock with C.P.Jet Spray	OPP-15041PM	RT5A9390 CA1	F1014161	FFAST603 601500BF0
20.0	JET SPRAY	ALD-573	RF9061A1	F8030109AB	CLTP405-CHZZ
21.0	15mm C.P. brass angle valve (Quarter turn type)	OPP-15053PM	RT5A8020 CA1	F1014201	F54400-CHACT
22.0	15mm C.P. Stop Cock	OPP-15083KPM	RT5A1520 CA1	Exposed part F1014351	F65601-CHADY; A- 5601
23.0	C.P.towel rail with hook	AKP-35711PS	RA816707 001	F5004101	FFAS0494- 908500BF0
24.0	C.P. Tumbler Holder	AKP-35741P	RA816705 001	F5006107	FFAS1484- 908500BF0
25.0	C.P soap dish	AKP-35731P	RA816683 001	F5006106	FFAS1482- 908500BF0
26.0	C.P. brass twin way Coat hooks	ACN-CHR-1161N	RA815491 001	F5004108	FFAS1481- 908500BF0
27.0	C.P. napkin ring for wash basin	AQN-7721	RA816659 001	F5006105	FFAS1490- 908500BF0
28.0	C.P.liquid soap dispenser with bottle for wash basin	AKP-35735P	RA816678 001	F5007111	

2.0. WATER SUPPLY

2.1 Scope of Work

All the water supply work 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 Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the Schedule of Quantities without restricting to the generality of the foregoing, the water supply system shall include the following: -

- a) Distribution system from main supply headers to all fixtures and appliances for cold/hot water.
- b) Cold water supply lines from tube wells and city water connections to fire and underground water tanks.
- c) Municipal water and Bore-well connections to U.G. water tanks.
- d) Garden irrigation system if any
- e) Excavation and refilling of pipes trenches.
- f) Insulation to hot water pipes if required.
- g) Pipe protection and painting.
- h) Control valves, masonry chambers and other appurtenances.
- i) Connections to all plumbing fixtures, tanks, appliances and Municipal mains

2.2 General Requirements

- 2.2.1 Materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Project Manager.
- 2.2.2 Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat work man like manner.
- 2.2.3 Short or Long bends shall be used on all main pipe lines as far as possible. Use of Elbows shall be restricted for short connections.
- 2.2.4 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.
- 2.2.5 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.
- 2.2.6 Clamps, hangers and supports on RCC walls, columns and slabs shall be fixed only by means of approved made of expandable metal fasteners inserted by use of power drills.
- 2.2.7 All pipe clamps, supports, nuts, bolts, washers shall be galvanized MS steel throughout the building. Painted MS clamps & MS nuts, bolts and washers shall not be accepted.
- 2.2.8 Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.
- 2.2.9 Water Supply System
- 2.2.10 Contractor should study the site plan and water supply system diagram for an overview of the system.
- 2.2.11 Source Water supply will be acquired from Municipal Corporation water mains to a service connection and captive tube wells within the site and collected in water storage tanks located in ground floor. Pipe Supports

All pipes clamps, supports, hangers, rods, pipe supports, nuts and washers shall be factory made galvanized MS steel or alternatively galvanized after fabrication to suit site requirement CPVC pipes in shafts and other locations shall be supported by galvanized M.S clamps of design approved

by pipes in wall chases shall be anchored by G.I hooks, pipes at ceiling level shall be supported on structural clamps fabricated from M.S structural steel. Pipes in typical shafts shall be supported on Galvanised slotted angles/channels as specified elsewhere.

Clamps:

G.I. pipes in shafts and other locations shall be supported by M.S. clamps of design approved by Project Manager. Pipes in wall chases shall be anchored by iron hooks, Pipes at ceiling level shall be supported on structural clamps fabricated from M.S. structural steel as described above. Pipes in typical shafts shall be supported on slotted angles/channels as specified.

3.0 Anchor Fasteners:

3.01 All pipe supports, hangers and clamps to be fixed on RCC walls, beams, columns, slabs and masonry walls 230mm thick and above by means of galvanised expandable anchor fasteners in drilled holes of correct size and model to carry the weight of pipes. Drilling shall be made only by approved type of power drill as recommended and approved by manufacturer of the anchor fasteners. Failure of any fastening devices shall be the entire responsibility and contractor shall redo or provide additional supports at his own cost. He shall also compensate the owner for any damage that may be caused by such failures.

3.02 Hangers & Supports:

For horizontal runs, support should be given at 3 ft (90 cms) intervals for diameter of 1" and below and at 4 ft (1.20 mtr) intervals for larger size. Hangers should not have thrown or sharp edges which come in contact with the tubing and shall be of GI. Support should be as per the below mentioned table: S.No. Size of Pipe 210 C 490 C

S.No	Size of Pipe	21 ⁰ C	49 ⁰ C	71 ⁰ C	82 ⁰ C
	Inch	Ft	Ft	Ft	Ft
1	½"	5.5	4.5	3.0	2.5
2	¾"	5.5	5.0	3.0	2.5
3	1"	6.0	5.5	3.5	3.0
4	1¼"	6.5	6.0	3.5	3.5
5	1½"	7.0	6.0	3.5	3.5
6	2"	7.0	6.5	4.0	3.5

4.0 Valves

4.1 Non-Return Valve (Dual Slim Type)

Where non return valve shall be provided through which flow shall occur in one direction only. Each Butterfly and Slim Type Swing Check (NRV) Valve shall be provided with a pair of flanges screwed or welded to the main line and having the required number of nuts, bolts and washers of correct length.

Each tank shall be provided with a 560mm Dia Heavy Duty Cast Iron / SFRC manhole frame and cover Valves Gunmetal, cast iron, butterfly and non return valves and puddle flanges shall measure by numbers and shall include wheels I caps, GI nuts, bolts, washers, insertion gasket.

Painting/pipe protection/insulation Painting/pipe protection /insulation for pipes shall be measured per linear meter over finished surface and shall include all valves and fittings for which no deduction shall be made. No extra payment shall be made for fittings, valves or flanges.

Ball Valve (Brass): The ball valve shall be of Brass or Gunmetal as specified conforming to IS 1703. The ball valve shall be of following two classes:-

High Pressure: High pressure float valves are indicated by the abbreviation 'HP' and are designed for use on mains having pressure of 0.175 MPa or above.

Low Pressure: Low Pressure float valves are indicated by the abbreviation 'LP' and are designed for use on mains having a pressure up to. 0.175 MPa.

The ball valves shall be of following nominal sizes 15 mm, 20 mm, 25 mm, 32 mm, 40 mm and 50 mm. The nominal size shall correspond with the nominal bore of the inlet shanks. Polyethylene floats shall conform to IS9762.

4.2 Butterfly Valves

The butterfly valve shall be of cast iron body of IS 210 with PN16 rating. The disc shall be made of Stainless Steel/Cast Bronze material and shaft shall be made of SS AISI 410.

The valve seat shall be synthetic material Nitrile Rubber suitable for water duty. It shall line the whole body. The disc should move in slide bearings on both ends with 'O' ring of nitrile Rubber Material to prevent leakage. The handle should have arrangement for locking in any set position. The valve should be suitable for working pressure (PN16 Rating) as mentioned in the Bill of Quantity.

All the valves 50mm & above shall be butterfly type. Butterfly valves up to 6" dia. Will be lever operated & valves above 6" dia. shall be gear operated.

Extended stem valves to be used for all water applications where insulation is used.

The butterfly valve shall be coated with two coats of zinc chromate paint (LOW VOC) for its anti-rust properties and then shall be finally painted with epoxy paint of required colour including all fittings like valves, flanges & unions. The valves used for both HW and CHW application shall be covered with insulation (CFC & HCFC FREE)/lag coating/glass cloth as specified in schedule of quantity. The Adhesive used for shall be of low volatile organic compound. Pressure testing of valves shall be done at manufacturer's works. The contractor shall furnish material test certificates of various components of the valve & performance test certificates carried out by manufacturer.

In case of motorized modulating butterfly valve with PN16 rating as mentioned in schedule of quantity. It should be complete with motor actuator of suitable torque & control power wiring (including step down transformer and required accessories with internal wiring for converting 220volt AC single phase power up to 10 volt DC or as required for modulation of actuator- the same arrangement to be inbuilt in controller panel only which are in other scope). The valve should be IEC 534 compliant, have suitable stroke and insulated.

4.3 BALL VALVES

All ball valves shall be forged brass body construction with chrome plated with the pressure rating PN 16 as per schedule of quantity and handle of

stainless steel constructions & shall be covered with Plastic material. End connections of ball valve to be screwed type & shall be applicable for 15mm to 40mm in dia. The ball valve shall be coated with two coats of zinc chromate paint (LOW VOC) for its anti-rust properties and then shall be finally painted with epoxy paint of required color including all fittings like valves, flanges & unions. The valves used for both HW & CHW application shall be covered with insulation (CFC,HCFC FREE)/lag coating/glass cloth as specified in schedule of quantity. The Adhesive used for shall be of low volatile organic compound. Pressure testing of valves shall be done at manufacturer's works. The contractor shall furnish material test certificates of various components of the valve & performance test certificates carried out by manufacturer.

4.4 Y' STRAINER & POT STRAINER

Strainers shall be 'Y' type or Pot Strainer suitable for PN16 rating as mentioned in schedule of quantity. 'Y' Strainer shall be fabricated of Ductile CI body for 65 to 300mm. Strainer size should be in the range of 15 to 50mm of size. Permanent magnet shall be provided in the body of the Strainer to arrest MS particles. Filter element shall be of non-magnetic SS sheet minimum 1mm thick with 3 mm perforation. Cartridge having five different type of filters made out of SS 304 with different mesh sizes shall be provided. These will be replaced so as to get good quality of water in system during commissioning. Filtration area of Y-Strainer shall be minimum four times the connecting pipe size. 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 main pipe.

Pot Strainers body shall be fabricated of MS/CI body. Thickness of sheet shall be as per size of the strainer chamfered pipes with flanges shall be provided at inlet /outlet connections of the strainer. The tangential entry of water shall create a centrifugal action and due to velocity shall separate sediments and deposit on the inner surface of filter element and at bottom of the Strainer. Butterfly valves shall be provided at inlet / outlet connections as shown included in schedule of quantity. The strainer body shall have two separate chambers properly sealed to avoid mixing of

filtered and unfiltered water. A powerful magnet shall be provided in the body to arrest MS particles. Filter element of Pot Strainer shall be of non-magnetic 18 gage SS sheet properly reinforced to avoid damage of the element. A cone with sufficiently large drain pipe with butterfly valve shall be provided at the bottom chamber to flush-out foreign particles. This arrangement shall avoid frequent opening of Pot Strainer for cleaning of filter element. Gage connection shall be provided at inlet and outlet connection.

The Y-strainers & POT strainer shall be coated with two coats of zinc chromate paint (LOW VOC) for its anti-rust properties and then shall be finally painted with epoxy paint of required colour including all fittings like valves, flanges & unions.

Pressure testing of valves shall be done at manufacturer's works. The contractor shall furnish material test certificates of various components of the valve & performance test certificates carried out by manufacturer.

4.5 Float valve

Bronze bodies, diaphragm chambers and trim, screwed ends only, in sizes 11 /2 inches and smaller. Larger sizes have cast iron bodies, screwed or flanged ends (4-inch size has flanged ends only), and bronze trim. All sizes have composition neoprene discs for tight closing and reinforced diaphragms.

The floats are stainless steel. The rubber parts that may need to be replaced are inexpensive and easily accessible without removing the valve from line the ball is not attached to the stem and always seats perfectly. No tilting, cocking, or binding. The ball turns so that all parts are kept scoured clean by the flow. The rounded form permits high capacity. The tapered seat gives a moderate wedging effect to insure tight closing. The seat can be quickly replaced when necessary

4.6 AIR VENTS

Air vents shall be of forged brass body for purging of air trapped in piping system shall be provided at the highest point and shall be fitted with forged brass ball valves of the size indicated in the Bill of Quantity shall be provided.

The air vent shall be coated with two coats of zinc chromate paint (LOW VOC) for its anti-rust properties and then shall be finally painted with epoxy paint of required color including all fittings like valves, flanges & unions.

PRESSURE GAUGE & TEMPERATURE GAUGE

5.0 Water Pressure Gauges (Dial Type)

Water pressure gauges 6"dia. made out of stainless steel SS-304 all parts are made from copper alloy and stainless steel to prevent from corrosion attack. Dial shall be in white color and number shall be in the black and red color for the visibility, gauges shall have 'A' stainless steel 'U' tube of 6mm dia. x 400mm in length both side threaded with stainless steel nut, A pet cock along with SS syphon tubing shall be provided at one end of tube for protecting gauge during testing of system.

6.0 Temperature Gauges (Dial type) Temperature gauges of 6"dia. with stainless steel SS-304 bulb and thermos well shall be used, the length of the thermos well shall be in accordance to the condenser water pipe diameter. The temperature gauge should in range of 0-50 Deg.C & it's to be filled with red oil liquid. Gauges shall be suitable for 15mm connection and for condenser line they shall have long site.

7.0 Flexible coupling V grooves joints (expansion bellows) :

Flexible connections shall be provided at the pumps & in between expansion joint, and other machine where requires as per following specifications-The Flexible connections shall be flanged type expansion joint. Flanges shall be non-compressible and mechanically strong type and the Neoprene rubber shall be provided in between the flange ends. The connections shall work for a temperature range of minus 10°C to 70°C. Connections shall be provided with control rods to control the excessive elongation or compression of piping systems with also over pipe hot water expansion joint with thermal insulated. These shall be capable to withstand tensional movement up to 3 degree without damage.

8.0 INSULATION -SCOPE

The scope of this section comprises the supply and application of various type of insulation conforming to these specifications:

8.1 MATERIAL (NITRILE RUBBER THERMAL INSULATION):

Insulation material for Duct insulation shall be closed cell anti-fungus, anti-microbial Elastomeric Nitrile Rubber (CFC/HCFC FREE) on one side with factory laminated glass cloth. Thermal conductivity of the insulation material shall not exceed $0.033 \text{ W/m}^{\circ}\text{K}$ at an average temperature of 0°C . Density of the nitrile rubber shall be $40\text{-}60 \text{ Kg/m}^3$. The product shall have temperature range of -40°C to 105°C . The insulation material shall be fire rated for Class O as per BS 476 Part 6: 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapor permeability shall be not less than 0.024 per inch ($1.74 \times 10^{-14} \text{ Kg/m.s.Pa}$ i.e. $\mu=10000$: Water vapor diffusion resistance).

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for thermal conductivity values, density, water vapor permeability and fire properties. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for thermal conductivity and density at Contractor's cost. Adhesive used for sealing the insulation shall be not-flammable, vapor proof adhesive (LOW VOC) strictly as per manufacturer's recommendations.

8.2 MATERIAL (NITRILE RUBBER THERMAL INSULATION)

Insulation material for Duct insulation shall be closed cell anti-fungus, anti-microbial Elastomeric Nitrile Rubber (CFC/HCFC FREE) on one side with factory laminated glass cloth. Thermal conductivity of the insulation material shall not exceed $0.033 \text{ W/m}^{\circ}\text{K}$ at an average temperature of 0°C . Density of the nitrile rubber shall be $40\text{-}60 \text{ Kg/m}^3$. The product shall have temperature range of -40°C to 105°C . The insulation material shall be fire rated for Class O as per BS 476 Part 6: 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapor permeability shall be not less than 0.024 per inch ($1.74 \times 10^{-14} \text{ Kg/m.s.Pa}$ i.e. $\mu=10000$: Water vapor diffusion resistance).

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for thermal conductivity values, density, water vapor permeability and fire properties. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for thermal conductivity and density at Contractor's cost. Adhesive used for sealing the insulation shall be not- flammable, vapor proof adhesive (LOW VOC) strictly as per manufacturer's recommendations.

9.0 DRAINAGE WORK

All the internal & external 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

TERMINOLOGY

Benching: The sloped floor of a manhole or an inspection chamber on both sides and above the top of the channel.

Channel: The open waterway through which sewage, storm water or other liquid waste flow at the invert of a manhole or an inspection chamber.

Cleaning Eye: An access opening having a removable cover to enable obstructions to be cleared by means of a drain rod.

Connections: The junction of a foul water drain, surface water drains with public sewer, cesspool soak-way or other water courses.

Flushing Tank: Tank used to flush the sewer lime/manholes.

Curb, Kerb: The stone margin of a side walk.

Dispersion Trench: A trench in which open jointed pipes surrounded by coarse aggregate media and overlaid by fine aggregate, are laid. The effluent from septic tank gets dispersed through the open joints and is absorbed in the surrounding soil.

Depth of Manhole: The vertical distance from the top of the manhole to the outgoing invert of the main drain channel.

Drain: A line of pipes including all fittings and equipment, such as manholes traps, gullies and floor traps used for the drainage of a building, or a number of buildings or yards appurtenant to the buildings, within the same cartilage. Drain shall also include open channels used for conveying surface water.

Drainage: The removal of any liquid by a system constructed for the purpose.

Drop Connection: A branch drain of which the last length of piping of the incoming drain, before connection to the sewer, is vertical.

Drop Manhole: A manhole incorporating a vertical drop for the purpose of connecting a sewer or drain at high level to one at lower level.

Effluents

Tank Effluent: The supernatant liquid discharge from a septic tank.

Filter Effluent: The liquid discharged from a biological filter.

Gully Chamber: The chamber built of masonry around a gully trap, for housing the same.

Gully Trap: A trap water seal provided in a drainage system in a suitable position to collect waste water from the scullery, kitchen sink, wash basins, baths and rain water pipes.

Haunching Concrete bedding with additional concrete at the sides of the pipe.

Junction Pipe: A pipe incorporating one or more branches.

Invert: The lowest point of the interior of a sewer or drain at any cross section.

Inspection Chamber: A water tight chamber constructed in any house drainage system which takes wastes from gully traps and disposes off to manhole with access for inspection and maintenance.

Interceptor Manhole (Interceptor Chamber): A manhole incorporating an intercepting trap, and providing means of access thereto and equipped with a fresh air inlet on the upstream side of the trap.

Manhole (Manhole Chamber): Any chamber constructed on a drain or sewer so as to provide access thereto for inspection testing or the clearance of obstruction.

Rest Bend (Duck Foot Bend): A bend supported in a vertical position by a foot formed at its base.

Saddle: A purpose made fitting, so shaped as to fit over a hole cut in a sewer or drain, and used to form connections.

Soffit: The highest portion of the interior of a sewer or drain at any cross-section.

Soil Waste: The discharge from water closets, urinals, slope sinks, stable or cowshed gullies and similar appliances.

Soil Pipe: Which receives the discharges from soil fittings, such as water closets urinals, and slope sinks.

Sullage Waste Water: Spent water from baths, wash basins kitchen sinks, and similar appliances which does not contain human or animal excreta.

Sewer: A closed drain carrying night soil and other water borne waste.

Surface Water Drain: A drain conveying surface water including storm water.

Surface Water: The run off from precipitation, other water that flows over surface of the ground.

Sub Soil Water: Water occurring naturally below the surface of the ground.

Sludge: The settled solid matter in semi solid condition.

Scum: The greasy and other substances floating on the surface of sewage.

Vent Pipe: A pipe line installed to provide flow of air to or from a drainage system or to provide circulation of air within such system to protect trap seals from siphonage and back flow.

Waste Water: The discharge from wash basins, sinks and similar appliance, which does not contain human excreta.

GENERAL REQUIREMENTS

In designing a drainage system for building(s), the aim shall be to provide a self-cleansing conduit for the conveyance of soil, waste, surface or sub-surface waters and for the removal of such wastes speedily and efficiently to a sewer or other outlet, without risk of nuisance and hazard to health.

The discharge of water through a domestic drain is intermittent and limited in quantity and therefore, small accumulations of solid matter are liable to form in the drains between the building and the public sewer. There is usually a gradual shifting of these deposits as discharges take place. Gradients shall be sufficient to prevent these temporary accumulations building up and blocking the drains.

Normally, the sewer shall be designed for discharging three times the dry weather flow flowing half-full with a minimum self-cleansing velocity of 0.75 metre per second. The approximate gradients which give this velocity for the sizes of pipes likely to be used in building drainage and the corresponding discharges when flowing half-full are given in Table 3.1. The sizes and slopes shall conform to Local Municipal Bye-laws.

In cases, where it is practically not possible to conform to the minimum gradients, a flatter gradient may be used but the minimum velocity in such cases shall on no account be less than 0.61 metres per second.

On the other hand, it is undesirable to employ gradients giving velocity of

flow greater than 2.4 metres per second. Where it is unavoidable, cast iron pipes shall be used. The approximate gradients which give a velocity of 2.4 metres per second for the various sizes of pipes and the corresponding discharge when flowing half-full are given in **Table 3.1**.

TABLE 2.1 Gradients for Sewers

Diameter mm	Minimum Gradient		Maximum Gradient	
	Gradients	Discharge cum/Min.	Gradients	Discharge cum/Min.
100	1 in 57	0.18	1 in 5.6	0.59
150	1 in 100	0.42	1 in 9.7	1.32
200	1 in 145	0.73	1 in 14	2.4
230	1 in 175	0.93	1 in 17	2.98
250	1 in 195	1.10	1 in 19	3.60
300	1 in 250	1.70	1 in 24.5	5.30

9.1 S.W. Gully Trap: 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.

Each gully trap shall have one C.I. grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight C.I. cover with frame inside dimensions 300 x 300 mm the cover weighing not less than 4.50 Kg and the frame not less than 2.70 Kg. The grating, cover and frame shall be of sound and good casting and shall have truly square machined seating.

9.2 Fixing S.W. Gully Trap

Excavation: The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Engineer-in-Charge.

Fixing: The gully traps shall be fixed on cement concrete foundation 65 cm square and not less than 10 cm thick. The mix for the concrete will be 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size). The jointing of gully outlet to the branch drain shall be done similar to jointing of S.W. pipes described above.

Brick Masonry Chamber : After fixing and testing gully and branch drain, a brick masonry chamber 300 x 300 mm (inside) in brick work of specified class in cement mortar 1:4 (1 cement: 4 fine sand) shall be built with a half brick thick brick work round the gully trap from the top of the bed concrete up to ground level. The space between the chamber walls and the trap shall be filled in with cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size). The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside with cement mortar 1:3 (1 cement: 3 coarse sand), finished with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.

C.I. cover with frame 300 × 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and rendered smooth. The finished top of cover shall be left about 4 cm above the adjoining ground level so as to exclude the surface water from entering the gully trap.

Measurements: The work shall be enumerated. Excavation shall be measured separately under relevant item of earth work.

Rate: The rate shall include the cost of materials and labour involved in all the operations described above, except earth work which will not be paid for separately.

9.3 MANHOLES

At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manhole as far as possible. The maximum distance between manholes shall be 30 m.

Manholes of different types and sizes as specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawings or as directed by the Engineer-in-Charge. The size specified shall indicate the inside dimensions between brick faces of the manholes.

Where the diameter of the drain is increased, the crown of the pipe shall

be fixed at the same level and necessary slope given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the branch sewer may be fixed at lower level but in such cases the peak flow level of the two sewers shall be kept the same.

Sewers of unequal sectional area shall not be joined at the same invert in a manhole. The invert of the smaller sewer at its junction with main shall be at least $\frac{2}{3}$ the diameter of the main above the invert of the main. The branch sewers shall deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in main is not impeded.

No drain from house fittings, e.g. gully trap or soil pipe, etc. to manhole shall normally exceed a length of 6 m unless it is unavoidable. Manholes 90 × 80 cm are generally constructed within compound for house drainage only and near the buildings for house drainage. Manholes 1.2 m × 90 cm are generally constructed for main drainage work for depths less than 1.5 m.

Manhole 1.4 m × 90 cm is of the arched type and is generally constructed for main drainage works where depth is 1.50 m or more. The width of manholes shall be increased more than 90 cm on bends or junctions or pipes with diameter greater than 450 mm and that the benching width on either side of the channel is minimum 20 cm.

Manholes 1.4 m internal diameter are generally constructed for main drainage works where depth is 2.45 m or more as an alternative to manholes of arch type. The diameter shall be increased suitably, for pipes with diameter greater than 450 mm in the same manner as in the case of rectangular manholes. Before deciding size of manholes, Local Municipal Bye Laws shall be consulted. As a general guide some typical type designs of manholes followed in when manholes are constructed on foot path, these shall be provided with cover of medium duty casting and when built within the width of the road under vehicular traffic, these shall be provided with cover of heavy duty casting.

10.0 ROAD GULLY CHAMBER WITH GRATING

- 10.01** Road Gully Chamber with Horizontal Grating The chamber shall be of brick masonry of specified class and shall have a C.I. grating with frame fixed in 15 cm thick cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) at the top. The size of the chamber shall be taken as the clear internal dimensions of the C.I. frame. The chamber shall have a connection pipe, the length of which in metre between the road gully chamber and the manhole of the drain shall not be less than one by forty ($\frac{1}{40}$) times the nominal diameter of pipe in mm(i.e. for 150 mm connection pipe, length shall not be less than 3.7 m and for

250 mm connection pipe length shall not be less than 6.25 m). The chamber shall be built at the location fixed by the Engineer-in- Charge. Generally the spacing of the chambers shall be 18 to 36 m depending upon the grading of the road channel and the area of the drainage. R.C.C. gully grating shall be fixed in cement mortar 1:2 (1 cement: 2 coarse sand).

- 10.02** Road Gully Chamber with Vertical Grating The chamber shall be of brick masonry 12 mm dia round bar shall be fixed in cement concrete block at the bottom. The bars at the top shall be welded or riveted to M.S. flat 40 × 6 mm The specifications shall be same as described in 3.7.1.

Measurements Road gully chambers shall be enumerated.

10.03 Rate

The rate shall include the cost of materials and labour involved in all the operations described above except the cost of excavation and connection pipes.

UPVC pressure pipes (10 kg/cm²) confirming to IS: 4985.

10.04 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

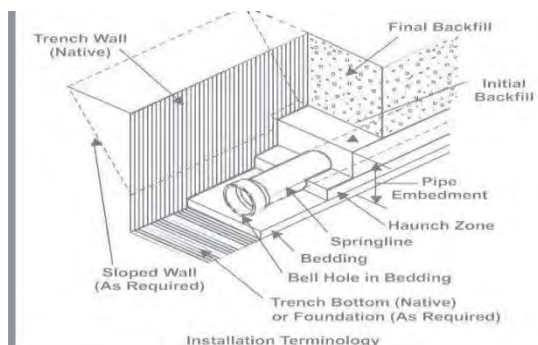
- 10.4.1 Nominal Size (DN) The numerical designation for the size of a pipe, other than a pipe designated by thread size, which is a convenient round number approximately equal to the manufacturing dimension in millimeters (mm).
- 10.4.2 Nominal Outside Diameter The specified outside diameter, in millimeters assigned to a nominal size.
- 10.4.3 Outside Diameter at any Point (de) The value of the measurement of the outside diameter of a pipe through its cross section at any point of the pipe, rounded off to the next higher 0.1 mm.
- 10.4.4 Mean Outside Diameter The quotient of the outer circumference of a pipe and 3.142 (π) in any cross-section, rounded off to the next higher 0.1 mm.
- 10.4.5 Minimum Mean Outside Diameter (dem, min) The minimum value for the mean outside diameter as specified for a given nominal size.
- 10.4.6 Maximum Mean Outside Diameter (dem, max) The maximum value for the mean outside diameter as specified for a given nominal size.
- 10.4.7 Mean Inside Diameter at Mid-Point of Socket Length (dim) The arithmetical mean of two measured inside diameters perpendicular to each other at the midpoint of the socket length.
- 10.4.8 Out-of-Roundness (Ovality) The difference between the measured maximum and the measured minimum outside diameter in the same cross-section of the pipe.
- 10.4.9 Nominal Wall Thickness A numerical designation of the wall thickness of a

- component which is a convenient round number, approximately equal to the manufacturing dimension in millimeters (mm).
- 10.4.10 Wall Thickness at any Point (e) The value of the measurement of the wall thickness at any point around the circumference of a pipe, rounded off to the next higher 0.1 mm.
 - 10.4.11 Minimum Wall Thickness at any Point (e_{min}) The minimum value for the wall thickness at any point around the circumference of a pipe, rounded off to the next higher 0.1 mm.
 - 10.4.12 Maximum Wall Thickness at any Point (e_{max}) The maximum value for the wall thickness at any point around the circumference of a pipe, rounded off to the next higher 0.1 mm.
 - 10.4.13 Mean Wall Thickness (e_m) The arithmetical mean of at least four measurements IS 4985 : 2000 regularly spaced around the circumference and in the same cross-section of a pipe, including the measured minimum and the measured maximum values of the wall thickness in that cross- section and rounded off to the next higher 0.1 mm.
 - 10.4.14 Tolerance The permitted variation of the specified value of a quantity, expressed as the difference between the permitted maximum and the permitted minimum value.
 - 10.4.15 **CLASSIFICATION OF PIPES:** The pipes shall be classified by pressure ratings (working pressures) at 27°C as follows:

Working pressure (PN)	Class of pipe
0.25 MPa (2.5 kg/cm ²)	Class 1
0.4 MPa (4.0 kg/cm ²)	Class 2
0.6 MPa (6.0 kg/cm ²)	Class 3
0.8 MPa (8.0 kg/cm ²)	Class 4
1.0 MPa (10.0 kg/cm ²)	Class 5
1.25 MPa (12.5 kg/cm ²)	Class 6

The following trenching and burial should be used to protect the system.

1. The trench should be wide enough to provide an adequate room the space between the pipe and trench wall must be wider that the compaction equipment used in the compaction of backfill Minimum trench width should be 350-400 wider mm over the pipe dia minimum trench height depends on pipe dia and min cover requirement. Optically pipe diameter plus 1 metre require.
2. The trench should be excavated to ensure that sides remain stable under all working condition.
3. The trench bottom should be smooth free and debris, Continuous and provide uniform support.
4. Upvc pipe fitting can be installed underground since of piping system is affected by side wall support.



10.5 **PVC Perforated pipe**

Scope of Work:

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 here in after and given in the Schedule of Quantities & Also excavation Including refilling soil over perforated pipe with minimum slope .

MATERIAL: The pipes shall be produced from material consisting substantially of polyvinyl chloride conforming 10 IS 10151 to which may be added only those additives as are needed to facilitate manufacturer of sound pipe with surface finish, mechanical strength in order to condition of use. None of these additives shall be used separately or together ID quantity sufficient to constitute toxic hazard or materially to impair the fabrication, chemical and physical properties of the pipe.

- a. Up to 10 percent addition of the manufacturers own rework material produced during the manufacture and testing of pipes, complying With the standard IS permissible
- b. The natural used shall be resistant 10 the chemicals normally present in the sub-soil and ground water Due to strong ultra-violet rays present In the intense sunlight under Indian conditions, the compound used for manufacturing drainage pipe should contam ultra-violet stabilizer
- c. The composition shall be based on PVC resin having a K-value of or greater when tested In accordance with IS 4669.

For the purpose of this standard, the single wall corrugated pipes shall be of perforated or non- perforated types.

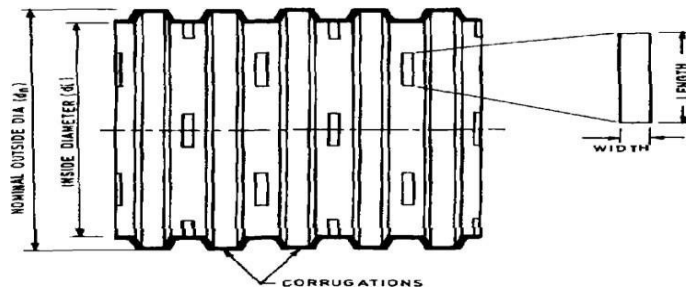


Table 1 Dimensions of Corrugated Single Wall Pipe
(Clause 7)

Sl No.	Nominal Outside Diameter of Pipes, d_n	Tolerances mm	Inside Diameter of Pipes, d_i
(1)	(2)	(3)	(4)
i)	80	± 0.5	72
ii)	100	± 0.5	88
iii)	125	± 0.5	112
iv)	160	± 0.5	144
v)	200	± 1.0	178
vi)	254	± 1.0	238
vii)	355	± 1.0	315
viii)	455	± 1.0	401

PLUMBING OF MAKE RECOMMENDED

S.N	ITEM NAME	MAKE
1	Pumps	GRUNDFOS/ARMSTRONG/XYLEM
2	RO water plan	ION EXCHANGE/THERMAX TECHNOMAX / OXYBEE SOLUTIONS
3	Heat Pump	ION EXCHANGE/THERMAX TECHNOMAX / OXYBEE SOLUTIONS
4	Sanitary Fixture	~~HINDWARE/PARRYWARE/JAQUAR~~ REFER TECH
5	Internal & Shaft Drainage pipes (PP)	HULIOT/OSTDENDORF/WAVIN
6	Internal & Shaft Water supply pipes (CPVC&UPVC)	AJAY PIPES/ SUPREME/ASTRAL
7	Nitrile rubber	AEROFLEX/ARMAFLEX/EQUIVALENT
8	PEX pipes	Kitech/Viega
9	Ball valve	LEADER/ZOOTO/C&R
10	Butterfly valve	Kitz/LEADER/ZOOTO
11	Air vent	ANERGY/SANT
12	Temperature Gauge	H-GURU/BAUMER
13	Pressure Gauge	H-GURU/BAUMER / DANFOSS
14	Y Strainer	Sant / Trishul / Leader
15	Non return valve	Advance / ZOOTO /SANT
16	Float valve	Jobe valves / Equivalent
17	Pressure Reducing Valve	ZOOTO/TIEMME/HONEYWELL
18	PVC Tank	Sintex / Sarita / Rio
19	NP-3 Class RCC pipes	LOCAL MANUFACTURE-ISI
20	UPVC gully trap	HULIOT/OSTDENDORF/WAVIN
21	FRP Chamber Cover	Neco/Prince/Thermodrain

PART-C

LOW SIDE FIRE FIGHTING SYSTEM WORK

LOW SIDE FIREFIGHTING WORKS

1.0 SCOPE OF WORK

The scope includes fire protection system only, the detection is covered under separate tender

- 1.1 Fire Hydrant system
- 1.2 Fire Extinguishers
- 1.3 Masonry work for valve chambers & underground pipe trenches.
- 1.4 Approval from Chief fire officer for fire & other required statutory approval required for firefighting Works
- 1.5 All necessary civil works & supporting MS structures required for successful installation, testing and commissioning of system shall be inclusive in the scope of vendor.
- 1.6 All necessary site housekeeping, material security, site construction lighting etc. required for site work shall be inclusive in the scope of vendor.

2.0 FIRE EXTINGUISHERS

2.1 GENERAL:

The scope of work under this part of the specification covers supply and installation of internal appliances as per requirements specified in schedule & marked on drawings and instructions of engineer-in-charge.

Makes of all the appliances supplied and installed shall be as per the 'List of Approved Make 'or as approved by CFO and shall be of identical design for the entire premises.

Contractor will need to submit technical data sheet of each and every equipment and ancillaries to MEP Consultant & get approval prior to procurement Mounting accessories, indicator boards etc are part of the scope of supply of internal appliances.

2.2 SPECIFICATIONS:

Internal appliances with various fire extinguishing medium shall conform to the following specifications and shall be installed and maintained as per IS: 2190 / NFPA 10

IS: 2878 Fire extinguisher, portable CO2

IS: 2171 Fire extinguisher, ABC type.

IS: 15683 Non Magnetic Fire extinguisher Portable Extinguishers of the following types shall be installed.

1. Dry chemical Powder type
2. Co2 type
3. ABC type
4. Non-Magnetic CO2 / ABC type

2.2.1 **DRY CHEMICAL POWDER TYPE:**

The Dry chemical powder type capacity shall be as mention in BOQ and shall have the IS mark 2171 complete with powder and charged including with fixing bracket, fitted with gunmetal cap, and discharge hose and open grip nozzle.

2.2.2 **CO2 water TYPE:**

The Co2 Extinguisher shall be ISI mark, with initial charge with high pressure cylinder, complete with wheel type valve, internal discharge tube, with high pressure discharge hose with horn and suspension brackets. The extinguisher shall have ISI mark of 2878 and capacity shall be as mention in BOQ.

The Co2 Extinguisher shall have ISI mark 2878 and necessary wheel valve, discharge hose and shall be mounted on light weight rubber tyres wheels capacity shall be as mention in BOQ.

CO2 Gas TYPE: The Co2 Extinguisher shall be ISI mark, with initial charge with high pressure cylinder, complete with wheel type valve, internal discharge tube, with high pressure discharge hose with horn and suspension brackets. The extinguisher shall have ISI mark of 2878 and capacity shall be as mention in BOQ.

Non-Magnetic Type: The Non Magnetic extinguisher shall be ISI mark, portable MRI Compatible Non-magnetic type fire extinguisher capacity as mention in BOQ Kgs (for MRI ,CT scan & Ultra sound machine) with aluminium squeeze grip and nozzle and complete in all respects including initial fill and non magnetic wall suspension/ floor mounting stand brackets etc.The extinguisher agent should be non magnetic in nature,non conductor of electricity,residue free and electronics friendly with zero downtime. Extinguisher

body, valves, gauges, should be non interfering with the magnetic field of MRI machine and with zero iron (i.e. Aluminium body/ stainless steel body).

3.0 PIPE WORK

3.1 GENERAL REQUIREMENTS:

- 3.1.1 All the materials shall be of CFO approved, best quality conforming to the specifications and subject to the approval of the Client / PMC. Materials shall be tested in an approved testing laboratory & the contractor shall produce the test certificate in original to the Engineer-in-charge & the entire charges for original as well as repeated tests shall be borne by the Contractor.
- 3.1.2 Before welding, the pipe faces shall be cleared & V grooved then shall be welded conforming to IS : 9595 – 1980. The electrodes used for welding shall comply with IS:814. the laying of welded pipe shall also comply to IS 5822 – 1986. The welding joints shall be tested in accordance to IS:3600, Part 1973.
- 3.1.3 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.
- 3.1.4 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.
- 3.1.5 Pipes shall be securely fixed to walls, and ceilings by suitable clamps or supported at every 3 mtr. & at change of direction as required. Only approved make of anchor fasteners shall be used for RCC ceiling and walls.
- 3.1.6 Valve and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

3.2 PIPING

Pipes of the following types are to be used :

- 3.2.1 GI pipes as per IS : 1239/IS:15105, heavy duty (for pipes of sizes 150 mm N.B. and below) suitably lagged on the outside to prevent soil corrosion. GI pipes buried below ground shall be wrapped with pyknot for ant-rust as per IS:10211.
- 3.2.2 GI pipe lines up to 150 mm dia. shall have all fittings as per IS:1239, Part-II (heavy grade) while pipelines above 150 mm dia shall be fabricated from IS:3589 Gr.320 pipes as applicable or from steel plates.

- 3.2.3 For GI pipelines below 50 mm dia screwed / threaded jointing shall be adopted, while for pipe 50 mm dia and above shall be welded or flanged construction is to be carried out or as specified in Bill of quantities.
- 3.2.4 Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. All guides, anchor, braces, dampener, expansion joint and structural steel to be attached to the building structure trenches etc. shall be provided. Hangers and components for all piping shall be approved by the Consultant / Client / Architect.
- 3.2.5 The piping system shall be capable of withstanding 150% of the working pressure including water hammer effects.
- 3.2.6 Flanged joints shall be used for connections to vessels, equipment, flanged valves and also on suitable straight lengths of pipeline of strategic points (@ at every 15-20 mtr.) to facilitate erection and subsequent maintenance work.
- 3.2.7 Excavations for pipelines in trench and pit in open areas where disposal or surplus earth shall be done along the alignment, including trimming and dressing sides, levelling of beds of trenches to correct grades, cutting joint holes, refilling consolidation and dewatering of refilling in 15 cm layers & restoration & unmetalled or unpaved surface to its original condition. The rate including the cost of necessary timbering dewatering of drain water, diversion of traffic, night signals, fixing caution boards, watching fencing etc. Excavation up to 1.5m depth in all classes of soil. Pipes shall be buried at least one and half meter below ground level and shall have 230 mm x 230 mm masonry supports at least 300mm high at 3m intervals. Masonry work to have plain cement concrete foundation (1 cement : 4 coarse sand : 8 stone aggregate) of size 380 x 380 x 75 thick resting on firm soil. Wherever required Contractor shall support all trenches or adjoining structures with adequate supports to prevent landslides.
- 3.2.8 On completion of testing and painting trenches shall be refilled with excavated earth in 15 cm layers and compacted.
- 3.2.9 Contractor shall dispose off all surplus earth within the site.
- 3.2.10 Contractor shall provide suitable cement concrete anchor blocks for overcoming pressure thrusts in underground / external pipes. Anchor blocks shall be of cement concrete 1:2:4 mix.
- 3.2.11 All underground piping shall be coated with Pypkote wrapping for anti-rust application.

For over ground pipes ,painting to be applied on G.I. pipes with one coat of Etching primer with two coats of synthetic enamel paint of approved colour / shade (Post Master Red Colour)etc.

4.0 VALVES

- 4.1 Valves shall be used to start, stop or control flow. Non-return valves shall be provided unidirectional flow.
- 4.2 Butterfly valve conforming to BS 5155 or as indicated in BOQ will be used for isolation of flow in pipelines. For sizes 50mm to 200mm, Butterfly valve shall be as per IS: specified in Bill of quantities. Non-return valves shall be swing check/spring operated type. An arrow mark in the direction of flow shall be marked on the body of the valve. These valves shall conform to IS:5312 for swing type or API 596/598 for spring type check valves
- 4.3 Valves below 50 mm size shall have screwed ends while those of 50 mm and higher sizes shall have flanged connections. Drain lines will have locks for draining.
- 4.4 Rating of all types of valves shall be as specify in BOQ.
- 4.5 All underground valve station shall be provided with masonry chambers as described below:

Constructing masonry chamber 600x600x150 cm. Inside with 75 class designation brick work in cement mortar 1:5 (1 cement : 5 fine sand) for sluice valve & top slab of 1:2:4 mix (1 cement : 2 coarse and : 4 graded stone aggregate 20 mm nominal size) necessary excavation foundation concrete 1:5:10 (1 cement : 5 coarse fine sand : 10 graded stone aggregate 40mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 15mm thick finished with a floating coat of neat cement complete as per standard design. The scope shall also include CI surface box as per approved quality & CI heavy duty cover for the valve chamber. The scope shall include all required civil work like excavation, dewatering, backfilling, etc.

5.0 INTERNAL HYDRANT:

Internal hydrant shall be provided at each landing or at suitable location consisting of **single headed** gunmetal landing valve as indicated in BOQ with 63 mm dia oblique female instantaneous pattern with caps & chains. Outlet and

80 mm inlet (IS:5290-1969) with separate shut off valve. Landing valves shall be 63 mm dia. oblique female instantaneous pattern with caps and chains. Landing valves shall be of gunmetal and fitted with instantaneous coupling conforming to IS:901. The valve body, stop valve, check valve, nut, instantaneous female outlet and blank cap shall be of leaded-tin bronze conforming to Grade-II of IS:318-1962. The valve spindle shall be of brass rod conforming IS:320 - 1962. The hand wheel shall be mild steel or cast iron washers gaskets shall be of rubber conforming to IS:638 - 1965 or leather conforming to IS:581 : 1969. The coupling shall be fitted with an internal plug secured by chain landing valves shall be installed on hydrant riser at a height of 1.0 to 1.2 meter from the floor level.

Each internal hydrant shall be provided with two nos. 63 mm. Diameter 15 mtr. Long hose pipe with gunmetal male and female instantaneous type coupling, machined wound with G.I. wire hose of IS 636 type A and couplings to IS:903 with IS certification, gunmetal branch pipe with nozzle conforming to IS:903. Entire valves to be provided inside the FHC casing. Internal hydrant shaft shall be covered with double leaf ss-304 material door painted red.

6.0 HOSES

Hoses pipes shall be of fabric reinforced rubber lines as per IS:636 Type II or canvas hose as per IS:4927, with nominal size of 63 mm and lengths of 15 meter, as per quantities specified for in schedule or bill of quantity.

All hose pipes shall carry ISI marking on the body of the hose.

The hose shall have instantaneous spring lock-type coupling on ends. The instantaneous coupling shall be as per IS:901. It shall be fixed to each other by copper rivets and galvanized M.S. wires and leather bands. All coupling shall be interchangeable with each other, and shall bear ISI markings.

7.0 Fire Hose cabinet (Only for Internal Hydrants)

Internal hydrant door of MS sheet (16 Gauge) of fully welded construction

Having front door with locking arrangement, partially glazed with 4 mm thick glass coated & Painted with post office red colour of size 2 mtr x 1.2 mtr. Door shall be mounted on the shaft directly to house fire hydrant and accessories. Small axe to be provided outside cabinet for breaking glass. Entire valve assembly should be fit into inside FHC cabinet.

8.0 HOSE REEL

The hose reel shall be directly tapped from the riser through a 25 / 32 mm dia pipe, the drum and the reel being firmly held against the wall by use of dash fasteners. The hose reel shall be swinging type (180degrees) and the entire drum, reel etc. shall be as per IS:3876 and IS:884. The rubber tubing shall be of best quality and the nozzle shall be shut off type.

9.0 BRANCH PIPES

Branch pipe shall be of either gun metal or aluminum and should conform to IS:903. One end of the branch pipe will receive the coupling while the other end shall have a nozzle screwed to it. It shall bear ISI marking.

10.0 YARD / EXTERNAL HYDRANT

Yard or External Hydrants shall be as per IS:908 and the valve as per IS:5290. The hydrant shall consist of stand post assembly and a masonry base 200 mm X 200 mm X 200 cm high and shall be made at the point where it comes out of the soil. The valve shall complete with hand wheel, quick coupling connection spring and blank cap. The hydrant shall be laid on 150 dia. or as mentioned in BOQ.

Yard or External hydrant shall be controlled by a cast iron sluice valve. Hydrant shall have oblique female instantaneous pattern 63 mm diameter outlet with caps and chains. The hydrant shall be of gunmetal and flange inlet and single outlet conforming to IS:5290, a duck foot bend and flanged riser of required height to bring the hydrant to level above ground. The valve body, stop valve, check valve, nut, instantaneous female outlet and blank cap shall be of leaded-tin bronze conforming to Grade-II of IS:318-1962. The valve spindle shall be of brass rod conforming IS:320 - 1962. The hand wheel shall be mild steel or cast iron washers gaskets shall be of rubber conforming to IS:638 - 1965 or leather conforming to IS:581 : 1969.

Each external hydrant shall be provided with two nos. 63 mm. Diameter 15 mtr. Long hose pipe with gunmetal male and female instantaneous type coupling, machined wound with G.I. wire hose of IS 636 type A and couplings to IS:903 with IS certification, gunmetal branch pipe with 20 mm nozzle conforming to IS:903. Yard Hydrant stand pipe shall be of GI material

11.0 HOSE CABINETS (HOSE BOX)(Only for External Hydrants)

Each hydrant shall be housed in a Hose cabinet of suitable size. The hydrant cabinet shall hold double / single headed hydrant as specified, 2 hoses and one branch pipe as required. Internal hydrants shall normally fit the size of the niche made for it. The cabinet shall be of minimum 14 SWG MS sheet with center

opening, double glass front doors (cleat glass of 4mm thickness). The glass shall be firmly fixed by means of steel clips and screw with rubber beading. Hinges shall also be screwed and not welded. The corner members (frame) shall be of 25 x 25 x 3 mm thick angle. The hose box shall be firmly fixed to the wall/support by means of brackets and dash fasteners. The steel work shall have one coat of primer and two coats of red paint. The words "Yard Hydrant", "Hydrant" etc. should be painted in white or red on the 75 mm high letters. The hose box shall be lockable for internal hydrant installation. Small axe for breaking glass to be provided outside the cabin

12.0 VALVE CHAMBERS

A valve chamber shall be brick masonry chamber in cement mortar 1:5 (1 cement : 5 coarse sand) on cement concrete foundation 150 mm thick foundation 1:5:10 mix (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size), 15 mm thick cement plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back filling, complete. The wall shall be 230 mm thick with heavy duty ISI marked C.I. manhole covers.

13.0 FIRE BRIGADE INLET CONNECTION

A fire brigade inlet connection with a non-return valve shall be provided to facilitate the fire brigade to pump water into the installation by the use of their own equipment. Four way or 150 mm dia connection to the system shall comprise of four instantaneous pattern 63 mm dia. male inlets shall be with caps and chains complete with 150 mm dia. sluice valves, non-return valve housed in a M.S. cabinet with glass fronted door. The cabinet shall be suitable for recess mounting.

Two way fire brigade inlet connection to the system shall comprise of two instantaneous pattern 63 mm dia. male inlets shall be with caps and chains complete with sluice valve, non-return valve housed in a M.S. cabinet with glass fronted door. The cabinet shall be suitable for recess mounting.

14.0 SYSTEM DRAINAGE

The system shall be provided with suitable drainage arrangements with G.I. Piping of 50 mm or 80 mm dia. complete with all accessories, and provided with ball valve for drain.

15.0 HYDRANT SYSTEM

- 15.1 The hydrant system shall comprise of AC motor driven pump sets. Diesel pump, Jockey pump etc. with all required accessories including valves, appurtenances, instrumentation and controls etc. complete in all respects. The system shall cover the entire area from independent pipe work from the fire water pump set. The hydrant work shall remain pressurized through the proposed Jockey pump taking care of any leakages in the system pipelines and valve glands. All pumps / motors / engines to be of makes approved by local Fire Authority.
- 15.2 The hydrant system shall be kept charged by pressurized water at approximately 7.5 Kg/cm² at all times. In the event of fire when any of the hydrant valves in the net work is opened, the resultant fall in header pressure should enable starting the Electric Motor driven fire water pumping set through pressure switches automatically. One Diesel Engine / DG set driven pump shall be a stand-by pump serving hydrant system & sprinkler both. In case of failure of electricity or failure of Elec. Pump to start on demand, the stand-by DG set operated pump shall automatically take over. Apart from the automatic starting of the pump sets, provision shall be kept for manual starting also. However shifting down of the pump sets shall be manual.
- 15.3 The hydrant system in the yard shall be furnished with external hydrants consisting of landing valves (positioned approx. one meter above ground level) fitted GI (Heavy) flanged single headed stand pipes installed on underground hydrant headers distributed 45 M apart approximately or as marked on the plan.
- The entire system including all pumps, motors, diesel pump set and panels shall be of approved make by Local Fire Authority.

16.0 PRESSURE GAUGE

All pressure gauges shall be dial type with Borden tube element of SS 304. The dial size shall be of 100 mm diameter and scale division shall be in metric units marked clearly in black on a white dial. The range of pressure gauge shall be 0-50 kg.sq.cm or as specified in BOQ. The pressure gauges shall be complete with isolation cock, siphon tubing, etc.

Sprinkler heads shall be quartzite bulb type with bulb, valve assembly, yoke and the deflector. The sprinkler shall be of approved make and type with 15 mm nominal diameter outlets.

The bulb shall be made of corrosion free material strong enough to withstand any water pressure likely to occur in the system. The bulb shall be shatter when the temperature of the surrounding air reaches at 68 c.

The nominal bore shall 15 mm diameter and color of liquid shall be as per temperature rating.

17.0 TESTING OF THE HYDRANT SYSTEM:

- 17.1 All air shall be trapped from the pipeline through hydrants & air valves. Each section of the pipe shall be slowly filled with the water & allow to stand the water for 2 hours minimum with the ends closed. No joints / connection shall be leaked within this duration. The hydraulic test pressure shall be 1.5 times the designed operating pressure.
- 17.2 Flushing of underground connections: Underground mains and lead-in connections to system risers shall be flushed before connections made to piping in order remove foreign materials which may have entered the underground during the course of installation. For hydrant system the flushing operation shall be continued until water is clear.
- 17.3 Underground mains and lead-in connection shall be flushed at a flow rate of not less than 480 ltrs. per minute.
- 17.4 Provision shall be made for the disposal of water issuing from test outlets to avoid property damage.

17.5 _Acceptance Test

At the time of taking over, the hydrant system shall fulfill the following acceptance tests:-

17.5.1 Starting up of the pressure suction (Jockey Pump) :

The pressure switch shall be set at 7.0 kg/cm² at the lower limit and 7.5 kg/cm² at the upper limit. The system drain shall be opened to cause a drop in the pressure. The Jockey Pump shall start as soon as the pressure gauge needle falls down to 7.0 kg/cm². (The Jockey pump shall also stop automatically when the system has been pressurised again up to 7.5kg/cm² .

- 17.5.2 Jockey is on and till pressure is dropping less than 7.0 kg/cm²,The main electrical pump shall be set to start at 6.8 kg/cm². An external hydrant valve using a single length of hose and branch pipe shall be fully opened to cause a drop of pressure in the system. At first, the jockey pump shall start when the pressure drops from 7.5 kg/cm². Further, drop in the pressure from 7.0 kg/cm² should be allowed to test automatic start-up of the electrical pump. The electrical pump shall continue to run at least for 5 minutes and register rise in the pressure up to 7.5 kg/cm² the Jockey Pump shall be automatically start at this. The electrical pump shall be stopped manually by pressuring the stop button.

- 17.5.3 After having the system got fully charged at 7.5 kg/cm² the external hydrant valve using hose and branch pipe at (ii) above shall be opened. When the pressure has dropped from 7.0 kg/cm², the electric main pump shall come into operation automatically.
- 17.5.4 After the main pump has run for 5 minutes, the power supply in the pump house shall be switched off. The diesel pump shall automatically come into operation immediately.
- 17.5.5 All these tests mentioned above shall be repeated after one hour interval. The result of all the tests shall be identical again. After the system has satisfactorily withstood the above tests, it can be taken over from the contractor.

18.0 START-UP/SYSTEM TESTING

It will be the responsibility of the tenderer to cause interim/stage inspection by the Fire Officer C.F.O during execution of the work as and when so called for by the Employer / Consultant and shall carry out any rectification / modification as may be suggested by the Chief Fire Officer (CFO).

Soon after the work is completed, the contractor shall inform the CFO in writing with a copy to the Consultant/Employer for getting the complete system including all sub system and instrumentation, control etc. thoroughly inspected and tested for satisfactory performance. After satisfactory completion of tests of the system by the CFO, the contractor shall be required to submit as built drawings to the Consultant / OWNER which have been so approved.

19.0 COMMISSIONING OF SYSTEM

- 19.1 Pressurized the fire hydrant system by running the main fire pump and after attaining required pressure shut off the pump.
- 19.2 Open bye-pass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the pre-set pressure. If necessary adjust the pressure switch for the jockey pump. Close bye-pass valve.
- 19.3 Open bye-pass valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump should cut-in at the preset pressure and should not cut-out automatically on reaching the normal line pressure. The main fire pump should stop only by manual push button. However, the jockey pump should cut out as soon as the main pump starts.
- 19.4 Switch off the main fire pump and test check the diesel engine driven pump in

the same manner as the electrically driven pump.

- 19.5 When the fire pumps have been checked for satisfactory working on automatic controls, open fire hydrant simultaneously and allow the hose pipe to discharge water into the fire tank to avoid wastage. The electrically driven pump should

FIRE FIGHTING LIST OF MAKE RECCOMANDED

run continuously for eight hours so that its performance can be checked.

- 19.6 Diesel engine / DG set driven pump should also be checked in the same manner as given in para above by running for 8 hours.
- 19.7 Check each landing valve, male and female couplings and branch pipes for compatibility with each other. Any fitting which is found to be incompatible and does not fit into the other properly, shall be replaced by the Contractor. Landing valves shall also be checked by opening and closing under pressure.

S.N.	Item Name	Makes
1	Hydrant fire water pump	GRUNDFOS / ARMSTRONG / XYLEM
2	Sprinkler fire water pump	GRUNDFOS / ARMSTRONG / XYLEM
3	Diesel fire water pump	GRUNDFOS / ARMSTRONG / XYLEM
4	Jockey pump	GRUNDFOS / ARMSTRONG / XYLEM
5	Terrace booster pump	GRUNDFOS / ARMSTRONG / XYLEM
6	Main fire panel	Siemens/ Schneider/ ABB / PANEL ENCLOSURE BY ARROW/ VIVIDH/ZENTIH
7	LT Cable	KENTER CABLE/ AVOCAB CABLE/ POLYCAB
8	Double compression crimping type gland	COMET/BRACO
9	Cable Trays	PROFAB/INDIANA/OBO
10	Earthing	OBO/JEFTECHNO / EQUIVALENT
11	Heavy grade G.I. Pipes 'C' class & MS pipe	TATA / JINDAL/ ESSAR Fittings - ZOLOTO/ equivalent (ISI Marked)
12	Ball valves	AUDCO / GIACOMINI / Zolotov
13	CI butterfly valves	C&R / KITZ / Zolotov
14	CI Strainers (Y type)	SANT / Honeywell / EMERALD
15	Double flanged Isolation OS & Y type Sluice valves	NEWAGE / Zolotov / SAFEX
16	NRV	Leader / C & R / Castle
17	Dial type Pressure gauge with SS Syphon tubing	H-Guru/Pioneer/Baumert
18	Automatic air vent valve	ANERGY/Newago/GIACOMINI
19	Alarm Valve check valve	Newago/ NITIE/VIKING
20	Single outlet landing hydrant valve	NEWAGE / SAFEX / NITIE
21	RRL hose pipe	NEWAGE / SAFEX / NITIE
22	S.S.orifice plates	NEWAGE / SAFEX / NITIE
23	Gunmetal branch pipe nozzle	NEWAGE / SAFEX / NITIE
24	Sprinkler control valve	TYCO/NEWAGE/Reliable
25	Standard response type sprinklers	TYCO/NEWAGE/Reliable
26	Braided stainless steel flexible pipe	TYCO/NEWAGE/Reliable
27	Rosette plate	TYCO/NEWAGE/Reliable
28	Fire Extinguishres	SAFEX / Cease Fire/Minimax
29	External fire hose cabinet	NEWAGE / SAFEX / NITIN FIRE
30	Brigade connection	NEWAGE / SAFEX / NITIN FIRE
31	RUBBER BELLOWS	RESISTOFLEX / DUNLOP / KANWAL
32	Fire sealant	HILTI/3M

PART-D
(ETP & STP)
EFFLUENT TREATMENT
PLANT WORK

Raw Effluent Tank

The raw water will be collected in a Raw Water tank to be constructed in civil.

Raw Effluent Feed Pumps

Raw water feed pumps will feed the raw water from Raw water tank to Lampak system.

LAMPAK

Lampak is a very compact unit consists of pump, static mixer, flocculator, lamella clarifier, gravity sand filter and dosing systems. It is designed to produce 5 m³/hr. treated water from the raw water having suspended solids (TSS) as high as 800 mg/l.

Static Mixer

The raw water is pumped to static mixer. The static mixer is a stationary device to thoroughly mix chemicals with the raw water. Coagulant such as alum is dosed prior to static mixer. Sodium hypochlorite is dosed for the disinfection of water.

Flocculator

Water from the static mixer fed to the flocculator, prior to which synthetic Polymer is dosed for the effective flocculation. The flocculator also does not have any rotating mechanism. During the retention time of 20 minutes in the flocculator, the coagulated particles come together and forms large flocs that can easily settle in the clarifier.

Lamella Clarifier

Water from the flocculator outlet enters the lamella clarifier section. It is the inclined plates type clarifier, which provides compact design by providing large surface area of the plates. The large flocculated particles slide down on inclined plates and accumulate in hopper bottom of the clarifier and sludge scrapper is eliminated. Clarified water comes out from the top of the clarifier having the total suspended solid (TSS) below 20 mg/l.

Sand Filter

The clarified water from the Lamella Clarifier comes to the gravity sand filter from top for further removal of suspended solids. Typically, less than 30 ppm turbidity water is obtained through the sand filter. The unit also has capacity for backwashing of the sand filter. At a regular interval (typically 8 hours), the sand filter is backwashed.

ETP Parameters: (Raw effluent coming from Laundry, Dialysis beds, OT scrubs and Laboratory of the Hospital Building)

Parameter	Unit	Incoming Raw Sewage Characteristics	Outgoing Treated Sewage Characteristics
Flow	m3/day	150	142
pH	--	5.5-9.0	6.5-8.5
TSS	mg/lit	250-300	≤10 mg/l
BOD	mg/lit	200-250	≤10 mg/l
COD	mg/lit	300-400	≤30 mg/l
Oil & Grease	mg/lit	40-50	Nil
Odour			Nil
Total hardness	PPM of caco3	300-500	≤50 mg/l
TDS		≤300 mg/l	≤150 mg/l
INFECTION/MIR OBIAL COUNT			NIL

Sr No	Equipments	Units	Specifications
1	Bar Screen Chamber		
2	Bar Screen		
	Qty	Nos	
	MOC		
3	Oil & Grease Chamber		
4	Oil & Grease Trap		
5	Equalization Tank		
6	Raw Water Transfer		

	Pump		
	Feed Flow	m3/hr	
	Head	Mtrs	
	MOC		
	Make		
7	Coagulant Dosing System	Make	
	Quantity	Nos	
	Tank	Lts	
	MOC		
	Pump	LPH	
	MOC		
8	Polymer Dosing System	Make	
	Quantity	Nos	
	Tank	Lts	
	MOC		
	Pump	LPH	
	MOC		
9	Disinfectant Dosing System	Make	
	Quantity	Nos	
	Tank	Lts	
	MOC		
	Pump	LPH	
	MOC		

10	Static Mixer	Make	
	Quantity	Nos	
	Size	mm	
	MOC		
11	LAMPAK SYSTEM	Make	
11a	Flocculation		
	Size	mm	
	Flow		
	Volume		
	Retention Time		
	MOC		
11b	Flocculator		
	Quantity		
	Type		
	RPM		
	MOC		
11c	LAMELLA CLARIFIER		
	MOC		
	Over all Size	mm	
	MOC of Plates		
	No of plates		
	Spacing Between Plates	mm	
	Angle of inclination		

	Dimensions	MM	
11d	SLUDGE Recirculation Pump		
	Quantity	Nos	
	Feed Flow	m ³ /hr	
	Head	kg/cm ²	
	MOC		
	Make		
11e	Sand Filter		
	MOC		
	Over all Size	mm	
	Media		
	B/W velocity	m/hr	
	Sevice Velocity	m/hr	
	Backwash Duration	min	
	B/W pump	m ³ /hr	
	Quantity of B/W pump & Blower	Nos	
	Air Agitation	m ³ /min	
12	Clarified Water Tank	Vol	
	MOC		
13	Activated Carbon Filter		
14	Treated Water tank	Vol	

	MOC		
15	ICPW	Lot	
16	Electrical Panel & Cabling	Lot	
17	Sludge Holding Tank	1 no	
18	Centrifuge/Filter Press Feed Pump	1W+1S	
19	Centrifuge/Filter Press	1 No	
20	Poly Dosing System with SS Agitator		
21	Filtrate Pumps	1 No	
22	Ultra violet systems	1 No	

TREATMENT SCHEME & PROCESS:

Multi Grade Sand Filter

The raw water is first passed through a Multigrade sand filter to reduce the suspended solids present in the raw water. The filter will have to be washed with effluent water for 10 to 15 min. daily. This filter is provided to keep a check on the suspended solids.

Activated CARBON FILTER:

Activated Carbon Filter for removal of Chlorine & odor. The unit is made of FRP fitted with Multi port valve. The Unit is filled with Activated Carbon & will remove Free Chlorine up to 3ppm.

Water Softener:

Softener for removal of Harness caused by Calcium & Magnesium Ions. The unit is made of FRP fitted with Multi port valve. The Unit is filled with Cation Resin & will remove Ca & Mg by Ion Exchange Process using Resin & Brine Solution.

CHLORINE DOSING SYSTEM

The specialty Sodium Hypochlorite chemical is dosed for chlorination of disinfection of water to avoid bacterial contamination. The water is dosed with the requisite quantity of chemical by means of an electronic dosing pump. The control is achieved by varying of stroke length and stroke frequency. The dosing pump is mounted directly on top of the solution tank.

ANTISCALANT DOSING SYSTEM

The specialty anti-scaling chemical is dosed to control the scaling tendency of water. The water is dosed with the requisite quantity of chemical by means of an electronic dosing pump. The control is achieved by varying of stroke length and stroke frequency. The dosing pump is mounted directly on top of the solution tank.

CONTROLS & ELECTRICAL WORK

1.0_ General

- a. The various controls listed below shall be electrically operated and generally comply with the specifications listed below:
- b. In case of low voltage controls necessary step-down transformers shall be provided with each control as required.

2.0 ELECTRICAL PANEL:

One (1) common control panel for the operation, controls and monitoring of complete Sewage treatment system which comprising of:

- a. Relays, Terminal blocks,
- b. All necessary auxiliaries
- c. Control panel details:

Type / duty: Indoor application Standard for wiring: International standard for electrification Internal protection: IP 54 Outdoor Protection: IP 64

- d. Control panel features following controls:
 - i. ON / OFF / TRIP indication lamp for all the electrically driven equipment,
 - ii. Duty / standby indication lamps for all electrically driven equipment,
 - iii. AUTO / OFF / MANUAL selector switch for all the electrically driven equipment.
 - iv. High-high level indication for the tanks,

- v. Trip alarm for all electrically driven drives,
- vi. Alarm (mute) acknowledgement switch,
- vii. Alarm reset switch,

3.1. Contactor

Motor starter contactors shall be of the electromagnetic type rated for uninterrupted duty as defined in applicable standards.

Main contacts of motor starter contactors shall be of silver-plated copper.

Each motor starter contactor shall be provided with two NO and two NC auxiliary contacts.

Insulation class of operating coils shall be class B or better.

Operating coils of contactors shall be suitable for operation from the specified control supply system.

Contactors shall be of the double break, non-gravity type.

One number spare auxiliary contactor with 4 No./4NC contact along with its coil completely wired up to the terminal should be provided.

3.2. Direct On Line Starters

Direct on line starters shall be suitable for Class AC 3 utilization category.

3.3. Reversing Starters

Reversing starters shall comprise forward and reverse contactors, electrically interlocked with each other. Reversing starters shall be suitable for Class AC 4 duty.

3.4. Thermal Overload Relays

Starters shall be complete with three elements, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings. The settings range shall be properly selected in accordance with the rating of the motor.

Thermal overload relays shall be hand reset type. 'Stop' push button of the starter and hand reset device shall be separate from each other.

Overload relay hand reset push button shall be brought out on the front of the compartment door. Overload relay shall be provided with at least one 'NO' and one 'NC' or one change over contact.

3.5. Current Transformers

Current transformers shall be of the dry type.

Current transformer shall have a short time withstand rating equal to the short time withstand rating of the associated switchgear for one second.

Unless otherwise specified, the minimum performance requirement of current transformers is as follows:

- a) Measuring CTs 7.5VA, accuracy class 1.0 and an instrument safety factor of 5.
- b) Protective CTs 7.5 VA, accuracy class 5P and an accuracy limit factor of 10.
- c) Notwithstanding the above it shall be the VENDOR'S responsibility to coordinate the current transformer burden with the requirements of relays, instruments and leads associated with that particular current transformer.
- d) Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests.
- e) All current transformers shall be earthed through a separate earth link on the terminal block to permit easy measurement of the current transformer insulation resistance. (CTs built in with the thermal relays of the contactors are excluded).

3.6. Voltage Transformer

Voltage transformers shall be of dry type.

Unless otherwise specified, the minimum performance requirements of voltage transformers are as follows:

- a) Measuring VTs 15 VA per phase and accuracy class 1.0.
- b) Protective VTs 15 VA per phase and accuracy class 1.0.
- c) Dual purpose VTs 100 VA and dual accuracy class 1.0/3.0 for metering and protection respectively. VA is per phase.

All secondary windings of voltage transformers including open delta windings shall be rated for 110/ 3 V per phase.

Voltage transformers shall have a continuous overvoltage factor of 1.2 and short time overvoltage factor as follows:

1.5 for 30 seconds in case of effectively earthed. 1.9 for 8 hours in case of non-effectively earthed system.

Voltage transformers shall be complete with suitable rated primary, secondary and tertiary fuses. Primary fuses shall have a rupturing capacity equal to the rupturing capacity rating of the associated switchgear. Fuses shall be provided on each sub circuit.

It shall be possible to replace voltage transformers without having to de energize the main bus bars.

The terminals of V.T. secondary and tertiary windings which are required to be connected to earth shall be earthed by an isolating link without a fuse.

Single phasing preventers relay shall be provided when required to protect motor against single phasing. The relay shall not operate for supply voltage unbalance of + 5% but shall positively operate for supply voltage unbalance of more than + 5%. The relay shall operate in the event of a single phase fuse blowing even though the motor c.m.f. in the concerned phase is of the order of 85%.

After sensing single phasing the relay shall operate with a time delay of 2 to 3 sec. The relay shall not operate for a 3 phase power supply failure. The relay shall be of the hand reset type with a hand reset push button. Resetting shall be instantaneous and independent of the adjusted time delay in the tripping of the unit. Visual indication for the operation of the relay shall be provided.

The relay shall be suitable for application to protect reversible and non reversible motors. The relay operation shall be independent of the motor KW rating, the loading conditions prior to the occurrence of the single phasing and rpm of the motor. The relay shall be of the fail safe type and shall operate to trip the motor when the relay internal wiring is accidentally open circuited.

3.7. Relays

The following clauses shall apply to the protective relays.

Relay shall be

- a) Enclosed in dust proof flush mounting draw out type cases.
- b) Accessible for setting and resetting from the front.
- c) Provided with positive acting hand reset flag indicators visible from the front.
- d) Access to setting devices shall be possible only after the front covers are removed. Access to resetting devices shall be external to the case.
- e) Auxiliary relays shall be rated to operate satisfactorily between 70% and 110% rated voltage.

- f) Each relay shall be provided with at least two separate voltage from contacts.
- g) Make and type of relays shall be subject to the EIC approval.

3.8. Indicating Instruments and Meters

Electrical indicating instruments shall be of minimum 96mm x96mm square size, suitable for flush mounting.

Indicating instruments shall have provision for zero adjustment outside the cover.

Instrument dials shall be parallax free with black numerals on a white dial.

Ammeters provided on motor circuits shall be provided with a suppressed extended scale to indicate motor starting current.

Watt-hour meters shall be of the direct reading electro dynamometer type complete with cyclometer type dials and reverse running stops.

3.9. Indicating Lamps

Indicating lamps shall be:

- a) The filament type and of low watt consumption
- b) Provided with services resistors
- c) Provided with translucent lamp covers of colours 'Red', 'Green' and 'Amber' as required in the control wiring diagrams.
- d) Bulbs and lenses shall be easily replaceable from the front.

3.10. Control and Selector Switches

Control and selector switches shall be:

- a) The rotary type
- b) Adequately rated for the purpose intended (Minimum acceptable rating is 10A continuous
at 240V AC and 1A inductive break) 220V DC.
- c) Provided with escutcheon plates clearly marked to show the positions.
- d) Control switches for circuit breakers shall be provided with pistol grip type handles.

- e) Control switches for circuit breaker control shall be provided with Contact development and sequencing device.

Selector switches shall be:

- a) Of the maintained contact stay put type. Switches in ammeter circuits shall have make before break type contact.
- b) Provided with oval handles.

3.11. Push Buttons

Push button shall be:

- a) Of the momentary contact, push to actuate type rated to carry 10A at 240V AC and 1A (inductive breaking) at 220V DC.
- b) Fitted with self-reset, 2 NO and 2 NC contacts.
- c) Provided with integral escutcheon plates marked with its function.
- d) 'Start', 'Open', 'Close' push buttons shall be green in colour.
- e) 'Stop' push buttons shall be red in colour.
- f) All other push buttons shall be black in colour.
- g) Emergency Stop' push buttons shall be of the lockable in the pushed position type and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button.

3.12. Cable Terminations

Suitable compression type heavy duty brass cable glands with nuts, rubber sealing ring and brass washers mounted on a removable and control cables entering the switchgear shall incorporate built in facilities for earthing the wire armour of cables. Cable glands shall be plated to avoid corrosion.

Power cable glands and crimping type lugs shall be supplied to suit the cable sizes given in clause 3. If during course of detailed engineering of the switchgear it is found necessary to provide more glands or glands of higher size than those envisaged the vendor shall provide and accommodate the same.

Wire Sizes:

The vendor shall select the power cable glands and lugs based on the following cable sizes.

Type of cable:

1100 V grade stranded copper conductor PVC insulated PVC sheathed armoured and outer sheathed FRSL coated cable conforming to IS:1554 Part I.

KW Rating Service	No. of cores x conductor size (mm ²)	approximate overall diameter/mm
Upton 3	3 x 4	18
3.1 7.5	3 x 6	19.5
7.6 1.5	3 x 16	24
16 25	3 x 35	30
26 40	3 x 70	34
41 55	3 x 120	40
56 70	3 x 185	49
71 85	3 x 240	55.5
86 110	3 x 400	60
111 175	3 x 1C x 500	
Space Heating	2 x 6	19

For supporting & clamping cable cores at regular intervals inside the cable alleys, suitable shuttled angles, up to the respective terminal blocks shall be provided.

Necessary crimping type of tinned copper cable lugs for connecting the individual cores to the respective terminals shall be provided.

3.13. Internal Wiring

Control wiring shall be of the rating of 650V and power wiring shall be of the rating of 1100V.

Wiring inside the switchgear shall be carried out with 1100/650 V grade, PVC insulated, stranded conductor wires. Minimum size of conductor for power circuits is 4 sq.mm copper or equivalent size aluminum conductor. Control circuits shall be wired with copper conductor of at least 2.5 sq.mm for CT circuits and 1.5 sq.mm for other circuits, the number and size of strands shall be 7 of 0.67 mm and 0.5mm diameter respectively.

Engraved identification ferrules, marked to correspond with the wiring diagrams shall be fitted to each wire. Ferrules shall be of yellow colour with black lettering.

Wires forming part of a tripping circuit of circuit breaker shall be provided with an additional red ferrule marked 'T'.

Spare auxiliary contacts of all equipment forming part of the switchgear shall be wired up to the terminal blocks.

Spare and unassigned modules shall be complete with internal wiring.

Wiring shall be terminated on preferably stud type terminal blocks such that the wires are connected by cable lugs with nuts and washers/lock nuts.

Not more than two connections shall be made on any one terminal.

3.14. Terminal Blocks

Terminal blocks (both for power and control circuit) shall be of reputed make especially for CT and VT circuit. It shall comprise of finely threaded pairs of brass studs of at least 6mm diameter, links between each pair of studs, washers, nuts and locknuts. The studs shall be securely locked within the mounting base to prevent their turning. Insulated barriers shall be provided between adjacent terminals.

Terminals for circuits with voltage exceeding 125 V shall be shrouded. Terminal blocks shall be grouped depending on circuit voltage. Different voltage groups of terminal blocks shall be segregated.

Terminal blocks shall be adequately rated to carry the current of the associated circuit. Minimum rating of the terminal block is 10A.

Terminals shall be numbered for identification. Engraved white on black labels shall be provided on the terminal blocks, describing the function of the circuit. Where duplication of a terminal block is necessary it shall be achieved by solid bonding links.

Terminal blocks for CT secondary lead wires shall be provided with shorting and disconnecting/ earthing facilities.

Terminal blocks shall be arranged with at least 100mm clearance between two sets of terminal blocks. Control terminals for external connections shall be suitable for terminating at least two conductors each of 2.5 sq.mm size.

3.15. Labels

All labels shall comprise white letters on a black background.

Labels shall be made of non-rusting metal or 3 ply lamicaid, or engraved PVC.

Labels shall be properly fixed, with provision to prevent distortion due to expansion.

Size of lettering shall be 6mm.

3.16. Earthing

Each MCC and LCC shall be provided with an earth busbar running along the entire length of the board. Material and size of the earth busbar shall be as specified in data sheets. At either end of the earth bus, one (1) clamp type terminal with nuts, bolts and washers shall be provided for bolting the main earthing conductor of size and material indicated in data sheets. In case the earth bus is provided near top of the switchgear, one down comer at either end shall be provided for connection to the main earthing conductor.

Earth busbars shall be supported at suitable intervals.

Positive connection between all the frames of equipment mounted in the switchboard and earth busbar shall be provided by using insulated copper wires/bare busbars of cross section equal to that of the busbar, or equal to half the size of circuit load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to the earth busbar using 1100/650 V grade, 2.5 sq.mm stranded, copper, earthing conductor.

3.17. Local Push Button Stations

Constructional Features

The constructional features of the local push button stations shall be as follows:

- a) Metal enclosed weather proof suitable for mounting on wall or steel structures. The enclosure shall be die cast aluminum or sheet metal of 2mm thickness.
- b) Dust and vermin proof.
- c) Provide a degree of protection of not less than IP:54.
- d) Metal parts shall be given tropicalizing treatment as per standards and painted with one coat of epoxy primer and two coats of light grey epoxy paint.
- e) Provided with inscription plates of rear engraved Perspex with white letters on black background. The letter size shall be 6mm.

- f) Provided with two earthing terminals suitable for 8 SWG G.I. wire.
- g) Provided with removable undrilled gland plate and adequate members of cable glands
for PVC insulated, armoured cable. The cable entry shall be from the bottom.
- h) All local push button stations shall have locking facility. The lock switch shall have two positions "locked" and "unlocked". When in unlocked position the switch shall allow individual starting of the equipment. Start/stop push buttons provided for local operation of the equipment shall be provided on the same enclosure and stop push buttons shall be lockable in stop position. The lock switch shall be key-operated.

3.18. Push Buttons

- a) The Open/Close/Start push buttons shall be of the momentary contact push to actuate type.
- b) The stop push buttons shall be stay put type with mushroom knob.
- c) All push buttons shall be :
- d) Fitted with two (2) normally open and two (2) normally closed contacts rated to carry and break 6 Amps at 415 Volts. (10A at 240 AC).
- e) Provided with integral escutcheon plates marked with its function.
- f) 'Open/Close/Start' push buttons shall be green colour.
- g) 'Stop' push button shall be red in colour.
- h) Wiring

The push button stations shall be as follows : Push button station Type A Each P.B., station shall comprise three push buttons viz. 'OPEN' 'CLOSE' and 'STOP' for control of reversible motors.
- i) Push button station type B Each P.B. station shall comprise two push buttons viz. 'START' and 'STOP' for control of non reversible motors.
- j) Push button station type C Each P.B. station shall comprise only one push button i.e. 'STOP' for emergency stop function.
- k) Power Electricity at specified voltage (415/220V).

3.19. Drawings and Data

As part of proposal BIDDER shall furnish the following drawings and data:

- a) For each switchgear, overall dimension drawing showing front view, plan, elevation and cross section.

- b) All drawings and data sheets shall be annotated in English

3.20. Circuit Breakers

The panel and the bus bars plus outgoing of all devices shall be protected by different types of circuit breakers as described below and conforming to specification as given later on:

Sl. No.	Type	Upto 40 Amp	Upto 63 Amp	80 – 200 Amp	200 – 400 Amp	Above 630 Amp
01	Incoming	MCB	MCCB	MCCB	MCCB	MCCB
02	Outgoing	MCB	MCB	MCCB	MCCB	MCCB

Moulded Case Circuit Breakers (MCCB)

The MCCB shall have TP + NL and be suitable for simultaneous manual opening and closing with rotary operating handle.

The ON/OFF/TRIP positions shall be clearly marked and easily visible to an operator and confirm to latest IS: 13947-1993.

There shall be fixed/adjustable tripping devices with inverse time characteristics for overload and short circuit protection.

Suitable Interlocking mechanism shall be provided, where required.

Miniature Circuit Breakers (MCB)

The MCB shall have quick make/break contacts with a heat resistant housing, having high Impact strength and confirm to IS 8828-1996.

The contacts shall be of silver nickel alloy.

The MCB shall permit over load for short duration, as required for Inductive loads and the breaking capacity shall not be less than 10 KV at 415 Volt A.C.

It shall be equipped with overload and short circuit protection devices and shall be suitable for DIN mounting.

Isolator Switches

Isolator switches are to be provided for equipment located outdoors or for those located in separate enclosure, other than those Nos. having the Electric Panel.

The Isolator Switch should be of Rotary Load Break type with a weather proof sheet steel enclosure. Its rating shall be same as the outgoing device in the Electric Panel.

3.21. Contactors

All non-inductive loads shall be provided with suitable sized magnetic contactors.

The contactors shall have 3/4 poles plus a minimum 2 'NO' and 2 'NC' contacts. All contacts shall be of solid silver.

The No volt coil shall generally be suitable for 220 Volts + 10%, - 15% (wide band type) A.C. supply except when specified or required otherwise.

3.22. Starters

The type of starters to be provided for the motors shall be as follows :

Squirrel Cage motors: up to 7.5 HP (5.6 KW) Direct on Line Type

Squirrel Cage motors: Above 7.5 HP (5.6 KW) Automatic Star Delta Type

Compressor motor: Above 300 HP (225 KW) Automatic Auto Transformer (where specified) All starters shall have auxiliary contacts for interlocking different machines, connecting indicating lights, controls, alarms, etc.

All starters shall be provided with separate single phasing preventers.

Direct On-Line Starters

These starters shall have heavy duty air break contactors of suitable rating.

These starters shall be complete with adjustable overload relays on all three phases, single phase preventing device and under voltage release. The starters should be "hand reset" type.

The "No Volt Coil" of these starters shall be 220 Volts + 10% - 15% (wide band type) whenever any controls or safety devices are connected in the starter's circuits, otherwise standard 415 volts coils may be used. There shall be ON-OFF push button for each starter unless remote operation of the starter is required. Digital type Ammeter and voltmeter and energy meter to be fixed to the enclosure along with the necessary wiring.

3.23. Automatic Star Delta Starters

These starters shall have heavy duty air break contactors of suitable ratings along with an adjustable timer to automatically switch the motor connections from star to delta connections.

Each starter shall be complete with adjustable overload relays on all three phases and under voltage release. The starters should be "hand reset" type.

The "No Volt Coil" shall be of 220 Volts + 10% - 15% (wide band type) rating wherever any controls of safety device are connected in the starter circuit, otherwise standing 415 volts coils may be used. There shall be ON-OFF push button for each starter unless remote operation of the starter is required. Digital type Ammeter and voltmeter and energy meter to be fixed to the enclosure along with the necessary wiring.

3.24. Automatic Auto -Transformer Starter

These starters will be oil immersed, each one fixed on a separate panel.

Necessary devices shall be provided for the automatic tap setting of the starter.

The starter should have "No Volt Coil" wide band type circuit of 220 volts to be connected to control circuits.

The Motor starter shall be in accordance with IS 1882. The starter shall be totally enclosed metal clad, dust and vermin proof construction. The starter shall be of continuous rating.

Contactors shall have the number of poles as required for appropriate duty. The making capacity of the starters shall be suitable for AC 3 duty.

3.25. Panel Accessories

All Voltmeters and Ammeters as specified shall be square of 96 mm x 96 mm, flush mounting type. The Indicating Lamps shall be of LED type with Low Watt Power. The Lamps shall have translucent covers of following colours.

- Red/Yellow/Blue for phase light.
- Green/Amber for ON/OFF indication.
- Concealed door lock.

3.26. Subsidiary Panels (With Single Switch)

Subsidiary panels shall be provided for equipment located away from the plant room, such as air handling units, blower etc.

The construction of these panels should be similar to the main panel and shall have all related accessories, except when specified.

The sub panel shall be wall hung type and as compact as possible.

Panel fabrication drawings shall be got approved before fabrication.

3.27. ENCLOSURES FOR CONTROLLERS AND ELECTRICAL PANELS

All the Panel shall be housed in Lockable Vandal proof boxes which shall either be floor mounted or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.

The panel shall be metal enclosed 14 SWG CRCA sheet steel cubicle with gaskets between all adjacent units and beneath all covers to render the joints dust proof. All doors and covers shall be hinged and latched and shall be folded and braced as necessary to provide a rigid support. Joints of any kind in sheet metal shall be seam welded with welding slag grounded off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with nuts. Self-threading screws shall not be used in the construction of control panels. Knockout holes of approved size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. Clamps shall be provided to support the weight of the cables. The dimension of the boxes shall depend on the requirement with the colour decided in consultation with the Architect/Consultant.

Note: All panel enclosures shall be suitable for Indoor application (IP 54 protection) and UL listed. **The system shall have capability to interface with the BMS & FAS System.**

4.0. Installation, testing, commissioning:

4.1 Installation of all equipment's at site, testing of all equipment's, commissioning of process is included in scope of work. Necessary raw sewage will be provided by client. In case of absence of raw sewage/ sludge even after one month from installation, system will be tested with plain water. Commissioning will be carried out within 1 month from date of completion of all erection and installation activities.

The drawings show the suggested flow diagram and a feasible layout of various tanks and equipment. The tenderer shall make the following submittals along with the tender.

- i) A detailed process narrative and a flow diagram
- ii) Suggested plant layout conforming to the space provisions made.
- iii) Deviations from specifications stating necessity and financial implications.
- iv) Confirmation of plant conformance to the state pollution control standards as well the specified quality standards.

4.2 On award of the contract, final detailed layouts and shop drawings of equipment and piping shall be submitted for approval. The process flow diagrams and plant layout drawings shall be submitted simultaneously to the state P.C.B and approvals

obtained. These approvals will enable the contractor to proceed with the procurement and fabrication.

4.3 All civil works will be constructed by others in accordance with the approved drawings but all internals and inserts for ingress into the civil elements shall be provided by the contractor.

4.4 All piping within the battery limits shall be the responsibility of the contractor. Piping handling sewage shall be of cast iron M.S and water piping shall be of heavy-duty galvanized steel.

4.5 The installation shall be carried out in a workman like manner and to approved drawings. All equipment shall automatically start and stop to a programmer. Twin equipment, one working and one standby, shall operate alternately in a manner to have equal run time over one week.

4.6 Before starting up the plant, the contractor should have it inspected and approved by PCB and the Project Managers. Contractor should arrange for necessary seeding microbial mass for the startup of the plant. The plant shall be operated for 2 days of 24 hours each before test readings and taken in accordance with Annexure 2.3-1. The plant shall be operated for at least 2 weeks after stabilized system performance or 6 weeks whichever is later. All consumables, operating personnel for the above duration shall be borne by the contractor.

5.0 Mode of Measurement

5.1 Supply, installation, testing and commissioning of the entire sewage treatment plant shall be treated as one unit for purpose of measurement and payment. The work embraces.

1. Supply of detailed drawings of the process, the plant and all appurtenant civil works.
2. Supply installation and testing of all plant viz
 - i) Effluent pumps
 - ii) Sludge pumps
 - iii) Blowers, piping network with valves and diffusers
 - iv) Doses
3. All interconnected piping, tank internal and inserts.
4. Obtaining approvals from PCB and any other statutory bodies.

5.2 Tertiary equipment shall be measured as described in the schedule of work.

5.3 Variable speed pumping shall be measured as described in the schedule of work.

5.4 All electrical work shall be measured as described in the schedule of work.

Annexure-3

Compact Effluent treatment plant (ETP) with complete system (To be filled by Tenderer)

1.0 Capacity of RCC tanks

- i. Raw Effluent tank(collection Sump) (size m x m x n)
- ii. Coagulation tank (size m x m x n)
- iii. Flocculation tank (size m x m x n)
- iv. Clarfier tank (size m x m x n)
- v. Any other RCC tank (size m x m x n)

2.0 Vendor to specify all consumables required for full capacity operation of the ETP per day.

- i.
- ii.
- iii.
- iv.
- v.

3.0 Vendor to specify connected load and maxir CL Kw MD Kw

- i. Sump Pumps (1+1)
- ii. Raw Effluent pump (1+1)
- iii. Blower (1+1)

4.0 Vendor to specify maximum guaranteed power consumption of the plant at different operating capacities.

37 Kl / day	kwh
75 Kl / day	kwh
150 Kl / day	kwh

5.0 Vendor to specify operating charges per month including cost of all consumables excluding electricity.

Year 1	Rs / month.....
Year 2	Rs / month.....
Year 3	Rs / month.....
Year 4	Rs / month.....
Year 5	Rs / month.....

6.0 Vendor to specify comprehensive maintenance contract charges per year after expiry of 36 months DLP.

Year 1	Rs / Year.....
Year 2	Rs / Year.....

7.0 **(A)** Vendor to submit following documents.

- a) Supply P & I diagram
- b) ETP Layout
- c) GA drawings for civil unit with requisite
- d) Technology used to treat the Effluent Basis of design for Effluent treatment plant including characteristics of treated.
- e) The design has to be as per requirement of All necessary required statutory and legal documentation, licensing etc.

(B) To offer trial run, Guarantee run with to operate the plant for 1 month from the date of completion with all cost of manpower, consumable etc.

(C) The treated effluent water is proposed to be used for cooling.

(D) Supply of material : supply of all material, equipment, electrical, mechanical is in scope of tenderer.

(E) Water and Electricity : required shall be arranged by Tenderer at his own cost.

(F) Civil work : Necessary civil work for ETP shall be carried out by the Civil contractor. The Tenderer should give details of civil work required for ETP.

Sign of Tenderer with stamp

SEWAGE TREATMENT PLANT (STP)

TECHNICAL SPECIFICATIONS FOR SEWAGE TREATMENT PLANT

PREFACE

Supply Installation, testing & commissioning of STP work for the Entire Hospital.

SCOPE OF WORK

The scope of work covers supply, installation, testing and commissioning of **MBR type MODULAR TYPE Compact Sewage Treatment Plant**. The final effluent quality after the primary and tertiary treatments shall meet the quality standards specified or the requirements of the local/central pollution control authorities whichever is more stringent.

1.0 The treatment process proposed is for a contact stabilization plant to produce and maintain the quality standards of effluent as set down in the section "DESIGN CRITERIA". If the tenderer, by virtue of his experience and process know how, considers that the specified process needs modification and/or addition to meet the specified end results, the tenderer should lay down such modifications and/or additions together with its merits and demerits and also the additional costs.

The tenderer may even propose any proven alternate process with all the details and costs.

The tenderer should also obtain the approval of the State Pollution Control Board (PCB) not only for the process but also for operation of the plant after it is commissioned.

The Process

2.1: The process plant shall essentially consist of the following:

- 1) A primary sedimentation and flow balancing tank with bar screens and grit Chamber. (shall be in civil scope).
- 2) Inlet wastewater piping with valve spool
- 3) Compact Sewage treatment plant tank of MSEP/FRP with required partitions for process flow.
- 4) 2# sewage pumps, one working and one standby for lifting sewage from the Primary tank to the compact Sewage treatment plant.
- 5) Secondary basket screen
- 6) Internal piping and cabling - complete
- 7) Integral Bioreactor
- 8) Air blowers with air diffusion grid-work
- 9) Integral bio-sludge Settler
- 10) MBR water tank
- 11) Bio-sludge recycling and dewatering system
- 12) 1# Filter press

- 13) Sludge re-circulation pumps, one working and one standby.
- 14) 2 Nos filter pumps
- 15) Control panel with necessary instrumentation such as flow meter, energy meter, faults annunciation panel, etc.
- 16) Electrical incomer cabling and earthing
- 17) The Hypo-sodium dosing treatment of the effluent, shall be consists basically of

3. Process Description:

Coarse Bar Screen

Raw sewage from the source is usually received into the bar screen chamber by gravity. Screen provided will remove all floating and big size matter such as plastic bottles, polythene bags, glasses, stones, etc., which may otherwise choke the pipeline and pumps. Coarse Bar Screen size of 10 mm is suggested for removal of coarser materials at the inlet line to Equalization Tank.

Fine Bar Screen

Trash and non-biodegradable solids, such as hair, lint, grit and plastics may foul or damage the membranes if allowed to pass into the membrane chamber. An internally-fed screen with punched-hole openings less than or equal to 6 mm in diameter with no possibility of bypass or carryover is absolutely required to maintain both membrane warranty, and optimal MBR operation.

Oil and Grease Trap

If the sewage generated includes maximum quantity from kitchen and Canteen, there is a possibility of higher concentrations of OIL and GREASE in the raw sewage. It needs to be removed / separated before biological treatment as it otherwise may cause problems for biological treatment. Usually, a small tank with a baffle wall and slotted oil pipe skimmer/Belt Skimmer is to be provided by client. The oil and grease removed by gravity floats to the surface, which is to be removed manually. In case of large installations, this can be mechanized by client.

Grit Chamber

The sewage before enters to the Equalization Tank is passed through the Grit Chamber wherein the grit and other heavy particulates that can cause abrasion to the surface and the membranes. The heavy particulates settle quickly at the bottom of the tank and the inlet sewage overflow to the Equalization Tank.

Equalization Tank (Civil Construction)

Usually, sewage generation is more during morning hours and evening hours. Visually no sewage is generated during night hours. Any biological system needs constant feed for bacteria to work efficiently. Hence, it is important to install an equalization tank upstream of the Biological Tank to collect the variable & excess flow during peak hours and feed sewage in lean hours. The required equalization volume can also be

incorporated into the biological tank under certain circumstances and a typical equalization tank has a capacity of 8 – 10 hours of average flow rate. The tank is generally of civil construction by client.

Provision of air grid is to be made for thoroughly mixing the sewage to make it of homogenous quality and to keep the suspended matter in suspension and to avoid septic conditions.

Transfer of Sewage

Sewage Transfer Pumps (Eq Tank to Biological system)

Ion Exchange's scope starts from transfer of sewage from Equalization Tank to Biological System. The discharge distance of transfer should not exceed beyond 10 meters. The transfer pump can be either submersible or non-submersible type for this application. The pump should not run dry and Client to ensure sufficient sewage is available in the Equalization Tank.

Automatic Fine Screen 3 mm size.

In the discharge line of the raw sewage pump before entering the Anoxic tank or Aeration tank, 3 mm Automatic Fine screen is provided to ensure, above 2 mm particulates and hair are separated.

Anoxic Tank

The raw sewage thoroughly mixed with the sludge re-circulated from MBR tank. The sufficient hydraulic retention time ensures nutrient reduction. Sufficient quantity of Ferric or Non-ferric Alum is also dosed for reduction of Phosphates.

Aerobic Treatment in Biological Tank

Screened waste water from Equalization Tank / Anoxic Tank will flow to bioreactor where MLSS is maintained by ensuring proper aeration to maintain required MLSS to degrade the BOD and other bio de-gradable contents of waste water.

The process aeration blowers provide air for the biological tank and ensure that sufficient oxygen is available to maintain the biological processes in the tank. A fine bubble diffused aeration system delivers air from the aeration blowers to the aerobic zone of the process tank.

To maintain the MLSS, recirculation of sludge is carried out from MBR Tank either directly or through Anoxic Tank.

4. The Process

MBR Tank

We are proposing sewage treatment plant with state-of-the-art membrane separation technology called as Membrane Bio-Reactor (MBR) which can produce very good quality with highest possible bacterial reduction without adding any chemicals. MBR (Membrane Bio Reactor) is the latest technology in wastewater treatment. MBR has many advantages such as higher quality of treated water, smaller space for installation and easier operation compared to conventional activated sludge process.

Designed to produce high quality treated water from wastewater the **Membrane Bio Reactor (MBR)** is among the latest technologies in biological treatment.

The characteristic of the MBR process is the use of revolutionary submerged Ultrafiltration membranes in the biological process water tank, so as to produce high quality permeate from domestic sewage, primary and secondary waste water, cooling tower blow down etc. The **INDION** MBR is also ideal for retrofitting/augmenting capacity/quality of existing wastewater plants.

The MBR can handle very high sludge concentrations in the Aeration Tank because of which the size of the aeration tank reduces four to five folds. As the membrane acts as a fine filter, it does not require any further treatment using sand filters, activated carbon filters, etc. The MBR is available in standard and customized modules.

Activated sludge in the Aeration Tank is clearly separated by the Hollow Fibre type submerged membrane. The membrane module consists of module cassette housing, aeration manifold diffusers, permeate water manifold and membrane modules. The membrane element consisting of hollow fibre modules properly supported at top is set up vertically. Feed water including activated sludge is filtrated by hollow fibre membranes with pore size of 0.1micron meter. The air bubbles supplied from the bottom of the membrane elements continuously scour off cake of activated sludge accumulated on the membrane surface. This is continuous filtration operation. The air bubbles are also used for the biological reaction to decompose organic substances included in the raw sewage.

MBR MODULE

The material of the membrane is PVDF (Poly Vinylidene Fluoride), non-ionic and hydrophilic in nature. PVDF is fluorine polymer, which has high stability for chemicals and good physical strength. The form of membrane is reinforced Hollow Fibre membrane of appr. 0.95 mm outside diameter and 0.47 mm inside diameter. The membrane has small and uniform pore size. Therefore, the rejection property of this membrane is excellent. Almost all particles with nominal sizes more than 0.02micron meter can be removed effectively using this membrane.

The mixed liquor from the bioreactor/biological/Aeration Tank will flow to membrane tank by gravity to Hollow Fibre membrane installed in the Membrane Bioreactor Tank. The proposed system has either Single or two train of membrane tank. Periodically, activated sludge is wasted to maintain desired system SRT.

One duty and one standby membrane aeration blowers are included to provide membrane air scouring. The air scouring on the membrane is to avoid accumulation of sludge on the surface of the membranes that may hinder permeability of membrane.

Permeate/Back Pulse Multipurpose Pump

One permeates pump per train is employed to draw water through the membranes. Under normal operation and average day flow conditions, permeation is stopped for a specific period of time at regular intervals. This is mentioned as membrane relaxation period in which there is no permeate drawn from the MBR but the operation is combined with air scouring, effectively removes solids that have accumulated on the membrane surface or within the fibers and reduces electrical costs. At the same time, the same permeate pump with Automatic valve arrangement is provided for back pulsing the membranes. Under increased flow or adverse sludge conditions, the operator is able to select a "back pulse" mode. In this instance, the Back-pulse pump will reverse the flow of permeate through the membrane fibers to dislodge solids that have accumulated on the membrane surface or within the fibers. This operation is to ensure the membrane pores are cleaned with forced permeate water from Inside Out and Air Scouring outside the membranes.

Mixed Liquor Recirculation Equipment

Recirculation pumps are used to transfer mixed liquor from the Membrane Tank to Bioreactor. The effluent overflows by gravity from Bio-Reactor tank/Aeration Tank to the Membrane tank at a rate. The sludge recirculation transfers solids away from the membranes and provides proper distribution within the bioreactor.

Treated Water Collection Tank

The treated water collection tank can be of civil construction by client in case required. Generally, 8– 10 hours storage is recommended as the usage in the night time is less and day time is more whereas the biological system gives the average flow needs to be stored when usage is less.

5. Sodium Hypo Chlorite Dosing System for Treated Water

Dosing of Sodium hypochlorite helps in disinfecting the water and making it suitable and safe for gardening and flushing and other applications after post treatment. The chemical is dosed by means of an electronic dosing pump wherein a facility is available for manual control of stroke length and / or stroke frequency. Based on the Pollution Control Board treated water requirements, the Free Residual Chlorine (FRC) of appr. 1.0 ppm is maintained to reuse the water for various applications.

Cleaning System

The membranes are subject to fouling and the membranes needs to be cleaned periodically to get a better yield from the membranes. The frequency of cleaning depends on the fouling and appr. Weekly once or twice the in-situ cleaning and soaking is carried out using Sodium Hypo Chlorite or Citric Acid and this is done as a preventive

maintenance cleaning schedule in most cases to avoid any major break down cause irreparable damage to the system.

Though the preventive cleaning is regularly done, it is also envisaged some amount of fouling is still present in the membranes requires shut down of the MBR system and soak with chemical solution in the MBR tank. The frequency may be once or twice in a year that depends on the fouling rate.

Sodium Hypochlorite Dosing system

The Sodium Hypochlorite Dosing system is used during membrane cleaning applications to remove organic fouling from the membrane surface. The chemical is dosed during back pulse and allow the membrane to soak for the determined period to improve the performance of the membrane by removing the fouling of foreign matters especially organic matter adhered to the

surface. The chemical is also used during maintenance clean during such time the entire MBR tank is filled with chemical and the frequency depends on the intensity & nature of fouling.

Citric Acid Dosing System

The Citric Acid Dosing system is used during membrane cleaning applications to remove inorganic scaling from the membrane surface. The chemical is dosed during back pulse and allow the membrane to soak for the determined period to improve the performance of the membrane by removing the fouling of foreign matters especially inorganic matter adhered to the surface. The chemical is also used during maintenance clean during such time the entire MBR tank is filled with chemical and the frequency depends on the intensity & nature of fouling.

Sludge Handling System

The accumulated sludge from Eq Tank, Anoxic Tank, Aeration Tank and MBR tank is removed periodically. The MLSS is also diverted from the recirculation return line, via manual control or by pulling directly from the bioreactor. The frequency of removal is a function of influent characteristics, reactor design and operator preference. In certain operating circumstances, bioreactors can be designed to accommodate client preferences with regards to removal frequencies. The Polyelectrolyte addition will help to thickening & dewatering the sludge.

There are various options that can be provided depends on the site conditions and preference by client.

Sludge Storage Tank:

Sludge Storage Tank needs to be provided in the base of the units. Depending on the load applied there is approximately one day capacity provided. If the sludge generated is minimal this can be stored for more than 2 days also.

Sludge Handling System

The sludge from the MBR tank needs to be removed from the bottom of the tank by client and transferred. There are options to handle the sludge. Desludging can be carried out by Suction Tanker / Sludge Drying Beds / Centrifuge / Filter Press / Centrifuge Decanter or Sludge Thickener by Client.

6.0 Control Automation of Equipment's

INDION Programmable Logic Controller (PLC) and Panel View with a Human Machine Interface (HMI), monitors and manages all critical process operations. Level controls monitor the level of mixed liquor in the process tanks and transmit this information to the PLC. The PLC will automatically adjust the flow of the INDION UF membrane train based on proportional control to the process tank levels in order to minimize the instantaneous flux of the membranes. In the event of a system or equipment problem requiring operator attention, the PLC can either alert the operator or shut the system down. The PLC control panel includes all control signals from instruments and output signals to all the motor control hardware equipment.

Equipment Specifications:

A	Raw Sewage Transfer pump	
	Quantity	Two (1W + 1 SB)
	Application	Sewage Transfer to MBR
	Type	Horizontal centrifugal
	Capacity	To be furnished by vendor
	Material	CI
B	Bar Screen	
	Quantity	One
	Application	To screen the raw sewage
	Material	SS
C	Equalization Tank	
	Quantity	Two (one separately for Effluent collection and other one separately for other sewage collection)
	Application	To equalize flow variation.
	Capacity	To be furnished by vendor
	MOC	RCC
D	BIO Tank	
	Consist of	Aeration Tank fitted with MBR Ultra Pac & UF feed tank
	Total Bio Tank Volume	To be furnished by vendor
	MOC	RCC
E	Air Blower	

	Quantity	Two (1W + 1 SB)
	Application	Aeration in bio pac tank
	Type	Twin lobe
	MOC	CI
	Capacity	To be furnished by vendor
	Sludge transfer pump	
	Quantity	One
	Application	Recirculation sludge to MBR
	Type	Horizontal Centrifugal Pump
	Material	CI
	Capacity	To be furnished by vendor
	Dosing Pump	
	Quantity	One
	Application	Recirculation sludge to MBR
	Type	Horizontal Centrifugal Pump
	MOC	PP
	Capacity	To be furnished by vendor
	Material	PP
	Bag Filter	
	Quantity	Bag Filter
	Diameter of Housing	To be furnished by vendor
	Material of Filter Media	PP
	Filter Bag	Pore Size 100 mm (Woven)
	Ultrafiltration (UF) Module	To be furnished by vendor
	No. of membranes	To be furnished by vendor
	UF Feed cum CIP Pumps	
	Quantity	Two (1W + 1 SB)
	Type	Horizontal, centrifugal
	Capacity	To be furnished by vendor
	UF Backwash Pumps	
	Quantity	One
	Type	Horizontal, centrifugal
	Capacity	To be furnished by vendor
	Material	CI
	Treated Water Tank	(This tank shall be in other scope along with pumping system with piping)
	Quantity	One
	MOC	RCC
	Application	To store treated water for cooling tower, make up

	Capacity	
	CIP Tank	
	Quantity	One
	Capacity	To be furnished by vendor
	UF Skid	
	Quantity	1 set
	Softener Feed Pump	
	Quantity	Two (One working + One standby)
	Type	Horizontal, centrifugal
	Capacity	To be furnished by vendor
	Material	CI
	Softener	
	Quantity	1 Nos.
	Size	To be furnished by vendor
	Hardness for raw water	300 ppm (assume)
	Softener Water Tank	
	Quantity	1 unit
	MOC	RCC
	Application	To store soft water.
	Capacity	20 m3/hr
	Sludge Holding Tank	
	Quantity	One (1) unit
	MOC	RCC
	Application	To hold the sludge.
	Capacity	To be furnished by vendor
	Filter press feed pump	
	Quantity	One (1) unit
	Type	Screw
	Capacity	To be furnished by vendor
	Filter press	
	Quantity	One (1) unit

	Size	To be furnished by vendor
	MOC	MS Body, PP plates

7.0 CONTROLS & ELECTRICAL WORK

7.1 General

- a. The various controls listed below shall be electrically operated and generally comply with the specifications listed below:
- b. In case of low voltage controls necessary step-down transformers shall be provided with each control as required.

7.2 ELECTRICAL PANEL:

One (1) common control panel for the operation, controls and monitoring of complete Sewage treatment system which comprising of:

- a. Relays, Terminal blocks,
- b. All necessary auxiliaries
- c. Control panel details:
 - Type / duty: Indoor application
 - Standard for wiring: International standard for electrification
 - Internal protection: IP 54
 - Outdoor Protection: IP 64
- d. Control panel features following controls:

8.0 Motor Starters

Motor starter contactors shall be of the electromagnetic type rated for uninterrupted duty as defined in applicable standards.

Main contacts of motor starter contactors shall be of silver-plated copper.

Each motor starter contactor shall be provided with two NO and two NC auxiliary contacts.

Insulation class of operating coils shall be class B or better.

- i. ON / OFF / TRIP indication lamp for all the electrically driven equipment,
- ii. Duty / standby indication lamps for all electrically driven equipment,
- iii. AUTO / OFF / MANUAL selector switch for all the electrically driven equipment,
- iv. High-high level indication for the tanks,
- v. Trip alarm for all electrically driven drives.
- vi. Alarm (mute) acknowledgement switch.
- vii. Alarm reset switch.

8.1 Contactor

Motor starter contactors shall be of the electromagnetic type rated for uninterrupted duty as defined in applicable standards.

Main contacts of motor starter contactors shall be of silver-plated copper.

Each motor starter contactor shall be provided with two NO and two NC auxiliary contacts. Insulation class of operating coils shall be class B or better.

Operating coils of contactors shall be suitable for operation from the specified control supply system.

Contactors shall be of the double break, non-gravity type.

One number spare auxiliary contactor with 4 NO./4NC contact along with its coil completely wired up to the terminal should be provided.

8.2 Direct On Line Starters

Direct online starters shall be suitable for Class AC 3 utilization category.

8.3 Reversing Starters

Reversing starters shall comprise forward and reverse contactors, electrically interlocked with each other. Reversing starters shall be suitable for Class AC 4 duty.

8.4 Thermal Overload Relays

Starters shall be complete with three elements, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings. The settings range shall be properly selected in accordance with the rating of the motor.

Thermal overload relays shall be hand reset type.

'Stop' push button of the starter and hand reset device shall be separate from each other.

Overload relay hand reset push button shall be brought out on the front of the compartment door.

Overload relay shall be provided with at least one 'NO' and one 'NC' or one change over contact.

8.5 Current Transformers

1. Current transformers shall be of the dry type.
2. Current transformer shall have a short time withstand rating equal to the short time withstand rating of the associated switchgear for one second.
3. Unless otherwise specified, the minimum performance requirement of current transformers is as follows:
4. Measuring CTs 7.5VA, accuracy class 1.0 and an instrument safety factor of 5.
5. Protective CTs 7.5 VA, accuracy class 5P and an accuracy limit factor of 10.
6. Notwithstanding the above it shall be the VENDOR'S responsibility to coordinate the current transformer burden with the requirements of relays, instruments and leads associated with that particular current transformer.
7. Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests.

8. All current transformers shall be earthed through a separate earth link on the terminal block to permit easy measurement of the current transformer insulation resistance. (CTs built in with the thermal relays of the contactors are excluded).

8.6 Voltage Transformer

Voltage transformers shall be of dry type.

Unless otherwise specified, the minimum performance requirements of voltage transformers are as follows:

- a) Measuring VTs 15 VA per phase and accuracy class 1.0.
- b) Protective VTs 15 VA per phase and accuracy class 1.0.
- c) Dual purpose VTs 100 VA and dual accuracy class 1.0/3.0 for metering and protection respectively. VA is per phase.

All secondary windings of voltage transformers including open delta windings shall be rated for 110/ 3 V per phase.

Voltage transformers shall have a continuous overvoltage factor of 1.2 and short time overvoltage factor as follows:

1.5 for 30 seconds in case of effectively earthed. 1.9 for 8 hours in case of non-effectively earthed system. Voltage transformers shall be complete with suitable rated primary, secondary and tertiary fuses. Primary fuses shall have a rupturing capacity equal to the rupturing capacity rating of the associated switchgear. Fuses shall be provided on each sub circuit.

It shall be possible to replace voltage transformers without having to de energize the main bus bars.

The terminals of V.T. secondary and tertiary windings which are required to be connected to earth shall be earthed by an isolating link without a fuse.

Single phasing preventers relay shall be provided when required to protect motor against single phasing. The relay shall not operate for supply voltage unbalance of + 5% but shall positively operate for supply voltage unbalance of more than + 5%. The relay shall operate in the event of a single-phase fuse blowing even though the motor c.m.f. in the concerned phase is of the order of 85%.

After sensing single phasing, the relay shall operate with a time delay of 2 to 3 sec. The relay shall not operate for a 3-phase power supply failure. The relay shall be of the hand reset type with a hand reset push button. Resetting shall be instantaneous and independent of the adjusted time delay in the tripping of the unit. Visual indication for the operation of the relay shall be provided.

The relay shall be suitable for application to protect reversible and non-reversible motors. The relay operation shall be independent of the motor KW rating, the loading conditions prior to the occurrence of the single phasing and rpm of the motor. The relay

shall be of the fail-safe type and shall operate to trip the motor when the relay internal wiring is accidentally open circuited.

8.7 Relays

The following clauses shall apply to the protective relays.

Relay shall be

- h) Enclosed in dust proof flush mounting draw out type cases.
- i) Accessible for setting and resetting from the front.
- j) Provided with positive acting hand reset flag indicators visible from the front.
- k) Access to setting devices shall be possible only after the front covers are removed. Access to resetting devices shall be external to the case.
- l) Auxiliary relays shall be rated to operate satisfactorily between 70% and 110% rated voltage.
- m) Each relay shall be provided with at least two separate voltage from contacts.
- n) Make and type of relays shall be subject to the EIC approval.

8.8 Indicating Instruments and Meters

Electrical indicating instruments shall be of minimum 96mm x96mm square size, suitable for flush mounting.

Indicating instruments shall have provision for zero adjustment outside the cover.

Instrument dials shall be parallax free with black numerals on a white dial.

Ammeters provided on motor circuits shall be provided with a suppressed extended scale to indicate motor starting current.

Watt-hour meters shall be of the direct reading electro dynamometer type complete with cyclometer type dials and reverse running stops.

8.9 Indicating Lamps

Indicating lamps shall be:

- a) Of the filament type and of low watt consumption
- b) Provided with services resistors
- c) Provided with translucent lamp covers of colours 'Red', 'Green' and 'Amber' as required in the control wiring diagrams.
- d) Bulbs and lenses shall be easily replaceable from the front.

8.10 Control and Selector Switches

Control and selector switches shall be:

- a. Of the rotary type
- b. Adequately rated for the purpose intended (Minimum acceptable rating is 10A continuous at 240V AC and 1A inductive break) 220V DC.

- c. Provided with escutcheon plates clearly marked to show the positions.
- d. Control switches for circuit breakers shall be provided with pistol grip type handles.
- e. Control switches for circuit breaker control shall be provided with Contact development and sequencing device.

Selector switches shall be:

- F) Of the maintained contact stay put type. Switches in ammeter circuits shall have make before break type contact.
- G) Provided with oval handles.

8.11 Push Buttons

Push button shall be:

- h) Of the momentary contact, push to actuate type rated to carry 10A at 240V AC and 1A (inductive breaking) at 220V DC.
- i) Fitted with self-reset, 2 NO and 2 NC contacts.
- j) Provided with integral escutcheon plates marked with its function.
- k) 'Start', 'Open', 'Close' push buttons shall be green in colour.
- l) 'Stop' push buttons shall be red in colour.
- m) All other push buttons shall be black in colour.
- n) Emergency Stop' push buttons shall be of the lockable in the pushed position type and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button..

8.12 Cable Terminations

Suitable compression type heavy duty brass cable glands with nuts, rubber sealing ring and brass washers mounted on a removable and control cables entering the switchgear shall incorporate built in facilities for earthing the wire armour of cables. Cable glands shall be plated to avoid corrosion.

Power cable glands and crimping type lugs shall be supplied to suit the cable sizes given in clause 3. If during course of detailed engineering of the switchgear it is found necessary to provide more glands or glands of higher size than those envisaged the vendor shall provide and accommodate the same.

Wire Sizes:

The vendor shall select the power cable glands and lugs based on the following cable sizes.

Type of cable:

1100 V grade stranded copper conductor PVC insulated PVC sheathed armoured and outer sheathed FRSL coated cable conforming to IS:1554 Part I.

KW Rating Service	No. of cores x conductor size (mm ²)	approximate overall diameter/mm

Upton 3	3 x 4	18
3.1 7.5	3 x 6	19.5
7.6 1.5	3 x 16	24
16 25	3 x 35	30
26 40	3 x 70	34
41 55	3 x 120	40
56 70	3 x 185	49
71 85	3 x 240	55.5
86 110	3 x 400	60
111 175	3 x 1C x 500	
Space Heating	2 x 6	19

For supporting & clamping cable cores at regular intervals inside the cable alleys, suitable shunted angles, up to the respective terminal blocks shall be provided. Necessary crimping type of tinned copper cable lugs for connecting the individual cores to the respective terminals shall be provided.

8.13 Internal Wiring

Control wiring shall be of the rating of 650V and power wiring shall be of the rating of 1100V.

Wiring inside the switchgear shall be carried out with 1100/650 V grade, PVC insulated, stranded conductor wires. Minimum size of conductor for power circuits is 4 sq.mm

copper or equivalent size aluminum conductor. Control circuits shall be wired with copper conductor of at least 2.5 sq.mm for CT circuits and 1.5 sq.mm for other circuits, the number and size of strands shall be 7 of 0.67 mm and 0.5mm diameter respectively. Engraved identification ferrules, marked to correspond with the wiring diagrams shall be fitted to each wire. Ferrules shall be of yellow colour with black lettering.

Wires forming part of a tripping circuit of circuit breaker shall be provided with an additional red ferrule marked 'T'.

Spare auxiliary contacts of all equipment forming part of the switchgear shall be wired up to the terminal blocks.

Spare and unassigned modules shall be complete with internal wiring.

Wiring shall be terminated on preferably stud type terminal blocks such that the wires are connected by cable lugs with nuts and washers/lock nuts.

Not more than two connections shall be made on any one terminal.

8.14 Terminal Blocks

Terminal blocks (both for power and control circuit) shall be of reputed make especially for CT and VT circuit. It shall comprise of finely threaded pairs of brass studs of at least 6mm diameter, links between each pair of studs, washers, nuts and locknuts. The studs shall be securely locked within the mounting base to prevent their turning. Insulated barriers shall be provided between adjacent terminals.

Terminals for circuits with voltage exceeding 125 V shall be shrouded. Terminal blocks shall be grouped depending on circuit voltage. Different voltage groups of terminal blocks shall be segregated.

Terminal blocks shall be adequately rated to carry the current of the associated circuit. Minimum rating of the terminal block is 10A.

Terminals shall be numbered for identification. Engraved white on black labels shall be provided on the terminal blocks, describing the function of the circuit. Where duplication of a terminal block is necessary it shall be achieved by solid bonding links.

Terminal blocks for CT secondary lead wires shall be provided with shorting and disconnecting/ earthing facilities.

Terminal blocks shall be arranged with at least 100mm clearance between two sets of terminal blocks.

Control terminals for external connections shall be suitable for terminating at least two conductors each of 2.5 sq.mm size.

8.15 Labels

All labels shall comprise white letters on a black background.

Labels shall be made of non-rusting metal or 3 ply lamicaid, or engraved PVC.
Labels shall be properly fixed, with provision to prevent distortion due to expansion.
Size of lettering shall be 6mm.

8.16 Earthing

Each MCC and LCC shall be provided with an earth busbar running along the entire length of the board. Material and size of the earth busbar shall be as specified in data sheets. At either end of the earth bus, one (1) clamp type terminal with nuts, bolts and washers shall be provided for bolting the main earthing conductor of size and material indicated in data sheets. In case the earth bus is provided near top of the switchgear, one down comer at either end shall be provided for connection to the main earthing conductor.

Earth busbars shall be supported at suitable intervals.

Positive connection between all the frames of equipment mounted in the switchboard and earth busbar shall be provided by using insulated copper wires/bare busbars of cross section equal to that of the busbar, or equal to half the size of circuit load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to the earth busbar using 1100/650 V grade, 2.5 sq.mm stranded, copper, earthing conductor.

8.17 Local Push Button Stations

Constructional Features

The constructional features of the local push button stations shall be as follows:

- a. Metal enclosed weather proof suitable for mounting on wall or steel structures.
The enclosure shall be die cast aluminum or sheet metal of 2mm thickness.
- b. Dust and vermin proof.
- c. Provide a degree of protection of not less than IP:54.
- d. Metal parts shall be given tropicalizing treatment as per standards and painted with one coat of epoxy primer and two coats of light grey epoxy paint.
- e. Provided with inscription plates of rear engraved Perspex with white letters on black background. The letter size shall be 6mm.
- f. Provided with two earthing terminals suitable for 8 SWG G.I. wire.
- g. Provided with removable undrilled gland plate and adequate members of cable glands for PVC insulated, armoured cable. The cable entry shall be from the bottom.

- h. All local push button stations shall have locking facility. The lock switch shall have two positions "locked" and "unlocked". When in unlocked position the switch shall allow individual starting of the equipment. Start/stop push buttons provided for local operation of the equipment shall be provided on the same enclosure and stop push buttons shall be lockable in stop position. The lock switch shall be key-operated.

8.18 Push Buttons

- a) The Open/Close/Start push buttons shall be of the momentary contact push to actuate type.
- b) The stop push buttons shall be stay put type with mushroom knob.
- c) All push buttons shall be Fitted with two (2) normally open and two (2) normally closed contacts rated to carry and break 6 Amps at 415 Volts. (10A at 240 AC).
- d) Provided with integral escutcheon plates marked with its function.
- e) 'Open/Close/Start' push buttons shall be green colour.
- f) 'Stop' push button shall be red in colour.
- g) Wiring the push button stations shall be as follows: Push button station Type A Each P.B., station shall comprise three push buttons viz. 'OPEN' 'CLOSE' and 'STOP' for control of reversible motors.
- h) Push button station type B Each P.B. station shall comprise two push buttons viz. 'START' and 'STOP' for control of non-reversible motors.
- i) Push button station type C Each P.B. station shall comprise only one push button i.e. 'STOP' for emergency stop function.
- j) Power Electricity at specified voltage (415/220V).

8.19 Drawings and Data

As part of proposal BIDDER shall furnish the following drawings and data:

- a) For each switchgear, overall dimension drawing showing front view, plan, elevation and cross section.
- b) All drawings and data sheets shall be annotated in English

8.20 Circuit Breakers

The panel and the bus bars plus outgoing of all devices shall be protected by different types of circuit breakers as described below and conforming to specification as given later on:

Sl. No.	Type	Upto 40 Amp	Upto 63 Amp	80 – 200 Amp	200 – 400 Amp	Above 630 Amp
01	Incoming	MCB	MCCB	MCCB	MCCB	MCCB
02	Outgoing	MCB	MCB	MCCB	MCCB	MCCB

Moulded Case Circuit Breakers (MCCB)

The MCCB shall have TP + NL and be suitable for simultaneous manual opening and closing with rotary operating handle.

The ON/OFF/TRIP positions shall be clearly marked and easily visible to an operator and confirm to latest IS: 13947-1993.

There shall be fixed/adjustable tripping devices with inverse time characteristics for overload and short circuit protection.

Suitable Interlocking mechanism shall be provided, where required.

Miniature Circuit Breakers (MCB)

The MCB shall have quick make/break contacts with a heat resistant housing, having high Impact strength and confirm to IS 8828-1996.

The contacts shall be of silver nickel alloy.

The MCB shall permit over load for short duration, as required for Inductive loads and the breaking capacity shall not be less than 10 KV at 415 Volt A.C.

It shall be equipped with overload and short circuit protection devices and shall be suitable for DIN mounting.

Isolator Switches

Isolator switches are to be provided for equipment located outdoors or for those located in separate enclosure, other than those Nos. having the Electric Panel.

The Isolator Switch should be of Rotary Load Break type with a weather proof sheet steel enclosure. Its rating shall be same as the outgoing device in the Electric Panel.

8.21 Contactors

All non-inductive loads shall be provided with suitable sized magnetic contactors.

The contactors shall have 3/4 poles plus a minimum 2 'NO' and 2 'NC' contacts. All contacts shall be of solid silver.

The No volt coil shall generally be suitable for 220 Volts + 10%, - 15% (wide band type) A.C. supply except when specified or required otherwise.

8.22 Starters

The type of starters to be provided for the motors shall be as follows:

Squirrel Cage motors: up to 7.5 HP (5.6 KW) Direct on Line Type

Squirrel Cage motors: Above 7.5 HP (5.6 KW) Automatic Star Delta Type

Compressor motor: Above 300 HP (225 KW) Automatic Auto Transformer (where specified)

All starters shall have auxiliary contacts for interlocking different machines, connecting indicating lights, controls, alarms, etc.

All starters shall be provided with separate single phasing preventers

Direct On-Line Starters

These starters shall have heavy duty air brake contactors of suitable rating.

These starters shall be complete with adjustable overload relays on all three phases, single phase preventing device and under voltage release. The starters should be "hand reset" type.

The "No Volt Coil" of these starters shall be 220 Volts + 10% - 15% (wide band type) whenever any controls on safety devices are connected in the starters circuits, otherwise standard 415 volts coils may be used. There shall be ON-OFF push button for each starter unless remote operation of the starter is required. Digital type Ammeter and voltmeter and energy meter to be fixed to the enclosure along with the necessary wiring.

8.23 Automatic Star Delta Starters

These starters shall have heavy duty air brake contactors of suitable ratings along with an adjustable timer to automatically switch the motor connections from star to delta connections.

Each starter shall be complete with adjustable overload relays on all three phases and under voltage release. The starters should be "hand reset" type.

The "No Volt Coil" shall be of 220 Volts + 10% - 15% (wide band type) rating wherever any controls of safety device are connected in the starter circuit, otherwise standard 415 volts coils may be used. There shall be ON-OFF push button for each starter unless remote operation of the starter is required. Digital type Ammeter and voltmeter and energy meter to be fixed to the enclosure along with the necessary wiring.

8.24 Automatic Auto -Transformer Starter

These starters will be oil immersed, each one fixed on a separate panel.

Necessary devices shall be provided for the automatic tap setting of the starter.

The starter should have "No Volt Coil" wide band type circuit of 220 volts to be connected to control circuits.

The Motor starter shall be in accordance with IS 1882. The starter shall be totally enclosed metal clad, dust and vermin proof construction. The starter shall be of continuous rating.

Contactors shall have the number of poles as required for appropriate duty. The making capacity of the starters shall be suitable for AC 3 duty.

8.25 Panel Accessories

All Voltmeters and Ammeters as specified shall be square of 96 mm x 96 mm, flush mounting type.

The Indicating Lamps shall be of LED type with Low Watt Power. The Lamps shall have translucent covers of following colours.

- Red/Yellow/Blue for phase light.
- Green/Amber for ON/OFF indication.
- Concealed door lock.

8.26 Subsidiary Panels (With Single Switch)

Subsidiary panels shall be provided for equipment located away from the plant room, such as air handling units, blower etc.

The construction of these panels should be similar to the main panel and shall have all related accessories, except when specified.

The sub panel shall be wall hung type and as compact as possible.

Panel fabrication drawings shall be got approved before fabrication.

8.27 ENCLOSURES FOR CONTROLLERS AND ELECTRICAL PANELS

All the Panel shall be housed in Lockable Vandal proof boxes which shall either be floor mounted or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.

The panel shall be metal enclosed 14 SWG CRCA sheet steel cubicle with gaskets between all adjacent units and beneath all covers to render the joints dust proof. All doors and covers shall be hinged and latched and shall be folded and braced as necessary to provide a rigid support. Joints of any kind in sheet metal shall be seam

welded with welding slag grounded off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with nuts. Self-threading screws shall not be used in the construction of control panels. Knockout holes of approved size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. Clamps shall be provided to support the weight of the cables. The dimension of the boxes shall depend on the requirement with the colour decided in consultation with the Architect/Consultant.

Note: All panel enclosures shall be suitable for Indoor application (IP 54 protection) and UL listed.

The system shall have capability to interface with the BMS & FAS System.

9.0. Installation, testing, commissioning:

a) Installation of all equipment's at site, testing of all equipment's, commissioning of process is included in scope of work. Necessary raw sewage will be provided by client. In case of absence of raw sewage/ sludge even after one month from installation, system will be tested with plain water. Commissioning will be carried out within 1 month from date of completion of all erection and installation activities.

9.1 The drawings show the suggested flow diagram and a feasible layout of various tanks and equipment. The tenderer shall make the following submittals along with the tender.

- i) A detailed process narrative and a flow diagram
- ii) Suggested plant layout conforming to the space provisions made.
- iii) Deviations from specifications stating necessity and financial implications.
- iv) Confirmation of plant conformance to the state pollution control standards as well the specified quality standards.

9.2 On award of the contract, final detailed layouts and shop drawings of equipment and piping shall be submitted for approval. The process flow diagrams and plant layout drawings shall be submitted simultaneously to the state P.C.B and approvals obtained. These approvals will enable the contractor to proceed with the procurement and fabrication.

9.3 All civil works will be constructed by others in accordance with the approved drawings but all internals and inserts for ingress into the civil elements shall be provided by the contractor.

9.4 All piping within the battery limits shall be the responsibility of the contractor. Piping handling sewage shall be of cast iron M.S and water piping shall be of heavy-duty galvanized steel.

9.5 The installation shall be carried out in a workman like manner and to approved drawings. All equipment shall automatically start and stop to a programmed. Twin equipment, one working and one standby, shall operate alternately in a manner to have equal run time over one week.

9.6 Before starting up the plant, the contractor should have it inspected and approved by PCB and the Project Managers. Contractor should arrange for necessary seeding microbial mass for the startup of the plant. The plant shall be operated for 2 days of 24hours each before test readings and taken in accordance with Annexure 2.3-1. The plant shall be operated for at least 2 weeks after stabilized system performance or 6 weeks whichever is later. All consumables, operating personnel for the above duration shall be borne by the contractor.

10.0 Mode of Measurement

10.1 Supply, installation, testing and commissioning of the entire sewage treatment plant shall be treated as one unit for purpose of measurement and payment. The work embraces.

1. Supply of detailed drawings of the process, the plant and all appurtenant civil works.
2. Supply installation and testing of all plant viz
 - i) Sewage pumps
 - ii) Sludge pumps
 - iii) Blowers, piping network with valves and diffusers
 - iv) Dozer
3. All interconnected piping, tank internal and inserts.
4. Obtaining approvals from PCB and any other statutory bodies.

10.2 Tertiary equipment shall be measured as described in the schedule of work.

10.3 Variable speed pumping shall be measured as described in the schedule of work.

10.4 All electrical work shall be measured as described in the schedule of work.

STP Parameters:

Parameter	Unit	Incoming Raw Sewage Characteristics	Outgoing Treated Sewage Characteristics
Flow	m3/day	450	427
pH	--	5.5-9	6.5-8.5
TSS	mg/lit	400-500	≤10 mg/l
BOD	mg/lit	300-400	≤10 mg/l
COD	mg/lit	500-800	≤30 mg/l

Oil & Grease	mg/lit	15-20	Nil
Odour			Nil
Total Nitrogen	mg/lit	40-50	Nil
Total hardness	PPM of CaCO_3	150-200	$\leq 50 \text{ mg/l}$
TDS		$\leq 150 \text{ mg/l}$	$\leq 150 \text{ mg/l}$
INFECTION MICROBIAL COUNT /			NIL

Annexure-4

Compact Sewage treatment plant (STP) with complete system (To be filled by Tenderer)

1.0 Capacity of RCC tanks available for STP

i. Raw sewage tank(collection Sump)	(size m x m x n)
ii. Process tank	(size m x m x n)
iii. Clarified water tank	(size m x m x n)
iv. Treated water tank	(size m x m x n)
v. Any other RCC tank (MBR tank)	(size m x m x n)

2.0 Vendor to specify all consumables required for full capacity operation of the STP per day.

- i.
- ii.
- iii.
- iv.
- v.

3.0 Vendor to specify connected load and maximum demand of all electrically driven equipment.

- i. Sump Pumps (1+1)
- ii. Raw sewage pump (1+1)
- iii. Blower (1+1)
- Iv. Filter feed pump (1+1)
- V. Filter press feed pump
- Vi. Filter press

4.0 Vendor to specify maximum guaranteed power consumption of the plant at different operating capacities.

112 Kl / day

kwh

450 Kl / day kwh

Year 1 Rs / month.....

Year 2 Rs / month.....

Year 3 Rs / month.....

Year 4 Rs / month.....

Year 5 Rs / month.....

Year 1 Rs / Year.....

Year 2 Rs / Year.....

a) Supply P & I diagram

b) STP Layout

c) GA drawings for civil unit with requisite Data.

d) Technology used to treat the sewage for use for cooling tower make up basis of design for Sewage treatment plant including characteristics of treated water will be used for cooling tower make up water.

e) The design has to be as per requirement of Local PCB board/CPCB All necessary required statutory and legal documentation, licensing etc.

(B) To offer trial run, Guarantee run with necessary protocols before final to operate the plant for 1 month from the date of completion with all cost of manpower, consumable etc. Complete and to generate and maintain requisite operational data/report/log sheets as required by the treated sewage is proposed to be used for cooling tower make up.

(C) Water/ Landscape water/ Flushing within the premises.

(D) Supply of material : supply of all material, equipment, electrical, mechanical instrument required for the scope of supplier.

(E) Water and Electricity : required shall be arranged by Tenderer at his own cost.

(F) Civil work : Necessary civil work for STP shall be carried out by the Civil contractor. The Tenderer should give details of civil work required for STP.

Sign of Tenderer with stamp

PART-B3

**Proforma (Water Proofing,
Aluminium & Bank Guarantee)**

**TO BE EXECUTED BY CONTRACTOR FOR REMOVAL OF DEFECTS AFTER
COMPLETION IN RESPECT OF WATER PROOFING WORKS
GUARANTEE BOND FOR REMOVAL OF DEFECTS AFTER COMPLETION IN RESPECT
OF WATER PROOFING WORKS**

(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,
W INDOWS, 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

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. (Rupees

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- E

TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS

TECHNICAL SPECIFICATION FOR ELECTRICAL LOW SIDE WORK OF EXTERNAL INFRA WORK INCLUDING EXTERNAL LIGHTING, INTERNAL WORK FOR SUBSTATION-1, STP, PUMP ROOM, OWC, BMW, MGPS PLANT ROOM, COMMON DRIVES TOILETS, GATE SECURITY CABINS.

1. MAIN LT PANELS

- Discrimination study should be conducted by the OEM to whom the contract is awarded. The results shall be shared to the consultants.
- Low Voltage Switchgear and Control gear Assemblies (IEC 61439 – Franchisee Based Panels)
- All deviation shall be specifically mentioned in a separate sheet with justification; otherwise, it shall be considered that the supplier will abide by the following specifications.

1.1.1 Scope

- The scope includes Supply, Transportation and Storing at site, Installation, Testing and Commissioning; wherein supply covers design, manufacture, integrate, packing including routine testing as per IEC and supply of Low Voltage Switchgear & Control gear Assemblies up-to 1000 V (Will be termed as 'LV panel' here forth).

1.1.2 Standards

- The equipment's covered under this specification shall conform to the latest revisions of relevant Indian and International Standards some of which are listed below.
- IEC 61439 part 1 & 2 : Low voltage switchgear and control Gear assemblies
- IS / IEC 61439 part 1 & 2 : Low voltage switchgear and control Gear assemblies
- IS / IEC 60947 : General requirements of Switchgear and Control Gear for Voltage not exceeding 1000/ 1200V AC
- IS 11353 1985: Guide for uniform system of marking Identification of Busbar and Terminals.
- IS 13703 1993 : Low voltage fuses
- IS 2705 1992 : Current transformers

- IS 694 1990 : PVC insulated cables for voltages including 1100 V with Copper and Aluminium Conductor).
- IS 1248 1983 : Direct Acting Electrical Indicating Analog
- IS 8623 1993 : Low voltage Switch gear & control gear assemblies
- IS 5082: Electrolytic Aluminium Busbar, Trunking system, Rod tubes & sections for Electrical Purposes.
- IS 13779 1999: AC Electric Meters / Static Meters.
- 3. Site Conditions
 - 3.1. Location - Indoor,
 - 3.2. Altitude above main sea level - < 2000M above sea level.
 - 3.3. Design Ambient Temperature - 40 Deg. C
 - 3.4. Temperature rise - As per IEC 61439
 - 3.5. Relative Humidity Max - 95%
 - 3.6. Relative Humidity Min - 10%
 - 3.7. Pollution - Up to Degree of pollution-3
 - 3.8. Application - Indoor

1.1.3. Panel Construction

- The LV panels shall be of aesthetic design, dust, and damp & vermin proof.
- The LV panels shall be modular, extendable and shall have maintenance friendly
- Construction. The LV panel shall have compartmentalized bolted construction.
- The LV panels shall be metal clad sheet steel enclosed cubicle, fully compartmentalized, floor mounting type suitable for indoor installations.
- The LV panel shall be complete design verified assembly as per IEC 61439-1 & 2.
- The LV panel shall be factory manufactured by authorized franchisee based on design given by OEM. All type tested certificates of OEM only acceptable.
- The LV panel cubicles shall have structural steel framework. It is enclosed on all sides and top by Cold Rolled sheet steel of thickness not less than 2.0 mm. The doors and covers shall be fabricated from CRCA sheet steel of thickness not less than 1.6mm.
- The LV panel shall have integral base frame.
- The LV panels and covers shall be properly fitted and secured with the frame.

- The LV panel shall have provision for top / bottom in coming and bottom / top out going respectively to suit site conditions of cable entries.
- LV Panels with Incoming / Outgoing busducts should be provisioned with the cut-outs for Flange connections.
- The LV panel shall have provision to provide different panels heights from 1800 to 2400 mm to suit site varied condition.
- The maximum and minimum height of the operating handles from floor level shall be as 1800 / 250 mm respectively.
- Minimum clearance between phases / live parts shall be 23 mm and phases / live parts / neutral to ground shall be 19 mm except on the equipment terminals.
- The LV Panel shall comply with the Technical Data Sheet, SLD, and Feeder List as specified by customer.
- The LV panel shall be configured with Air Circuit Breakers, MCCB's, Switch Fuse units and other switchgear components & equipment as specified in the Schedule of Quantities by customer.
- The LV panel can be of double Front (except ACB feeders) based on site conditions.
- Front access shall be available to all components in each cubicle which require adjustment, maintenance, or replacement.
- All the doors and covers shall be with full neoprene gasket to prevent any ingress of dust.
- Door hinges shall be concealed type for compartment doors. However, for wire ways, busbar chambers covers and dropper chamber covers shall be bolted type for safety purpose.
- Removable undrilled gland plates shall be fitted for bottom cable entry.
- All fixing bolts, screws etc. appearing on the panel shall be so arranged as to present a neat appearance.
- The Air circuit breakers shall be equipped with Integral Micro Processor based protection release.
- The MCCB's and Switch Fuse units shall be arranged in multi-tier formation.
- Air Circuit Breakers shall be arranged in Single tier formation only to facilitate ease of operation and maintenance.
- All Outgoing MCCB/Motor Feeders shall be Non Draw-out type mounted on a single base plate
- All components like, circuit breakers, switches etc. shall be compatible with the short-circuit levels.

- All internal wiring shall be with suitable stranded copper conductor FR insulated wire.
- Indicating lamps shall be SMD type preferably.
- All CT's & PT's shall be resin cast unless specified otherwise or as approved by the customer.
- All relays, meters & switches shall be flush mounted.
- All metering equipment shall be digital unless specified otherwise or as approved by the customer.
- All holes in metalwork shall be protected by substantial grommets or bushes to protect wiring passing through them.
- The arrangement of controlling switches in the LV panels and their marking shall be such that these are prominent, easily identifiable and accessible.
- Single line power / control diagrams shall be placed at the back of door or other accessible locations in the panels or near to panel with complete details as required.
- LV PANELS shall be complete design verified assembly as per IEC 61439. Internal arc as per IEC 61641 at system design fault level on HBB, VBB and cable chamber, certified as per Seismic Zone-5 IEC 60068-3-3/IS 1893/ICC ES AC-156 requires compliance against acceleration. Rated Impulse Voltage -12 KV. Form 4B IP2 X (touch proof) protection even after opening the feeder compartment door. The compartmentalization to be achieved by using metal separators, use of PVC sheet/ Hylem sheets shall not be allowed.
- LV panels shall be internal arc type tested for min 50kA for 0.5 sec.
- LV panel 1 & 2 shall have Clean Agent System with NOVEC 1230/FK-5-1-15 UL listed Gas with Accessories.

1.1.4 Bus bars and insulating materials

- The busbar shall be Aluminium with high conductivity
- The busbar shall be colour coded using identifying colour rings at regular interval. Red, Yellow & Blue colour shall be used for phases & Black for neutral for each shipping section of panels. The earth Busbar shall be identified with Green color rings at regular intervals.
- The Busbar sizes shall be determined taking into consideration the continuous rating and fault level indicated, as applicable, without exceeding the temperature raise limits as per IEC, over ambient

temperature. Feeder in adjacent vertical to be feed with common vertical busbar / dropper.

- Bus bar supporting systems shall withstand the short circuit forces circuits, without deflection or deformation.
- The busbar shall be supported of regular intervals using SMC or DMC insulators as per the tested design. It should have minimum Comparative Tracking Index (CTI) of 600 V as per IS 2824).
- Minimum clearance between phases / live parts shall be 23 mm and phases / live parts / neutral to ground shall be 19 mm except on the equipment terminals.
- Direct access to, or accidental contact with busbar and primary connections shall not be possible.
- The Horizontal & Vertical busbar support to be supplied by OEM and the busbar rating shall be as per type tested design, complying to IEC 61439.

1.1.5. Earthing

- One Earthing terminals shall be provided on each side of switchboard.
- An earth bar size must be at least 1: 6 x 50 sq. mm Aluminium (same can be provided with GI or Cu also) if required. Provision for arrangement for 2: 6 x 50 sq.mm. Shall be possible, if required.
- The earth bar shall be electrically continuous and shall run the full extent of each board. This earth bar shall be on the same side as the cable entry.
- Each unit shall be constructed to ensure satisfactory electrical continuity between all metal parts which are not intended to be alive.
- Suitable holes with bolts and nuts shall be provided at each end of earth bar of switchgear for connection to a main Earthing grid.
- The earth bar shall be accessible in each cable entering compartment either directly or through a branch extension to ground the cable Armor and shields.
- Door earthing shall be provided for all feeder doors, rear doors and CBC doors.
- Painting and Finishing

- All metal works and metal parts of the switchboards shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphatising, passivating and then sprayed with a high corrosion resistant primer.

1.1.6 Internal Wiring:

- Minimum size of conductor for power circuits shall be 2.5 sq. mm copper.
- All control wiring except CT secondary wiring shall be carried out with minimum 1.5 sq. mm Copper conductor.
- CT secondary wiring shall be carried out with 2.5 sq. mm copper conductor.
- All wiring shall be securely fixed and neatly arranged to enable easy tracing of wires.
- All terminal blocks and wires shall be tagged for identification in accordance with IS 11353
- All wiring for external connections shall be brought out to the individual terminals on a readily accessible terminal block.
- Clamp or screw type control terminal blocks shall be provided for outgoing control cables. Minimum 10% spare terminals shall be provided for future use. Control terminal block shall be separated from power terminal blocks by means of an insulating barrier.
- Name Plates & Label
- One name-plate giving designation of the switchboard shall be affixed prominently on top.
- Details of designation shall be specified.
- Labels giving following details shall be affixed on each feeder panel:-
- Feeder No - As per feeder list
- Equipment tag Number and Description
- Rating (KW/KVA/AMP)
- All components whether mounted inside the switchboard or on the door shall be permanently and clearly labelled with reference number and/or letter of their function. Labels for feeder panel designation shall be fixed on the front side of respective panels with Special rivet made of nylon. These labels shall be identical size to permit interchange.
- Tests & inspections
- LV panel shall be subjected to routine tests as per latest IEC-61439 part 1&2 standard.9.2. Details of designation shall be specified.
- LV panel shall be subjected to Internal Arc certification as per IEC-61641 with 50kA 0.5 sec.
- LV panel shall be complying to Seismic zone 4 as per IS standard.

- All meters and other reference devices used for testing shall have valid calibration from
- Reputed national laboratories / Institutes like ERDA/CPRI.
- Shop test shall be witnessed by authorized / certified Quality engineer or owner or an agency authorized by customer, if required.

IS 11353 1985	Guide for uniform system of marking Identification of Busbar and Terminals.
IS 13703 1993	Low voltage fuses
IS 2705 1992	Current transformers
IS 3156	Voltage Transformers.
IS 694 1990	PVC insulated cables for voltages including 1100 V with Copper and Aluminium Conductor).
IS 1248 1983	Direct Acting Electrical Indicating Analog
IS 8623 1993	Low voltage Switch gear & control gear assemblies
IS 5082	Electrolytic Aluminium Busbar, Trunking system, Rod tubes & sections for Electrical Purposes
IS 13779 1999	AC Electric Meters / Static Meters.
IEC 60529	Degree of Protection

2. SUB LT PANELS & FLOOR PANELS

2.1.1 Scope

The scope includes Supply, Installation, Testing & Commissioning; wherein supply covers design, fabricate, integrate, pack, dispatch to site along with routine testing as per IS of Low Voltage Switch gear & Control gear Assemblies up-to 1000 V (Will be termed as 'LV panel' here forth).

2.1.2 Standards

The equipment's covered under this specification shall conform to the latest revisions of relevant Indian and International Standards some of which are listed below.

2.1.3 LV Panel Construction

- The LV panel shall be complete design verified assembly as per IS 8623 part-2 1993
- The Complete Design Verified Certificate to be submitted which is accredited from NABL laboratory.
- The enclosure shall comply with relevant standard. The enclosure protection shall not less than IP42 unless other specified in BOQ.
- The LV panels shall be of aesthetic design, dust, and damp & vermin proof.
- The LV panels shall be modular, extendable and shall have maintenance friendly Construction. The LV panel shall have compartmentalized bolted construction.
- The LV panels shall be metal clad sheet steel enclosed cubicle, fully compartmentalized, floor mounting type suitable for indoor installations.
- The LV panel shall have integral base frame.
- All LV panels and covers shall be properly fitted and secured with the frame.
- The LV panel shall have provision for top / bottom in coming and bottom / top out going respectively to suit site conditions of cable entries.
- Adequate and proper support provided in cable compartments to support cables.
- The maximum and minimum height of the operating handles from floor level shall be as 1800 / 250 mm respectively.
- The LV panel shall be of min. form 3B construction except for MCB feeders.
- The LV Panel shall comply with the Technical Data Sheet, SLD, and Feeder List as specified by customer. The LV panel shall be configured with Air Circuit Breakers, MCCB's, Switch Fuse units and other switch gear components & equipment as specified in the Schedule of Quantities by customer.
- The LV panel can be of double Front (except ACB feeders) based on site conditions.
- Front access shall be available to all components in each cubicle, which require adjustment, maintenance or replacement.
- All the doors and covers shall be with full neoprene gasket to prevent any ingress of dust.
- Door hinges shall be concealed type for compartment doors. However, for wire ways, busbar chambers cover and dropper chamber covers shall be bolted type for safety purpose.
- The Air circuit breakers shall be equipped with Integral Micro Processor based protection release.
- The MCCB's and Switch Fuse units shall be arranged in multi-tier formation.

- Air Circuit Breakers shall be arranged in Single tier/Multi-tier (Nor more than two ACBs in a single vertical) formation only to facilitate ease of operation and maintenance.
- All Outgoing MCCB/Motor Feeders shall be fixed type mounted on a single base Plate.
- All components like, circuit breakers, switches etc. shall be compatible with the short-circuit levels.
- All internal wiring shall be with suitable stranded copper conductor FRLS insulated wire.
- Indicating lamps shall be SMD type preferably.
- All CT's & PT's shall be resin cast unless specified otherwise or as approved by the customer.
- All relays, meters & switches shall be flush mounted.
- All metering equipment shall be digital unless specified otherwise or as approved by the customer.
- All holes in metalwork shall be protected by substantial grommets or bushes to protect wiring passing through them.
- The arrangement of controlling switches in the LV panels and their marking shall be such that these are prominent, easily identifiable and accessible.
- Single line power / control diagrams shall be placed at the back of door or other accessible locations in the panels or near to panel with complete details as required.
- Bus bars and insulating materials
- Current density for the bus bars shall be 0.8 A/sq.mm for aluminium and 1.25 A/sq.mm for copper bus bars
- The busbar shall be of rectangular cross sections suitable for full load current.
- The busbar shall be colour coded using identifying colour rings at regular interval. Red, Yellow & Blue colour shall be used for phases & Black for neutral for each shipping section of panels. The earth Busbar shall be identified with Green colour rings at regular intervals.
- The Busbar sizes shall be determined taking into consideration the continuous rating and fault level indicated, as applicable, without exceeding the temperature raise limits as per IS, over ambient temperature. Feeder in adjacent vertical to be feed with common vertical busbar / dropper.
- Bus bar supporting systems shall withstand the short circuit forces circuits, without

- Deflection or deformation.
- ACB termination connection Busbar must be selected as per ACB Manufacturer's recommendation only.
- For ACB Termination Busbar connection support should be at distance of 200 mm.

2.1.4 Earthing

- One Earthing terminals shall be provided on each side of switchboard. Earth Busbar should be run throughout the length of panels.
- An earth bar size must be minimum 50 x 6 sq. mm Aluminium in case not mentioned material in BOQ/ SLD.
- The earth bar shall be electrically continuous and shall run the full extent of each board as well as the same side as the cable entry.
- Each unit shall be provision to ensure satisfactory earthing continuity between all metal parts, which are not intended to be alive.
- Suitable holes with bolts and nuts shall be provided at each end of earth bar of panel for connection to a main Earthing grid. All ACBs should be earth with suitable earth Busbar size.
- Main earth Busbar should be with holes and necessary hardware in all cable compartment for external earthing of cable glandes.
- Door earthing shall be provided for all feeder doors, rear doors and CBC doors.
- Painting and Finishing
- All metal works and metal parts of the switchboards shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphatising, passivating and then sprayed with a high corrosion resistant primer.
- Internal Wiring:
 - All wires should be 1.1kV, FRLS type
 - Minimum size of conductor for power circuits shall be 2.5 sq. mm copper.
 - All control wiring except CT secondary wiring shall be carried out with minimum 1.5 sq. mm Copper conductor.
 - CT secondary wiring shall be carried out with 2.5 sq. mm copper conductor.
 - All wiring shall be securely fixed and neatly arranged to enable easy tracing of wires.
- All terminal blocks and wires shall be tagged for identification in accordance with IS 11353

- All wiring for external connections shall be brought out in cable chamber to individual terminals on a readily accessible terminal block.
- All power terminals should be stud-nut type / Busbar type only.
- Clip on type or screw type control terminal blocks shall be provided for outgoing control cables.
- Minimum 20% spare terminals shall be provided for future use. Control terminal block shall be separated from power terminal blocks by means of an insulating barrier.
- Name Plates & Label
- One name-plate giving designation of the switchboard shall be affixed prominently on top. Details of designation shall be specified.
- Labels giving following details shall be affixed on each feeder panel:-
- ACB Feeder LED Light with Ready to close indication must be installed along with Nameplate of All Ready to close checks in case light is not on to ease for facility management team.
- Feeder no as per feeder list
- Equipment tag Number Description
- Type of Unit (KW/KVA/AMP)
- All components whether mounted inside the switchboard or on the door shall be permanently and clearly labelled with reference number and/or letter of their function. Labels for feeder panel designation shall be fixed on the front side of respective panels with Special rivet made of nylon or screw. These labels shall be identical size to permit interchange.

2.1.5 TESTS & INSPECTIONS

- LV panel shall be subjected to routine tests as per latest IEC standard.
- All meters and other reference devices used for testing shall have valid calibration certificates from reputed national laboratories / Institutes.
- Client will not be carried out inspection unless the vendor confirms that equipment are ready for proceeding with the tests.
- Acceptance tests on completed LV panel shall be as follows:
- A visual inspection shall be carried out. This shall cover measurement of overall dimension, feeder allocation, number and type of switchgear, terminal boxes, and connection of terminals etc. as per approved drawing.
- Checking of bill of materials as per approved drawing.

- Operation check shall be carried out for every control function as per schematic drawings by manually simulating fault conditions and operation of control switches/relays etc.
- Checking of interchangeability of identical feeders, if applicable
- Insulation resistance test and value measurement on power before and after high voltage withstand test.
- High voltage test on power as per applicable standard.
- For equipment bought from other suppliers, certified test reports of tests carried out at the manufacturers works shall be confirmed for certain projects. Normally all routine tests as specified in the relevant standards shall be conducted by the sub supplier at its works.
- All Type test in compliance IS 8623 testing need to submit during the drawing approval process.
- Design verified should be partial or fully type tested & following test are mandatory.
 - A) Short time withstand 50KA for 1 sec
 - B) IP
 - C) Temperature rise
- ACB OEM's recommended Busbar charts and de-rating charts along with drawing approval stage need to submit for approval.

OT ISOLATION PANELS

Supply, Installation, testing & commissioning of ISOLATION PANELS for each "OPERATION THEATER".

Isolation panel shall be installed in operation theatre, to provide power to medical equipment's used in operation theatre. Isolation panel shall have M.S. enclosure & shall house, isolation transformer, MCB's suitable for incoming power and various power outlets within O.T., (including those outlets mounted on pendant), insulation monitoring, temperature sensor & indicator for transformer to indicate overloading / transformer faults and earth fault location system. The isolation panel shall generally help to achieve IEC 60364 - 7 - 710 & IS 3043 requirements for power supply.

Isolation Transformer: A single-phase isolating transformer according to IEC 61558-2-15 shall be used with a rated power 10KVA. The isolation transformer shall be two winding with earthed isolation shield between the two windings. Further specifications are secondary voltage of AC 250 V and a maximum transformer secondary leakage current of 0.5 mA to earth.

To protect the transformer and the connecting leads between the primary and secondary terminals and the distribution bus against overload and over-temperature, monitoring the load and temperature of the transformer is required. A visual and acoustic alarm shall be issued when the permissible load current and/or temperature are exceeded. For monitoring, a combination of temperature monitoring (PTC thermistors in the winding of the transformer) and current monitoring through CT shall be utilized to detect both a gradual heating of the transformer as well as the occurrence of a transient load when connecting high-capacity electrical equipment.

The isolation transformer shall be installed near the critical medical room as close as possible. It shall be enclosed in cabinet or enclosures to prevent unintentional contact with live parts. The transformer shall preferably be natural air cooled.

If the total load in one medical room or location is more than 10 KVA then more than one transformer with individual transformer rating of 10 KVA maximum to cater to the loads shall be used.

Insulation Resistance Monitor:

According to IEC 60364-7-710 & NEC-SP-30-2011, an ungrounded (IT) system shall be equipped with an insulation monitoring device with the following requirements:

- the AC internal impedance shall be at least 100 kohm
- the test voltage shall not be greater than DC 25 V
- the test current shall, even under fault conditions, not be greater than 1 mA
- the response value shall be 50 kohm
- the indication shall take place if the earth or wiring connection is lost.

For testing the insulation monitoring device, a test button shall be provided directly at the device and in the remote alarm indicator and test combination. Self-diagnostics shall be provided. In this way interruptions in connecting leads to the system and to earth are immediately recognized and indicated.

The insulation monitoring devices shall comply with IEC 61557-8.

Measuring technology shall be highly accurate with no spurious alarm even in case of modern electronic equipment work for all ungrounded system with AC, DC & AC/DC loads and shall be able to work and locate faults in the varying load conditions.

3. M. V. SWITCHGEARS:

Scope: - Scope includes Supply, Installation, Testing & Commissioning of M.V switchgears.

3.1.1 ACB

- All ACBs shall conform to latest version IEC 60947-2 & IS/IEC 60947-2. All ACBs shall be horizontal draw-out type with trip free mechanism. All Protection releases shall be Micro-processor-based RMS current sensing type.
- All ACBs shall have rated impulse withstand voltage of 12kV for main circuit & 4kV for auxiliary circuit. ACBs shall have Rated insulation voltage of 1000V and shall conform to Pollution degree -4.
- All ACBs shall have inbuilt Electrical & Mechanical anti-pumping to prevent auto reclosing on fault.
- ACB should be design to work on 50 degree without de-rating on rating current.
- All ACBs shall have $I_{cu}=I_{cs}=I_{cw}$ for 1 Second with Combined Test sequence Certification from Independent Testing Approved Authorities CPRI/ERDA/ASTA/KEMA etc.
- All ACBs shall have Electrical Life = Mechanical Life (with Maintenance).
- For safety of users, interlock shall be provided between breaker operating mechanism & the arc chutes to prevent closing of ACB in case the arc chutes are not properly secured.
- It shall be possible to remove the arc chute without using any tool for quick preventive maintenance / inspection.
- All Incomer breakers shall have LSING protections unless specified including Power Metering including Current & Voltage along with Communication. ACB shall have communication facility via RS485 Port Modbus Protocol providing Status of ACBs (ON/OFF) & shall also be capable of Controlling the ACB (ON/OFF) through Remote (User's Computer Interface). All Outgoing breakers shall have LSING protections unless specified.

3.1.2 MCCB

- All MCCBs shall conform to latest version IEC 60947-2 & IS/IEC 60947-2.
- All MCCBs shall comply with the isolation function requirement of IEC 60947-2, IS/IEC 60947-2 section 7.1.2.
- MCCBs up to 250A shall have thermal-magnetic release and beyond 250A with Microprocessor based releases.

- All The MCCBs shall have rated ultimate short circuit breaking capacity (Icu) equal to rated service short circuit breaking capacity (Ics)
- MCCBs should be design to work on 50 degree without de-rating on rating current
- All Incomer breakers shall have LSING protections unless specified including Power Metering including Current & Voltage along with Communication. MCCB shall have communication facility via RS485 Port Modbus Protocol roviding Status of MCCBs (ON/OFF) & shall also be capable of Controlling the MCCB (ON/OFF) through Remote (User's Computer Interface).
- All Outgoing breakers shall have LSI protections for Microprocessor based and LI protection for Thermal Magnetic release.

3.1.3 MCB

- MCBs shall comply to IS/IEC 60898. MCBs shall have Minimum Breaking Capacity of 10kA and shall comply Energy Limiting of Class 3.
- MCBs shall have "No line load bias".
- MCBs shall have dual termination for wire and bus bar on both sides. Offered MCBs shall have 50% lower watt loss as required by IS/IEC 60898 from 6A to 63A.
- MCBs shall have visible flag indication to indicate short circuit faults for easy diagnosis specific to each pole.
- MCBs shall be suitable for isolation as per IEC 60947-1. MCBs shall have safety shutter to avoid Any wrong insertion of cable.

3.1.4 RCCB

- RCCBs shall have conformance to IS 12640-1 / IEC 61008-1 and shall be truly current operated and
- shall operate on Core Balance Current Transformer (CBCT) mechanism.
- RCCBs shall have advance neutral mechanism and shall have no line load bias.
- RCCBs shall have rated conditional short circuit current of 10kA and shall be suitable for isolation.
- RCCBs shall give visible flag indication when RCCB trips on Leakage Fault.

3.1.5 Multifunction Meter (Load Manager)

- All Main PCC Incoming Meters shall as per IEC 62053-21 for Class 0.5S. Meter shall have multiline LCD display with following parameters:
- Phase wise instantaneous and Average values – Voltage, Current, Power Factor
- Phase wise instantaneous and Average values – Active Power, Reactive Power lead & lag, Apparent Power
- Import & Export Cumulative values– Active Energy, Reactive Energy lead & lag, Apparent Energy.
- True PF and Displacement PF for 3 phases and average
- Instantaneous Frequency
- Total Harmonics Distortion – Phase wise Voltage and Phase wise Current
- Min and max of VLL, VLN, A, F, W, VA, VAr, PF with date and time stamp
- Battery backed RTC with 2 years of power down time.
- Demand calculations based on W, VA, VAr
- Demand sync – Sliding window or block window site selectable.
- Demand interval: 5 to 30 min
- Individual harmonics upto 31st order for voltage and current
- Percentage Unbalance – Voltage and Current
- Cumulative Run Hours
- Data Logging with configurable interval (preferable 15 mins) and duration for a period of minimum 2 years.
- Continuous display of kWh parameter on the screen for monitoring energy without touching the button.
- All Main PCC Outgoing Meters and other panel Meters as per IEC 62053-21 for Class 1. Meter shall have multiline LED display with following parameters:
- Phase wise instantaneous and Average values – Voltage, Current, Power Factor
- Phase wise instantaneous and Average values – Active Power, Reactive Power lead & lag, Apparent Power
- True PF and Displacement PF for 3 phases and average
- Instantaneous Frequency
- Total Harmonics Distortion – Phase wise Voltage and Phase wise Current
- Min and max of VLL, VLN, A, F, W, VA, VAr, PF
- Percentage Unbalance – Voltage and Current
- Cumulative Run Hours

3.1.6. Motor Protection Circuit Breaker (MPCB) :

- Motor circuit breakers shall conform to the general recommendations of standard IEC 947 -1,2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-2 N°14.
- The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947-MPCB shall have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall be suitable for isolation conforming to standard IEC 60947-2 and shall have a rated impulse withstand voltage (Uimp) of 6kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without de-rating. Power supply shall be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc., by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles shall close, open, and trip simultaneously. The motor circuit breakers shall accept a padlocking device in the "isolated" position.
- The motor circuit breakers shall be equipped with a "PUSH TO TRIP" device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible. The front-mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC. All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type. The motor circuit breakers shall have a combination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination shall enable type 1 or type 2 co-ordination of the protective devices conforming to IEC 60947-4-1. Type 2 co-ordination shall be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory). The motor circuit breakers, depending on the type, could be equipped with a door-mounted operator which shall allow the device setting. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.

- All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without de-rating. The thermal trips shall be adjustable on the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available. Temperature compensation (-20°C to +60°C).

3.1.7 Plug-in Unit / Tap off units:

- A) Plug-in Units must be type tested design from NABL accredited laboratory for tests like, Thermal cycling test, Temperature rise test, short time withstand voltage, Mechanical operations, Impulse withstand voltage, Clearance & Creepage, Mechanical impact and ingress protection test
- B) Plug-in unit must achieve IP-54 protection & IK10 mechanical impact
- C) Plug-in Units must have interlocks with Busduct, door and MCCB for human safety
- D) Busduct interlock – a) When the MCCB in the Plug-in unit is in 'ON' position, the operator should not be able to open the door.
- E) MCCB can't be switched ON even when Plug-in Box is mounted on Busduct; it is possible only if interlock plate is engaged with feeder
- F) Door interlock – 1) Door can't be opened when MCCB is ON
2) MCCB can't be switched ON until door is completely closed
3) Door defeat feature should be available to use in case of emergency
- G) The design of plug-in units shall be such that, the Earth conductor shall be of 'First-Make' 'Last-Break'type.
- H) It should be possible to mount Plug-in Unit even when Busduct is in live condition but while insertion MCCB must be in OFF condition.
- I) The Plug-in unit will be suitable for accommodating MCCBs or other accessories, as required. The Plug- in unit should allow the flexibility of accommodating different reputed MCCB makes, to be mutually agreed depending on the tender requirements.
- J) Plug-in Unit must be operated using side handle without MCCB ROM, and provision of Padlocking must be provided for human safety.
- K) Plug-in Unit must have Lifting provision for ease of handling and Guide pin for ease of installation LED indicator must be provided on Plug-in Unit door which will glow once MCCB is switched ON.
- L) Plug-in units should be plug-in type up to 400A & Bolt-on Type from 630A.

- m) It should be possible to offer Bolt-on Type Tap-off Box for 100A & higher ratings to withstand vibration due to crane movement, heavy machines in industries.

4.0 AUTOMATIC TRANSFER SWITCHES (ATS):

4.1.1 SCOPE

This specification covers the requirements of design, manufacture, assembly, delivery, testing and commissioning of ATSE panels

Note: This specification is part of LT switchboards specifications, all technical details shall be complied with the LT switchboard/LT Panel specification and shall follow ATSE technical specifications.

The ratings and withstand capacity of the ATSE shall be as per the SLD or as given in the Bill of Quantities (BOQ).

4.1.2 SPECIFICATION

- The Enclosed ATS shall be designed, assembled, manufactured, and tested by the same manufacturer.
- The Enclosed ATS shall comply to the requirements of IEC 60947-3.
- The Enclosed ATS shall comprise of self-interlocked Changeover Switch with Electrically Operated Mechanism (EOM), arrangement for dual power supply and an Automatic Source Transfer controller for facilitating automatic transfer. The electrically operated unit shall be a motorized unit.
- There should not be any requirement for external auxiliary power supply.
- The Enclosed ATS shall have 3 stable positions: I (Position 1 – Source 1), O (Position OFF) and II (Position 2 – Source 2) and shall be of switch disconnector type.
- The complete enclosed ATS shall be factory tested and completed pre-wired and pre-programmed for the intended operation.
- The Enclosed ATS shall have 415Vac as Rated Operational Voltage. The Enclosed ATS shall be 4P. The neutral pole of the enclosed ATS shall be fully rated. The rated current shall be as per the Single Line Drawings/datasheets.
- The Enclosed ATS shall be rated for full current rating for AC-23A utilization category.

- The enclosed ATS must have rated insulation voltage (U_i) up to 1000V, an impulse voltage (U_{imp}) of 12 kV.
- The enclosed ATS shall have a manual and automatic mode. The selection of the same shall be through the controller.
- The Enclosed ATS shall be automatically operated. It shall also be possible to operate it manually through the keypad buttons on the controller and mechanically with a handle. A handle shall be provided for emergency manual operation. It shall be possible to operate the ATS manually with handle irrespective of the position of the switch and mode of operation selected on the ATS (Auto/Manual). The enclosed ATS shall have facility to safely store the handle outside of the enclosure.
- Emergency manual OFF operation must be possible without opening the door.
- The enclosed ATS shall be designed for minimum auxiliary power consumption, and it shall not consume any power while in a stable position other than the one required for the controller.
- The enclosed ATS shall have provision for padlocking in the OFF position. It should have provision for mounting upto three padlocks.
- Automatic, electrical, and manual commands shall be inhibited when the product is padlocked.
- It shall be possible to block the re-transfer process via programming.

The following features are required in the Controller of the Enclosed ATS:

- The Controller shall be equipped with back-lit LCD display on which the following shall be monitored with simple scrolling through keypad buttons:
 - Voltage of both the supplies
 - Frequency of both the supplies
 - Status of the Switching Unit
 - Activated alarms.
 - Programmed settings
- The type of connections, single phase or three phase connections shall be selectable from the controller. Similarly, option of single phase or three phase monitoring shall be selectable from the controller.
- The Controller shall have LED indications for status of the ATS as well as for both supplies.
- The Controller to be programmed with simple keypad buttons without the need to use any tools.
- The following flexible settings should be available as a minimum:
 - Under-voltage/Over-voltage

- Under-frequency/Over-frequency
- Minimum pick-up voltage setting
- Minimum drop voltage setting
- Phase sequence protection
- Phase failure protection
- Priority source selection
- It shall be possible to generate START & STOP signal for Generator ON/OFF.
- Two level Password- protected access is required for the Controller. Level 1 password shall allow the operator to view the settings, Level 2 password shall allow change in settings.
- The time-delay settings must be flexible. The following minimum time delay settings must be available:

Setting	Range
Time delay between disconnection from supply 1 and issue of command for transfer	0.1 sec to 1800 sec
Time for which connected supply is monitored for abnormality before transfer is initiated	0 sec to 600 sec
Restoration time delay	1 sec to 6000sec

- The Controller must have a cyclic event logger which can store up to 100 events.
- The Controller should have alarm indication with cause of failure displayed on the screen along with LED indication visually indicating alarm generation.
- The ATS shall have optional setting for automatic testing with options of day of test and time interval between tests.

4.1.3 INSTALLATION & TESTING

Preparation shall be in accordance with the reviewed product data, final shop drawings and the manufacturer's recommendations.

Installation shall be in accordance with manufacturer's instructions and

recommendations.

The ATSE shall be declared compliant to the IEC standards listed above by a testing laboratory having delegation or working under contract for certification to UL and IEC standards under the IEC Electrotechnical Equipment (IECEE) certification body scheme.

After installation of the equipment, a test report is to be submitted to state that the equipment has been installed and commissioned in accordance with the manufacturer's instructions.

5.0 **MEDIUM VOLTAGE**

CABLING SCOPE:

The specifications given below relates to the Supply, Installation, Testing and Supplying of length of LV Cables & number of L.V. Cable terminations in schedule of quantities at Site.

CODES & STANDARDS:

IS : 7098 Part I / IEC 60332 – 2	XLPE insulated electric cables (heavy duty). / FRLS XLPE Insulated electrical cables
IS : 39611, 2, 3, 5	Recommended current ratings for cables.
IS : 8130(2013)	Aluminum conductors for insulated cables Indian Electricity Act and Rules.
IS : 732 (2010) / IS 12307 / IS 12349(2007) / NBC, IS 5578 (2006)	Guide for marking of insulated conductors.
BS 6387 (2013)	Standard for Testing of Fire Survival for Category C, W, Z.
IEC 60332-1 (2004)	Standard for Testing of Flame Retardant
IEC 601034-3	Standard for Testing of Low Smoke
IS : 7098 (Part I)	Cross-linked Polyethylene (XLPE) insulated PVC sheathed cables. For working voltages from 3.3kV up to & including 33kV.

BS 8491(2008)	Method for assessment of fire integrity of large diameter power cables for use as components for smoke and heat control systems and certain other active fire safety systems
BS 8434-2	Methods of test for assessment of the fire integrity of electric cables. Test for unprotected small cables for use in emergency circuits - BS EN 50200 with a 930°C flame and with water spray (+A2:2009)
BS 8519 (2010)	Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications-Code of practice
IEC 60502-1	Power cables with extruded insulation
IS : 1554(2010)	Specification for PVC (heavy duty) cables
BS:7671(2008)	IET wiring regulations
BS 7846 (2009)	Electric cables- thermosetting insulated armoured, fire-resistant cables of rated voltage 600/1000V, having low emission of smoke and corrosive gases when affected by fire- specification
IS: 694(2010). IS 62271 1-5	PVC insulated cables for a working voltage up to and including 1100V
IS 10810	Method of test for cables
IS : 10418(2011)	Drums for electric cables
IS : 3975 (2009)	Mild steel wires, formed wires and tapes for armouring of cables
IS : 1255	CODE OF PRACTICE FOR INSTALLATION AND MAINTENANCE OF POWER CABLES UP TO AND INCLUDING 33 kV RATING

5.1.1 L.V. POWER & CONTROL CABLES

Abbreviations	PVC : Polyvinyl-Chloride XLPE: Cross Linked Polyethylene SWA : Steel Wire Armour PE : Polyethylene FR : Fire Retardant FS : Fire Survival LSH : Low Smoke Halogen Free

5.1.2 CABLE TYPES :

Aluminium and copper conductors shall have a 90°C operating temperature, the rated voltage of 600/1100V & system voltage up to 1000V with 3 Phase 3 or 4 wire AC having neutral solidly earthed. The cable constructions for various types are as detailed below:

5.1.2.1 Armoured Normal Service Cable (FRLSH)

Conductor : To be Copper / Aluminium as per SLDs ($\leq 16\text{mm}^2$ Cu, $> 16\text{mm}^2$ Al)

Insulation : XLPE (Cross linked polyethylene)

Core Identification: Up to 4

Cores colours 1C - Black

2C - Red, Black

2C + earth – red,

black, green/ yellow

3C - Red, Yellow,

Blue

4C – Red, Yellow, Blue & Black

5 or more cores –numbered (Black numbers printed on grey coloured Insulation).

Laying up : Cores to be laid up together with non-hygroscopic fillers

where necessary.

Bedding/Inner sheath : PVC(Tape) as per IS7098-pt1

Armouring : Multi core cables - single layer of galvanised steel wires (round or flat) as per IS 3974. Single core cables - single layer of aluminium wires.

Over Sheathing : FR-LSH PVC ST2 Conductor temperature 90°C.

Performance Tests : Test as per IS 7098, Part 1, plus

Oxygen Index

> 29%

Temperature

Index 21% at

250°C

Smoke Density and Test for Halogens where HCI < 20% of weight Non-Armoured Normal Service Câble (FRLSH)

Conductor : To be Copper / Aluminium as per SLDs ($\leq 16\text{mm Cu}$, $> 16\text{mm sq Al}$)

Insulation: XLPE (Cross linked polyethylene)

Core Identification: Up to 4 Cores –colours

1C - Black

2C - Red, Black

2C + earth – red,
black, green/ yellow

3C - Red, Yellow,
Blue

4C – Red, Yellow, Blue & Black

5 or more cores –numbered (Black numbers printed on grey coloured Insulation).

Laying up : Cores to be laid up together with non-hygroscopic fillers where necessary.

Bedding : NA.

Armouring : NA.

Over Sheathing : FR-LSH PVC ST2 Conductor temperature 90°C.

Performance Tests : Test as per IS 7098, Part 1, plus

Oxygen Index

> 29%

Temperature

Index 21% at

250°C

Smoke Density and Test for Halogens where HCI < 20% of weight

A) to cable ladder rack or tray.

5.1.3 FLEXIBLE / CONTROL CABLES :

All flexible cables used for pendant lighting fittings or for final connections to fixed or portable equipment shall be of 300/500 volts grade. Flexible cables shall be of annealed copper conductor insulated with heat resisting FRLSH and of circular construction. Flexible cables shall comply with relevant standards and codes of practice mentioned in the specification.

5.1.4 INSPECTION & TESTING:

- A) All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Employer's representative on Site, results will be noted and signed by all present and record be maintained.
- B) Following Routine Tests shall be witnessed by the Employer's representative at the manufacturer's shop:
 - 1) Fire Resistance Test.
 - 2) Insulation Resistance Test.
 - 3) Continuity resistance test.
 - 4) Earth test. (in armoured cables)
- C) The vendor/Manufacturer shall submit detailed Quality Assurance Plan (QAP), Inspection Test Plan (ITP) & test procedures for review/approval of client.
- D) The Employers Representative has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

- E) The results of all tests carried out shall be tabulated and signed jointly by manufacture and Employers Representative. In case the test results are not satisfactory and in accordance of contract specification and there are defects in the materials the same shall be attended and notified to Employers Representative. The equipment shall be dispatched to site of work only after receipt of acceptance of materials and clearance from Employers Representative.
- F) Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing.
- G) On completion of cable laying work, the following tests shall be conducted in the presence of the Employer representative.
 - 1) Insulation Resistance Test(Sectional and overall)
 - 2) Continuity resistance test.
 - 3) Earth test.
 - 4) Visual inspection throughout the length.

5.1.5 SHIPPING, HANDLING & STORAGE:

- A) Cables shall be drummed in maximum continuous lengths on:
- B) Returnable steel drums for all LT Power & Control Cables of large cross-sectional areas or long drum lengths.
- C) Non-returnable wooden drums where the manufacturer can guarantee that such drums are of sufficient strength to protect cable during shipping, handling and outdoor storage for three-year period.
- D) Cable ends shall be sealed and fixed to the drum so that both ends are accessible. To protect the cable during shipment battens shall be fitted around the entire periphery of the drum. Drums shall be suitable for long-term outdoor storage at site. Each cable run shall be manufactured in one length where no through joints shall be allowed. Phase identification of cable conductors at the termination at each end of the feeder shall be provided by markers on the respective switchboard terminals. If through joints are to propose, then approval shall be obtained from the Employers Representative.
- E) All cable drums shall have the Purchase Order Number, Purchase Order Item Number, Drum Number and Stock Code Number clearly stencilled on the outside of both flanges.
- F) Drum identification labels shall be of non-corrosive, non-hygroscopic material and attached to the outside and inside of the drum flanges.

Labels shall be protected by transparent plastic envelopes and give the following information:

- 1) Drum identification number and its direction of rotation for cable removal.
 - 2) Cable voltage grade
 - 3) Cable construction (e.g. FR-LSH etc.)
 - 4) Number of cores and cross-sectional area
 - 5) Cable quantity (Metres)
 - 6) Purchase order number and item number
 - 7) Total weight of cable and drum (kg)
 - 8) Manufacturer's name
 - 9) Year of manufacture
 - 10) Stock code number
- G) The Contractor shall provide the following data with his quotation:
- 11) Standard and maximum drum lengths for all the types of cable offered and his proposed drum lengths for all items.
 - 12) Inspection test plan.
 - 13) Cable dimensions (together with tolerances) as follows:
 - Diameter of (individual in case of multi stranded) conductor wire
 - Percentage of compaction as per data sheet.
 - Diameter under conductor screen (where applicable)
 - Diameter over conductor screen (where applicable)
 - Diameter over individual core insulators
 - Lay of cable in case of multi-core cable
 - Diameter over inner sheath (mm)
 - Diameter over centre sheath (mm)
 - Diameter over lead sheath (mm) where applicable
 - Diameter under armour (mm)
 - Diameter over armour (mm)
 - Diameter of armour wires (mm)
 - Overall diameter (mm)
 - 14) Cable Physical Properties
 - The filler materials to be used.
 - Cable weight in kg/km
 - Minimum bending radius (x OD)
 - Maximum conductor continuous operating temperature
 - FR/FS cabling certification
 - Suitability of outer sheath to resist attack from chemicals.

15) Cable electrical data as follows:

- Conductor dc resistance per km at ambient temperature 40°C
- Conductor ac resistance per km at operating temperature and system frequency
- Conductor inductive reactance per km at system frequency
- Conductor impedance per km at operating temperature and system frequency
- Conductor capacitance per km
- Cable armour resistance per km

- H) The current carrying capacity of single and multi-core cables when installed in defined conditions in air, in ducts and direct buried in the soil, together with rating factors for varying ambient temperatures, grouping and installation conditions and methods.
- I) Cable short circuit withstand capacity to include derating factors for temperature, grouping and burying in the ground as per manufacturer recommendation shall be presented in graphical form or by formulae approved by the Employers Representative.
- J) Descriptive literature (catalogues etc.).
- K) Cross sectional view of the physical make up of each cable.
- L) Recommended temperatures below which installation of cable should not be carried out.
- M) Minimum ambient temperature at which cables can be used.
- N) Maximum pulling force for each cable and any special pulling instructions.
- O) Maximum unsupported run of cable both horizontally and vertically.

6.0 CABLE TERMINATIONS:

6.1.1 : SCOPE:

Supplying and making end termination with brass compression gland and copper lugs for following size of PVC insulated and PVC sheathed / XLPE copper conductor cable of 1.1 KV grade as required.

- A) Multi-conductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.
- B) Thmbles/lugs: The wire shall be terminated with 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 degrees 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 Aluminium cable is used, Aluminium lugs shall be used, for copper cables. Copper lugs shall be used and if cable termination is of aluminium conductor and main bus bar is copper then tinned copper or bimetallic lugs shall be used.

C) Brass compression gland & lugs shall be used & as per CPWD specification.

6.1.2 Watertight cable termination box:

Supplying & fixing of PVC watertight terminal box size 205X255X122 with detachable gland plate in bottom, hinged front openable cover, 1 Nos 4way connector with 2 Nos clamp (for terrace area lighting) in accordance with -IEC 60670-22.

7.0 LIGHTNING PROTECTION SYSTEM

Scope:- Scope includes Supply, Installation, Testing & Commissioning of Lightning protecting system where in; supply includes design, manufacture, integration, packing, dispatching site.

7.1 SUMMARY

- A. This part specifies the general requirements for the lightning protection system, and its accessories. This shall be read in conjunction with other sections of systems specifications & other parts of the contract documentation.
- B. The requirement includes the detailed risk assessment of the structure to be protected, LPS design of structure, engineering, manufacture, testing, packing, forwarding and delivery with test certificate, storage at site, installation, supervision of erection, commissioning, and successful handing over. Protection methods of lightning protection system including all necessary accessories and coordination work as required for the work completion and specified in relevant specifications and to the satisfaction of the Customer, Consultant and End User.
- C. The lightning protection system shall include minimum of following components along with necessary mechanical support(s) and lightning event counter (if necessary).
 1. Air terminal(s),
 2. Down conductor(s),
 3. Earthing system.

7.2 REFERENCES

The publications listed below form part of this specification to the extent referenced. The publications are referred to within this specification by the basic code number alone. Year of publication shall be as per the table furnished below or the latest revision. Also, relevant CEIG/CEA guidelines shall be followed wherever applicable.

7.3 SYSTEM DESCRIPTION

- A. This specification gives guidance on how to assess the risk of being struck and it offers a method of compiling an index figure as an aid in deciding whether a particular structure needs protection.
- B. The specification also offers guidance on good engineering practice and the selection of suitable materials.

7.4 Site Data for Risk Assessment:

The following data is provided by us for each of the building to calculate Risk Assessment.

- 1. project state :
- 2. project location :
- 3. environmental factor : rural / suburban /
urban / urban with
tall buildings higher
than 20 m.
- 4. soil resistivity data :
- 5. length of power line :
- 6. type of installation : underground / above ground
- 7. line type : Ht line / lv power
- 8. cable shield type : armoured / un armoured
- 9. length of communication line :
- 10. type of installation : underground / above ground
- 11. cable shield type : shielded / unshielded
- 12. type of floor :
- 13. risk of fire : low / medium / high
- 14. fire protection : manual / automatic
- 15. total no.of. persons in building :
- 16. No. of operational hours of bldg. /year:

7.5 SUBMITTALS

7.5.1 Design and Construction documents

- A. Base layout and elevation drawings shall be provided by customer. A confirmation of the Employer's Requirements including specifications and drawings shall be submitted during the design stage. All technical submissions shall be approved by the customer. Also details related to Level of protection arrived based on risk assessment study , LPS specifications & test certificates, accessory model, Air terminal locations, Conductor routing and connections, Bonding and earthing provisions, design, finishing and equipment supplied ,Data on methods proposed for the concealment of LPS conductors and interfacing with the structure facades(where applicable) and dimensions of components including elevations shall be furnished during design and co-ordination.
- B. Also, the Design, Construction, Installation, shop and fabrication drawings for the lightning protection system including, but not limited to:
 - 1. Overall LPS layouts, identifying fittings, insulation, plates and markings, passage and routing of conductors, sleeves, grooves, niches etc.
 - 2. Sizes and dimensions of components and exact location of LPS earth pits, rods and details of installation and connections.
 - 3. Design details for the Lightning protection system
 - 4. Routing of buried earthing conductors, including indication of sizes, depth of laying and covering.
 - 5. Method of bonding of Lightning protection system with the structure / utility's existing earthing system through lightning earth bonds.

7.5.2 Product data

The documents shall include complete and detailed information of all materials and equipment along with catalog, data sheets, installation methodology, drawings, dimensions, compliance to the specifications. A compliance statement to each and every points mentioned in this specification needs to be produced with necessary reason and description including deviation if any.

7.6 QUALITY ASSURANCE

7.6.1 Product Requirements

The system shall be installed by competent installations team approved by the manufacturer/supplier of the product under the supervision of trained engineers. The installation must be strictly adhered to the approved drawing. Any modification/change from original drawing must be approved before installation.

7.7 DELIVERY, STORAGE & HANDLING

- A. Delivery and Acceptance Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Store products in manufacturer's unopened packaging until ready for installation.
- C. Store and handle in strict compliance with manufacturer's written instructions and recommendations
- D. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.
- E. Protect from damage due to weather, excessive temperature, and construction operations.

7.8 CO-ORDINATION

Coordinate with architects/electrical consultants/contractor for structural earthing/ ring earthing/ proper routing of conductors and earth pit locations.

7.9 WARRANTY

- A. All necessary warranty certificates shall be issued in accordance with the requirements.
- B. Product shall be warranted free of defects in material or workmanship. Product shall be warranted to perform the intended function within design limits. Manufacturer's sole obligation under this warranty is to replace any defective part or component.
- C. As recommended by the manufacturer all maintenance procedures shall be scheduled and carried out during the

Defects Liability Period according to the requirements. A clear program on maintenance of the system shall be scheduled detailing the frequency of maintenance intervals.

7.10 DEVIATIONS

- A. The bidders are not allowed to deviate from the principal requirements of the Specifications. However, the bidder is required to submit the relevant schedule a detailed list of all deviations if at all without any ambiguity. In the absence of a deviation list in the deviation schedules, it is understood that such bid conforms to the bid specifications and no post-bid negotiations shall take place in this regard.
- B. All the schedules shall be prepared by vendor and are to be enclosed with the bid.

PART 2 PRODUCTS

7.11 MANUFACTURERS

Acceptable Manufacturer: As per approved list of makes for Lightning protection system & associated accessories

7.12 PRODUCT DATA

7.12.1 Materials

Only materials made of aluminum or stainless steel / Copper (Wherever Applicable) are recommended for exposed areas on installations as recommended in NBC 2016. The material used in Lightning Protection system should have been tested as per the standard requirement of IEC 62561 - 1 to 7 (as applicable for relevant components)- latest edition in a third-party lab. Vendor must submit in third party laboratory Test reports for conductors & Components to be submitted as per IEC 62561.

7.12.2 Dimensions

The component parts of lightning protective systems should have dimensions not less than those mentioned in IS IEC 62305 Part 3 (Table 3,6 &7) based on the type of material.

7.12.3 Component parts

- A) The principal components of a lightning protective system are:
1. Air terminations,
 2. Down conductors,
 3. Joints and bonds,
 4. Testing joints,
 5. Earth terminations,
 6. Earth electrodes.

7.12.3.1 Air Terminations

- A. Depending upon the level of protection and area to be protected the number of air termination will be decided.
- B. The maximum distance of any point on the roof from the nearest horizontal / vertical conductor shall be decided as per nature of LPS system and level of protection.
- C. Forms of air termination [General Guidelines]
1. Simple vertical conductor
 2. Horizontal conductors with vertical conductor at the mesh node for flat roof –For a structure with large flat roof a system of horizontal conductors is recommended. The mesh spacing of the horizontal conductor depends on the class of LPS .

Class of LPS	Mesh size w_m m
I	5 × 5
II	10 × 10
III	15 × 15
IV	20 × 20

3. Structures with complex geometry - The main block is protected by a horizontal air termination consisting of a peripheral roof conductor, subsidiary roof conductors being used for the abutting buildings where these are outside the zone of protection of the main structure. The additional structures shown on the roof of the main block such as Lift Machine Room, water tanks, etc. are protected by a peripheral conductor.

4. An isolated lightning protection, preferably 1m away from the building with / without centenary wire as per the site connection is recommended for buildings with explosives & Hazardous areas as classified in IS/IEC 62305.
5. At the corner, the material shall not be at right angle. It should be smooth curve, preferably at 45-degree angle bend.
6. Suitable expansion joints with connector must be provided at every 20m distance wherever applicable.

7.12.3.2 Down conductors

- A. The function of a down conductor is to provide a low impedance path from the air termination to the earth electrode so that the lightning current can be safely conducted to earth.
- B. The down conductor system must, where 'practicable, be directly routed from the air termination to the earth termination network, and be symmetrically placed around the outside walls of the structure starting from the corners, In all cases consideration to side flashing must always be given
- C. The material, configuration and minimum cross-sectional area of down conductor should be strictly as per Table 6 of IS IEC 62305 Part 3
- D. Recommendations for their number should be strictly (to be removed) as per Table 4 of IS IEC 62305 Part 3 (down conductor spacing) which purely depends on the level of protection. However, the position and spacing of down conductors on structures is often governed by architectural convenience and hence the location and spacing may be decided in consultation with customer and as per standard guidelines.

Table 4 – Typical preferred values of the distance between down-conductors according to the class of LPS

Class of LPS	Typical distances m
I	10
II	10
III	15
IV	20

- E. Routing - A down conductor should follow the most direct path possible between the air terminal network and the earth termination network. Down conductors should be arranged as evenly as practicable around the outside walls of the structure
- F. Use of reinforcement in concrete structures - Details should be decided at the design stage, before building construction begins. The following precautions are, however, recommended:
- G. Good contact between reinforcing bars to be ensured by Steel rod/strip with connection clamps tested as per the requirement of IEC 62561-4-(Lightning Protection system component - Requirements for conductor fasteners
 - 1. Proper conductor holders should be used to avoid spark overs and for mechanical strength.
 - 2. Suitable Earth point along with accessories shall be considered.

7.12.3.3 Joints

- A. Joints should be mechanically strong and electrically tested, Joints of dissimilar metals should be protected against corrosion or erosion from the elements or the environment and should present an adequate contact area. Where incompatible material has to be joined (Ex. Copper with aluminum), suitable bi-metal connectors have to be used.

7.12.3.4 Test Joints

Each down conductor should be provided with a test joint in such a position that, whilst not inviting unauthorized interference, it is convenient for use when testing.

Test joint is not applicable in case of using natural components.

7.12.3.5 Earth termination network

- A. Resistance to earth - Combined resistance of the earth system i.e., interconnected system consisting horizontal and vertical earth conductors **shall be ≤ 10 ohms**
- B. Common network for all services - A common earth termination network is recommended for the lightning protective system and all other services. It should be in accordance with the recommendations of IS IEC 62305 & IEC 60364 and should also comply with any regulations applicable to the Services concerned. The resistance to earth should; in this case, be the lowest value required for any of the individual services.
- C. Isolation of earth electrodes for testing - Earth electrodes should be capable of being isolated and a reference earth point should be provided for testing purposes.
- D. Type B Earthing (Ring Earthing) system shall be selected as per standard requirement & site condition.

7.12.3.6 References:

IS/IEC62305 – PROTECTION AGAINST LIGHTNING:

Part 1: General Principles Part 2: Risk Management Part 3: Protection of structures

Part 4: Protection of Electrical & Electronic equipment within structure

IS3043: 1987: Code of practice for earthing.

8.0 SPD

Scope: - Scope includes Supply, Installation, Testing & commissioning of surge protection devices with required and necessary accessories, supports, etc required for smooth functioning of the system.

Specifications:

8.1.1 Type I+II SPDs

- A) Surge Protection Device with Test Class I & II according to IEC 61643-11 Ed. 1 (2011-03) and Type 1 and 2 according to EN 61643-11 (2012-10), Connection type 3+1, Impulse Discharge Current (10/350 μ s) $I_{imp} = 25KA$

(L-N) & 100KA (N-PE), Nominal Discharge Current(8/20 μ s) I_n = 60KA (L-N) and 100 KA (N-PE), Maximum Continuous Operating Voltage U_c ≥335V (L-N) and U_c ≥255V (N-PE), Voltage Protection Level Up 1.25 kV at 25KA and 1.5kV (N-PE), Short Circuit withstand capacity(I_{sc})=5KA without backup fuse and Upto 50KA with 250A gG fuse, Temporary Overvoltage TOV (U_t)= 440V/120 min (Withstand mode) L-N & 1200V/200ms (Withstand mode) N-PE, Potential Free Contact for remote indications, Progressive Performance Indication, Pollution degree 3. Device must be tested according to IEC 61643-11 and certified quality mark.

- B) Surge Protection Device with Test Class I & II according to IEC 61643-11 Ed. 1 (2011-03) and Type 1 and 2 according to EN 61643-11 (2012-10), Connection type 3+1, Impulse Discharge Current (10/350 μ s) I_{imp} = 13KA (L-N) & 52KA (N-PE), Nominal Discharge Current(8/20 μ s) I_n = 35KA (L-N) and 52 KA (N-PE), Maximum Continuous Operating Voltage U_c ≥335V (L-N) and U_c ≥255V (N-PE), Voltage Protection Level Up 1.25 kV at 20KA and 1.5kV (N-PE), Short Circuit withstand capacity(I_{sc})=5KA without backup fuse and Upto 50 to 100 KA with 160 A gG fuse, Temporary Overvoltage TOV (U_t)= 440V/120 min (Withstand mode) L-N & 1200V/200ms (Withstand mode) N-PE, Potential Free Contact for remote indications, Progressive Performance Indication, Pollution degree 3. Device must be tested according to IEC 61643- 11 and certified quality mark.
- C) Surge Protection Device with Test Class I & II according to IEC 61643-11 Ed. 1 (2011-03) and Type 1 and 2 according to EN 61643-11 (2012-10), Connection type 3+1, Impulse Discharge Current (10/350 μ s) I_{imp} = 8KA (L-N) & 52KA (N-PE), Nominal Discharge Current(8/20 μ s) I_n = 30KA (L-N) and 52 KA (N-PE), Maximum Continuous Operating Voltage U_c ≥335V (L-N) and U_c ≥255V (N-PE), Voltage Protection Level Up 1.25 kV at 20KA and 1.5kV (N-PE), Short Circuit withstand capacity(I_{sc})=5KA without backup fuse and Upto 50 to 100 KA with 125 A gG fuse, Temporary Overvoltage TOV (U_t)= 440V/120 min (Withstand mode) L-N & 1200V/200ms (Withstand mode) N-PE, Potential Free Contact for remote indications, Progressive Performance Indication, Pollution degree 3. Device must be tested according to IEC 61643- 11 and certified quality mark.

8.1.2 Type II SPDs

Surge Protection Device with Test Class II according to IEC 61643-11 Ed. 1(2011-03) and Type2 according to EN 61643-11 (2012-10), Connection type 3+1, Nominal Discharge Current(8/20 μ s) I_n = 10KA (L- N) and 40 KA

(N-PE), Maximum Continuous Operating Voltage $U_c \geq 335V$ (L-N) and $U_c \geq 255V$ (N-PE), Voltage Protection Level Up 1.00 kV at 5KA and 0.83 kV at 1KA and 1.5kV (N-PE), Short Circuit withstand capacity (I_{sc}) = 5KA without backup fuse and Up to 50 to 100 KA with 125 A gG fuse, Temporary Overvoltage TOV (U_t) = 440V/120 min (Withstand mode) L-N & 1200V/200ms (Withstand mode) N-PE, Potential Free Contact for remote indications, Progressive Performance Indication, Pollution degree 3. Device must be tested according to IEC 61643-11 and certified quality mark.

8.1.3 SURGE PROTECTION DEVICE- Important Selection Parameters

8.1.3.1 INTRODUCTION

Lightning flashes to earth may be hazardous to structures and to lines. The hazard to a structure can result in damage to the structure and to its contents, failure of associated electrical and electronic systems, and injury to living beings in or close to the structure. Consequential effects of the damage and failures may be extended to the surroundings of the structure or may involve its environment. To reduce the loss due to lightning, protection measures may be required. Surge protection device is one which can limit surge current caused by lightning or switching. It is connected in parallel with respect to ground against the equipment which is to be protected. SPD offers low impedance path to the surge current and discharge it through grounding system. Fuses and circuit breakers are Overcurrent Protective Devices (OCPDs) are designed to protect your home, business, equipment, and possibly even your life from an event such as a short circuit or overload. The Surge Protective Device is specifically designed to protect equipment from events such as extremely short duration high voltage spikes.

Part 2 of IEC 62305 is applicable to risk assessment for a structure due to lightning flashes to earth.

Its purpose is to provide a procedure for the evaluation of such a risk. Once an upper tolerable limit for the risk has been selected, this procedure allows the selection of appropriate protection measures to be adopted to reduce the risk to or below the tolerable limit.

8.1.3.2 SPD MODES OF PROTECTION AND INSTALLATION

When the equipment to be protected has a sufficient over voltage withstand or is located close to the main distribution board, one SPD may be sufficient and should be installed as close as possible to the entrance of the installation. The

SPDs should have sufficient surge withstand capability for this location. Figures 1 & 2 show typical connections of SPDs located at the entrance of the installation for different types of systems. SPDs at or near the entrance of the installation shall be connected at least between the following points:

a) if there is a direct connection between the neutral conductor and PE at or near the origin of the installation or, if there is no neutral conductor, between each line conductor and either the main earthing terminal or the main protective conductor, whichever route is shorter; or

NOTE 1 The impedance connecting the neutral to PE in IT systems is not considered as a connection.

b) If there is no direct connection between the neutral conductor and PE at or near the entrance of the installation either:

Between each line conductor and either the main earthing terminal or the main protective conductor, and between the neutral conductor and either the main earthing terminal or the protective conductor, whichever route is shorter - Connection type 1 (CT 1), see Figure 1

Or Between each line conductor and the neutral conductor and between the neutral conductor and either the main earthing terminal or the protective conductor, whichever route is shorter - Connection type 2 (CT 2), see Figure 2.

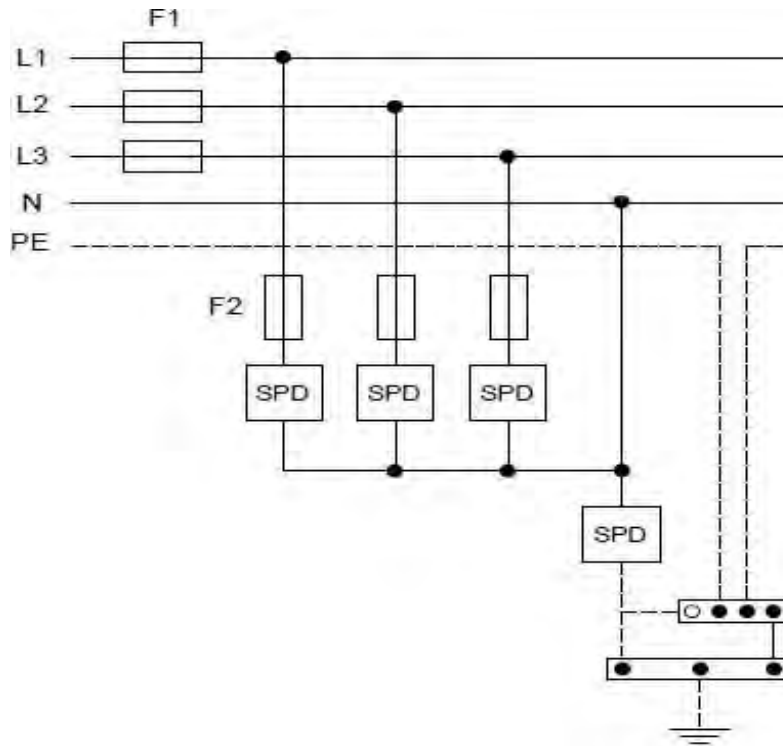


Figure 1. Connection Type 1 (CT1)

The installation of SPDs in specific power distribution System must be coordinated with protective measures against indirect contact (fault protection) and with the protective devices and their capability to withstand impulse currents.

The coordination depends on the type and earthing arrangement of the power system, as there are TN, TT and IT systems according to HD 60364-1 and corresponding protective devices may be: Overcurrent protective devices, Residual current protective devices, insulation monitoring devices, etc.

8.1.3.3 SIMPLE CALCULATION OF I_{imp} :

In case of a LPS being fitted to the building hosting the electrical installation, there is a need to recall the rules given in IEC 62305 series to calculate the sharing of current and thus the current withstands I_{imp} of the SPD located at the entrance.

According to the IEC 62305 series, there is a need to use an equipotential SPD at the entrance of the installation as soon as an LPS is present on the building. This SPD is tested with Class I tests and is defined mainly by a 10/350 withstand I_{imp} .

Depending of the lightning protection level (LPL) of the LPS, this value ranging from 1 to 4, the current can be calculated by the following formula in the simple case where there is only one power line fitted and all other lines and conduits are not existing or ignored (most severe case).

In practice the above method assumes that only one service enters the facility. In general there may be more services that carry portion of the lightning current away from the facility (such as metal pipes) and this will lead to lower values for I_{imp} . In tables below values for I_{imp} are maximum values.

In such a case, the maximum current linked to the LPL of the LPS is divided equally by the number of conductors in the line and divided by two (as 50 % of current is assumed to flow in the earthing system). Thus, the impulse current I_{imp} that the SPD shall withstand for each mode of protection, can be easily calculated with the following formula:

$$I_{imp} = \text{Maximum current corresponding to LPL} / (2 n)$$

This leads to the following Tables for I_{imp} for both CT1 and CT2 connection schemes when such a scheme is available. In case of old installations or where the electrical contractor is unaware of the installation detail, the worst case must be assumed (LPL I). Table 1 is for the most usual LV power systems.

Table 1:

LV System (Single Phase and Three Phase) I_{imp} KA									
LPL	Maximum Current Corresponding to LPL	No. of Conductors (n)	TT			TN-C CT1	TN-S/ TN-C-S		
			CT 1	CT2			CT1	CT2	
			L-PE N-PE	L-N N-PE	N-PE	L-PEN	L-PE N-PE	L-N N-PE	N-PE
I	200KA	5	NA	NA	NA	NA	20	20	80
		4	25	25	100	25	NA	NA	NA
		3	NA	NA	NA	NA	33.3	33.3	66.7
		2	50	50	100	50	NA	NA	NA
II	150KA	5	NA	NA	NA	NA	20	20	80
		4	18.8	18.8	75	18.8	NA	NA	NA
		3	NA	NA	NA	NA	25	25	50
		2	37.5	37.5	75	37.5	NA	NA	NA
		5	NA	NA	NA	NA	10	10	40

III/IV	100KA	4	12.5	12.5	50	12.5	NA	NA	NA
		3	NA	NA	NA	NA	16.7	16.7	33.3
		2	25	25	50	25	NA	NA	NA

NOTE When the LPL value is not known, the worst case shall be assumed.

8.1.3.4 CHOICE OF THE VOLTAGE PROTECTION LEVEL U_p

The surge withstands of the equipment (or impulse immunity of critical equipment) to be protected and the nominal voltage of the system shall be considered in choosing the preferred voltage protection level value of the SPD.

The lower the value the better the protection.

Maximum Continuous Operating Voltage (U_c):

Def: Maximum rms voltage which may be applied to the SPD's mode of protection.

It is selected depending on

- Nominal Operating Voltage (U_o)
- Low Voltage Distribution System (TN,TT,IT)
- Required modes of protection (L-N, L-PE, N-PE)
- The TOV to be expected and its withstand requirements U_c :

SPD	TN-system	TT-system	IT-systems
phase to neutral	$U_c \geq 335 \text{ V}$	$U_c \geq 335 \text{ V}$	$U_c \geq 335 \text{ V (1)}$
phase to earth	$U_c \geq 335 \text{ V}$	$U_c \geq 400 \text{ V}$	$U_c \geq 400 \text{ V}$
neutral to earth	-	$U_c 255 \text{ V (2)}$	$U_c 255 \text{ V (2)}$

$1.45 \times U_o$: $1.45 \times 230\text{V}$: 333.5V ac (335V ac)

Immunity against commonly temporary overvoltage for 230/400V guaranteed by selection of the following U_c Values (tested for TOV of 1200V for 200ms).

8.1.3.5 NOMINAL DISCHARGE CURRENT I_n

The Nominal Discharge Current is the peak value of surge current conducted through SPD. It has 8/20 μ s impulse current waveform. The SPD must function after 15 applied surges.

The selection of the appropriate I_n of an SPD depends on many complex and interconnected parameters. The user not only needs to consider how the injection current will distribute within the structure and its power distribution

system, but also needs to take into account the statistical probabilities associated with the magnitude of this discharge and the wave shapes involved. It is important to keep in mind that the probability of damage to electronic systems within the building due to surges entering via power, phone and data lines, is far greater than that due to a direct strike to the building itself.

When addressing such complexities, one needs to keep in mind that the most important aspect in selecting an SPD is its limiting voltage performance during the expected surge event, and not the energy withstands (I_n) which it can handle. An SPD with a low limiting voltage (U_p) will ensure adequate protection of the equipment, while an SPD with a high energy withstand may only result in a longer operating life.

I_n corresponds to a current that is expected to occur frequently in the field. The preferred values for I_n are: (0,05; 0,1; 0,25; 0,5; 1,0; 1,5; 2,0; 2,5; 3,0; 5,0; 10; 15 and 20) kA. IEC 60364-5-53 requires a minimum of 5 kA at the entrance of the installation.

This current discharge parameter (I_n) should be selected in accordance with impulse withstand voltage of the equipment to be protected, if not then SPD will survive such a stress but the equipment will not be protected.

Therefore, the voltage protection level and surge current withstand of the SPD shall be selected accordingly.

8.4 KEY POINTS:

- The KA rating of surge protection device is one of the most misleading terms. We normally use 50KA SPD to protect 50KA panel. The KA rating of SPD has nothing to do with fault current of electrical distribution panel. When surge enters a panel does not know panel size so it is totally miscalculation to use 50KA SPD for 50KA panel.
- Size of surge protection depends upon location of panel within the electrical system than the panel size.
- Intermediate stages of the status indicator or other similar functions may also be provided e.g. for preventive maintenance, before it has reached its end of life.
- I_{max} is optional parameter so it should not be considered while selecting SPD.
- Voltage protection level of SPD must be below impulse voltage withstand value of load.
- Large size of SPD does not give better protection; larger KA ratings are for redundancy & longer life only. Size of SPD depends upon location of panel.

- SPD should have intermediate stages of the status indicator (multicolour progressive performance indicator).
- Selected SPD should be immune to pollution degree 3 and internal disconnector capable to quench more Isccr without backup fuse to ensure full discharge capacity.
- MCB never be used as backup fuse.

9.0. ANTI BACTERIAL SWITCHES & SOCKETS:

Scope:- Scope includes Supply, Installation, Testing & commissioning of switches, sockets, face plate, back- box, etc including required & necessary accessories and supports for smooth operation / functioning.

- All switches and sockets with faceplates for all ICU and OTs shall be anti-microbial type only. The anti- microbial shall be infused during moulding and no spray or outer treatment shall be acceptable.

10. FLOOR JUNCTION BOX

SCOPE :

- Supply & Installation of floor box for which back box made of pre-galvanised sheet for mounting LV & ELV points on floor Consist of back box, lid & trim. Height adjustable from 65-90mm for mounting of tile/marble on the top. Cover fitted on to the back box can be opened easily if required. Protection level should be IP 20 & IK 08. Standard size of back box 325 X 325mm is required. Confirms to standard EN 60-670, EN 50 085 - 2 - 2 & IEC 61534-22. Resistance to vertical load applied through small surface area should be 1500 N & Resistance to vertical load applied through large surface area should be 3000 N. Floor box should be supplied with complete accessories i.e. flat plate/waved plate & WD from the same manufacturer..
- Floor Box for suitable for mounting 4 nos 6-amp switch with 4 nos of 6/13 amp multistranded socket & 4 IO's with Lid & Trim for tile 8-15 mm thickness material for head band & single cable outlet - stainless steel 304 tile mounting on the top to match finished floor.
- Supplying and fixing Pop-Up Box 8 module with 02NOS. 6A SOCKET + 02 NOS. 6A SWITCH + 01NO.
1. USB MOBILE CHARGING + 01NO. DUMMY PLATE compatible for furniture only. Matte Aluminium finish for Pop-Up Box. Slim design for perfect integration into the furniture. Soft opening for enhanced comfort

and safety. Equipped with "Push Button" locking system. Confirm to NFC 61-314 / IEC 60884-Pop up box shall have IK07 protection against mechanical impact and material shall be halogen free, fire proofed and no propagator of the flame.

11. Light Fixture:

11.1. Scope:

The scope of work shall cover the supply, installation, and testing LED type light fixtures with all, required & necessary accessories as specified in the schedule of work for smooth operation / functioning.

11.1.2 Standards:

- The following standards and rules shall be applicable:
 - (i) CPWD general specifications for electrical works Part – I (Internal) – 2013, Part II (External) -1994 amended up to date
 - ii) Lighting Design should be carried out as per BIS code/National Lighting Code 2010/NBC-2016/ECBC guidelines latest amended up to date. Wherever range of illumination for space is mentioned, higher side of Lux level must be taken for design purpose. 7. Room wise / floor wise / building wise data sheets mentioning Illumination calculation, Luminaire selection to Engineer in charge for approval .Arrangement of luminaries in various areas of buildings shall be done on the basis of BIS code/ National Lighting code 2010 and NBC 2016.
- All codes and standards mean the latest. Where not specified otherwise the installation shall generally follow the Indian Standard Codes of Practice.
- The different light fixtures within this design to be used to serve the purpose of Normal Lighting as well Emergency Lighting.

The Normal Lighting shall be for the normal working hours / duration with necessary mode of control such as through the Switches / MCBs etc.

However, the Emergency Lighting shall be used basically for the time duration of complete black-out. This black-out can be because of loss of electricity board (E.B.) power supply or because of change power source of from E.B. to D.G. These Emergency lights shall be backed-up through the dedicated Inverter with the battery pack provision as specified.

Primarily all the Emergency lighting shall be looped through the separate

circuits emanated from the Inverter / UPS fed distribution boards. So that these Emergency Lighting can be 'ON' during the normal time & the same shall be continuously operative during the loss of normal power.

The necessary change-over facility to be included to work the system satisfactorily.

- All lighting fixtures should be LED type having efficacy more than 120 Lumen/ Watt except for down lighter for which efficacy shall be more than 120 lumen/watt and CRI >80, THD shall be as per specification, LM 79 & LM 80 test report from NABL accredited lab should be submitted by the agency. Colour temperature may be 3000/4000/6000K as per site requirement. The external light shall be IK 10, IP 66 rating fitting. Lamp life of LED lights shall be 50000 hrs or better.

11.1.3. General Requirements:

- All fixtures shall be complete with accessories and fixings necessary for installation whether so detailed under fixture description or not.
- Fixture housing, frame or canopy shall provide a suitable cover for the fixture outlet box or fixture opening.
- Fixtures shall be installed at mounting heights as detailed on the drawings or instructed on site by the Architects/Consultants and individually earthed with specified sized Cu wire.
- Fixtures and/or fixture outlet boxes shall be provided with hangers to adequately support the complete weight of the fixture. Design of hangers and method of fastening other than shown on the drawings or herein specified shall be submitted to the Architect/Consultant for approval.
- Pendant fixtures within the same room or area shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation as per Architect's/Consultant's instructions.
- Flush mounted and recessed fixtures shall be installed so as to completely eliminate light leakage within the fixture and between the fixture and adjacent finished surface.
- Fixture mounted on outlet boxes shall be tightly secured to a fixture stud in the outlet box. Extension pieces shall be installed where required to facilitate proper installation.
- Fixture shall be completely wired and constructed to comply with the regulations and standards for Electric Lighting Fixtures, unless otherwise specified. Fixtures shall bear manufacturer's name and the factory inspection label unless otherwise approved.

- Wiring within the fixture and for connection to the branch circuit wiring shall be not less than 1.5 sq.mm. Copper for 250-volt application. Wire insulation shall suit the temperature conditions inside the fixture and wires bypassing the choke shall be heat protected with a heat resistant sleeve.
- Metal used in lighting fixtures shall be not less than 22 SWG or heavier if so required to comply with the specification or standards. Sheet steel reflectors shall have a thickness of not less than 20 SWG. The metal parts of the fixtures shall be completely free from burrs and tool marks. Solder shall not be used as mechanical fastening device on any part of the fixture.
- Ferrous metal shall be bonderized and given a corrosion resistant phosphate treatment or other approved rust inhibiting prime coat to provide a rust-proof base before application of finish.
- Non-reflecting surfaces such as fixture frames and trim shall be finished in baked enamel paint.
- Light reflecting surface shall be having a reflection factor of not less than 80%. All parts of reflector shall be completely covered by finish and free from irregularities. Finish shall be capable of withstanding 72 hours continuous exposure to an ultraviolet sun lamp placed 10 cm from the surface without discoloration, hardening or warping and retain the same reflection factor after exposure. Test results shall be furnished for each of fixtures.
- Fixture with visible frames shall have concealed hinges and catches. Pendant fixtures and lamp holders shall be provided with ball type aligners or similar approved means. Recessed fixtures shall be constructed so as to fit into an acoustic tile ceiling or plaster ceiling plaster rings/flanges shall be provided for plaster ceiling. Fixtures with hinged diffuser doors shall be provided with spring clips or other retaining device to prevent the diffuser from moving.
- Detailed catalogue cuts for all fixtures, or, if so required by the Architect/Consultants sample fixtures shall be submitted for approval to the Architect/Consultants before orders for the fixtures are placed. Shop drawings for non-standard fixture types shall be submitted for approval to the Architect/Consultant.
- Recessed fixtures shall be constructed so that all components are replaceable without removing housing from the ceiling.

- i) Lamp shall be supplied and installed in all lighting fixtures furnished under this contract.

All lamps shall be rated for 250 volts.

- ii) Lamps used for temporary lighting service shall not be used in the final lamping of fixtures units.
- iii) Lamps shall be of wattage and type as shown on the drawings and schedule. Where not shown, the details shall be ascertained from the Architect/Consultant before procurement.
- iv) Lamps for permanent installation shall not be placed in the fixtures until so directed by the Architect/Consultant, and this shall be accomplished directly before the building portions are ready for occupation.
- v) Minimum details of the light fittings to be installed in different areas of internal work for- STP & Pump room, OWC, BMW, MGPS Plant Room, Common Drives Toilets, Gate Security Cabins)

SR.No.	Description for Specialized light fittings in various areas as per category:	Area / Location for specialized light fittings Installation
1	7W (more than 100 lm/W system effacasy) wall mounted LED light of 600 mm Batten (Mirror Light) with following specifications :with Extruded Aluminium with Polycarbonate diffuser, Energy Efficient Integrated Driver and all the accesories required for installation,Color Temperature between 5700k - 6000k Color Randereng > 80 Beam Angle 120 Degree diffused HET DiffuserIngress Protection > IP 40	Toilet

2	Supply installation, testing and commissioning of 10 / 12W LED Bulkhead with 105lm/W system efficacy. System output is 1050 lm for 10W. Housing made of pressure die cast aluminium with High translucent PMMA diffuser. Proposed CCT is 6500K along with CRI$\geq$80. Product is having dimension of 149X95X55mm. LM 80-08 compliant LEDs from reputed makes such as APT Electronics / Cree, / Bridgelux / Lumiled should be provided. Product should have IP65 protection. LEDs used in the product shall comply with EN 62471 for Photo-biological safety and certificate for the same from manufacturer shall be provided. Driver is having p.f. $\geq$0.90 with iTHD$\leq$20% ,efficiency of $\geq$80%. Product is suitable to operate in 140 - 270V Ac range. service life is 25000 HRS as per L70B50.	BMW / MGPS / STP
3	Supply, installation, testing and commissioning of 18W Surface mounted LED circular downlight with 2000lm system output. Product is with 110lm/W system efficacy. Housing made of extruded polycarbonate with High translucent Polycarbonate diffuser. Product is with dia of 220mm. Proposed CCT is 6500K along with CRI$\geq$80. LM 80-08 compliant LEDs from reputed makes such as APT Electronics / Cree, / Bridgelux / Lumiled should be provided. Product should have IP20 protection. LEDs used in the product shall comply with EN 62471 for Photo-biological safety and certificate for the same from manufacturer shall be provided. Driver is having efficiency of $\geq$85%. Driver is having p.f. $\geq$0.95 with iTHD$\leq$20%. Driver is having inbuilt surge protection of 2.5KV. Product is suitable to operate in 140 - 270V Ac range. service life is 30000 Hrs as per L70B50.	Gate / MGPS
4	Supply, installation, testing and commissioning of 8W Surface mounted LED circular downlight with 900lm system output. Product is with 110lm/W system efficacy. Housing made of extruded polycarbonate with High translucent Polycarbonate diffuser. Product is with dia of 220mm. Proposed CCT is 6500K along with CRI$\geq$80. LM 80-08 compliant LEDs from reputed makes such as APT Electronics / Cree, / Bridgelux / Lumiled should be provided. Product should have IP20 protection. LEDs used in the product shall comply with EN 62471 for Photo-biological safety and certificate for the same from manufacturer shall be provided. Driver is having efficiency of $\geq$85%. Driver is having p.f. $\geq$0.95 with iTHD$\leq$20%. Driver is having inbuilt surge protection of 2.5KV. Product is suitable to operate in 140 - 270V Ac range. service life is 30000 Hrs as per L70B50.	Toilet / Gate / MGPS

5	Supply, installation, testing and commissioning of 33W, 4ft linear LED Batten with 4000 lm system output. Product is with 120 lm/w system efficacy. Housing made of pressure die cast aluminium with High translucent Polycarbonate diffuser. Product is with CCT6500K & CRI>80. LM 80-08 compliant LEDs from reputed makes such as APT Electronics / Cree, / Bridgelux / Lumiled should be provided. Product should have IP20 protection. The LED shall be compliant with LM80-08 standard with Useful L70 life of 25000 Hrs tested at maximum current as per L70B50. LEDs used in the product shall comply with EN 62471 for Photo-biological safety and certificate for the same from manufacturer shall be provided. Driver is having efficiency of $\geq 85\%$. Driver is having p.f. ≥ 0.90 with $iTHD \leq 10\%$. Product is suitable to operate in 140 - 270V Ac range. Driver should have 2.5KV inbuilt surge protection is given.	BMW / Gate / MGPS / OWC / STP
6	Supply, installation, testing and commissioning of 40W (more than 120 lm/W system efficacy) weatherproof LED Tube light Surface or Suspended mounting 1200mm Batten with following specifications : (Equivalent to Philips-BN308C LED40S-6500 L120 PSU WH) Pressure die cast aluminium housing with High translucent Polycarbonate diffuser, Energy Efficient Integrated Driver and all the accessories required for installation, Color Temperature between 5700k - 6000k Color Rendering > 80 Beam Angle 120 Degree diffused HET Diffuser Ingress Protection $> IP 66$ Driver is having efficiency of $\geq 85\%$. Driver is having p.f. ≥ 0.90 with $iTHD \leq 10\%$. Product is suitable to operate in 140 - 270V Ac range. Driver should have 2.5KV inbuilt surge protection is given.	External Area

7	Supply ,installation, testing and commissioning of IP65 Symmetric medium beam, 40W LED Floodlight luminaire with system efficacy of 120lm/W. system output should not be more than 4800lm for 40W. Power consumption of luminaire should not exceed 195W. CCT should be 5700K with CRI ≥ 70. The housing should be made of non- corrosive high-pressure die-cast aluminum to withstand extreme environments. It should have corrosion resistant powder coating to pass NSS of 500 Hrs. Product should be suitable for continuous operation (10-12 Hrs. per day). The Ingress protection should be minimum IP 66 with an IK rating of 08. Optical and control gear compartments shall be maintainable/replaceable without impacting the LED units. The access to the optical and the gear compartment should be separate.. The Luminaire should have a 4KV SPD duly bolted in the Luminaire .The luminaire should be of Class B Serviceability. The wattage of each LED should be greater than 1 watt and less than 3 Watt. Only high power Single white LED chip with ceramic based suitable for outdoor use is allowed. Multi Chip , array multi die , mid power ,Integrated arrays and COB's are not permitted. The luminaire should be capable of withstanding voltage stress of 440V for 8 Hrs., should have an auto shutdown @ 325V and have an auto recovery feature. The Drivers should be a potted driver not a printed circuit board without casing, mounted inside the luminaire. Driver should have short circuit and open circuit protection. Luminaire and Driver both should be BIS approved and CRS no (individual R no) should be shared along with LM79 & LM80 during bid submission. Product should have Lifeclass of 50K hours @L70 with PF > 0.95 & THD $\leq 10\%$..product is designed to operate at (-10) Deg to 45deg operating temp. 50,000 Hrs burning life as per L70B50 is provided as per L70B50 (with suitable MS bracket as shown in typical installation drawing).	BMW / MGPS / OWC / STP / Toilet

8	Supply ,installation, testing and commissioning of IP65 Symmetric medium beam, 55W WELL GLAS LIGHT luminaire with system efficacy of 120lm/W.system output should not be more than 7090lm for 55W. Power consumption of luminaire should not exceed 60W. CCT should be 5700K with $CRI \geq 70$. The housing should be made of non-corrosive high-pressure die-cast aluminum to with stand extreme environments. It should have corrosion resistant powder coating to pass NSS of 500 Hrs. Product should be suitable for continuous operation (10-12 Hrs. per day). The Ingress protection should be minimum IP 66 with an IK rating of 08. Optical and control gear compartments shall be maintainable/replaceable without impacting the LED units. The access to the optical and the gear compartment should be separate.. The Luminaire should have a 4KV SPD duly bolted in the Luminaire .The luminaire should be of Class B Serviceability. The wattage of each LED should be greater than 1 watt and less than 3 Watt. Only high power Single white LED chip with ceramic based suitable for outdoor use is allowed. Multi Chip , array multi die , mid power ,Integrated arrays and COB's are not permitted. The luminaire should be capable of withstanding voltage stress of 440V for 8 Hrs., should have an auto shutdown @ 325V and have an auto recovery feature. The Drivers should be a potted driver not a printed circuit board without casing, mounted inside the luminaire. Driver should have short circuit and open circuit protection. Luminaire and Driver both should be BIS approved and CRS no (individual R no) should be shared along with LM79 & LM80 during bid submission. Product should have Lifeclass of 50K hours @L70 with $PF > 0.95$ & $THD \leq 10\%$..product is designed to operate at (-10) Deg to 45deg operating temp. 50,000 Hrs burning life as per L70B50 is provided as per L70B50.	Gate
9	Supply, Installation, Testing and Commissioning of 1200 mm sweep, BEE 5 star rated, ceiling fan with Brush Less Direct Current (BLDC) Motor, class of insulation: B, 3 nos. blades, 30 cm long down rod, 2 nos. canopies, shackle kit, safety rope, copper winding, Power Factor not less than 0.9, Service Value (CMM/W) minimum 6.85, Air delivery minimum 215 CMM, 350 RPM (tolerance as per IS : 374- 2019), THD less than 10%, remote or electronic regulator unit for speed control and all remaining accessories including safety pin, nut bolts, washers, temperature rise=75 degree C (max.), insulation resistance more than 2 mega ohm, suitable for 230 V, 50 Hz, single phase AC Supply, earthing etc. complete as required.	BMW / Gate / MGPS
10	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.	BMW / Gate / MGPS

ii)Minimum details of the light fittings to be installed in different areas of Substation

SR.No.	Description for Specialized light fittings in various areas as per category:	Area / Location for specialized light fittings Installation
1	7W (more than 100 lm/W system efficacy) wall mounted LED light of 600 mm Batten (Mirror Light) with following specifications :with Extruded Aluminium with Polycarbonate diffuser,Energy Efficient Integrated Driver and all the accesories required for installation,Color Temperature between 5700k - 6000k Color Randerling > 80 Beam Angle 120 Degree diffused HET DiffuserIngress Protection > IP 40	Substation
2	Supply, installation, testing and commissioning of 18W Surface mounted LED circular downlight with 2000lm system output. Product is with 110lm/W system efficacy.Housing made of extruded polycarbonate with High translucent Polycarbonate diffuser.Product is with dia of 220mm. Proposed CCT is 6500K along with CRI≥80.LM 80-08 compliant LEDs from reputed makes such asAPT Electronics / Cree, / Bridgelux / Lumiled should be provided.Product should have IP20 protection. LEDs used in the product shall comply with EN 62471 for Photo-biological safety and certificate for the same from manufacturer shall be provided.Driver is having efficiency of ≥85%. Driver is having p.f. ≥0.95 with iTHD≤20%.Driver is having inbuilt surge protection of 2.5KV. Product is suitable to operate in 140 - 270V Ac range. service life is 30000 Hrs as perL70B50.	Substation
3	Supply, installation, testing and commissioning of 33W, 4ft linear LED Batten with 4000 lm system output. Product is with 120 lm/w system efficacy. Housing made of pressure die cast aluminium with High translucent Polycarbonate diffuser. Product is with CCT6500K & CRI>80. LM 80-08 compliant LEDs from reputed makes such asAPT Electronics / Cree, / Bridgelux / Lumiled should be provided.Product should have IP20 protection. The LED shall be compliant with LM80-08 standard with Useful L70 life of 25000 Hrs tested at maximum current as per L70B50. LEDs used in the product shall comply with EN 62471 for Photo-biological safety and certificate for the same from manufacturer shall be provided. Driver is having efficiency of ≥85%. Driver is having p.f.≥0.90 with iTHD≤10%. Product is suitable to operate in 140 - 270V Ac range. Driver should have 2.5KV inbuilt surge protection is given.	Substation

4	Supply ,installation, testing and commissioning of IP65 Symmetric medium beam, 40W LED Floodlight luminaire with system efficacy of 120lm/W.system output should not be more than 4800lm for 40W. Power consumption of luminaire should not exceed 195W. CCT should be 5700K with CRI ≥ 70. The housing should be made of non- corrosive high-pressure die-cast aluminum to with stand extreme environments. It should have corrosion resistant powder coating to pass NSS of 500 Hrs. Product should be suitable for continuous operation (10-12 Hrs. per day). The Ingress protection should be minimum IP 66 with an IK rating of 08. Optical and control gear compartments shall be maintainable/replaceable without impacting the LED units. The access to the optical and the gear compartment should be separate.. The Luminaire should have a 4KV SPD duly bolted in the Luminaire .The luminaire should be of Class B Serviceability. The wattage of each LED should be greater than 1 watt and less than 3 Watt. Only high power Single white LED chip with ceramic based suitable for outdoor use is allowed. Multi Chip , array multi die , mid power ,Integrated arrays and COB's are not permitted. The luminaire should be capable of withstanding voltage stress of 440V for 8 Hrs., should have an auto shutdown @ 325V and have an auto recovery feature. The Drivers should be a potted driver not a printed circuit board without casing, mounted inside the luminaire. Driver should have short circuit and open circuit protection. Luminaire and Driver both should be BIS approved and CRS no (individual R no) should be shared along with LM79 & LM80 during bid submission. Product should have Lifeclass of 50K hours @L70 with PF > 0.95 & THD $\leq 10\%$..product is designed to operate at (-10) Deg to 45deg operating temp. 50,000 Hrs burning life as per L70B50 is provided as per L70B50 (with suitable MS bracket as shown in typical installation drawing).	Substation
5	Supply ,installation, testing and commissioning of IP65 Symmetric medium beam, 55W WELL GLAS LIGHT luminaire with system efficacy of 120lm/W.system output should not be more than 7090lm for 55W. Power consumption of luminaire should not exceed 60W. CCT should be 5700K with CRI ≥ 70. The housing should be made of non- corrosive high-pressure die-cast aluminum to with stand extreme environments. It should have corrosion resistant powder coating to pass NSS of 500 Hrs. Product should be suitable for continuous operation (10-12 Hrs. per day). The Ingress protection should be minimum IP 66 with an IK rating of 08. Optical and control gear compartments shall be maintainable/replaceable without impacting the LED units. The access to the optical and the gear compartment should be separate. The Luminaire should have a 4KV SPD duly bolted in the Luminaire .The luminaire should be of Class B Serviceability. The wattage of each LED should be greater than 1 watt and less than 3 Watt. Only high power Single white LED chip with ceramic based suitable for outdoor use is allowed. Multi Chip , array multi die , mid power ,Integrated arrays and COB's are not permitted. The luminaire should be capable of withstanding voltage stress of 440V for 8 Hrs., should have an auto shutdown @ 325V and have an auto recovery feature. The Drivers should be a potted driver not a printed circuit board without casing, mounted inside the luminaire. Driver should have short circuit and open circuit protection. Luminaire and Driver both should be BIS approved and CRS no (individual R no) should be shared along with LM79 & LM80 during	Substation

	bid submission. Product should have Lifeclass of 50K hours @L70 with PF > 0.95 & THD ≤ 10%..product is designed to operate at (-10) Deg to 45deg operating temp. 50,000 Hrs burning life as per L70B50 is provided as per L70B50.	
6	Supply, Installation, Testing and Commissioning of 1200 mm sweep, BEE 5 star rated, ceiling fan with Brush Less Direct Current (BLDC) Motor, class of insulation: B, 3 nos. blades, 30 cm long down rod, 2 nos. canopies, shackle kit, safety rope, copper winding, Power Factor not less than 0.9, Service Value (CMM/W) minimum 6.85, Air delivery minimum 215 CMM, 350 RPM (tolerance as per IS : 374- 2019), THD less than 10%, remote or electronic regulator unit for speed control and all remaining accessories including safety pin, nut bolts, washers, temperature rise=75 degree C (max.), insulation resistance more than 2 mega ohm, suitable for 230 V, 50 Hz, single phase AC Supply, earthing etc. complete as required.	Substation
7	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.	Substation

12. PROTECTIVE EARTHING:

12.1.1. Scope:

The scope of work shall cover earthing stations, laying G.I. / pipes, and connecting the power panels, DBs and switch boards.

12.1.2. Standards:

- The following standards and rules shall be applicable:
 - i) IS:3043 - 1966 Code of Practice for earthing.
 - ii) Indian Electricity Act and Rules.
 - iii) IEEE - 80:86.
 - iv) IEEE - 142:92.
 - v) Earthing: Earthing system comprising of earth electrode, earth conductor, earth bus, protective conductor etc. for building shall be as per provision laid down in CPWD specifications part – I, 2013 IS-3043:2018 amended up to date & IEEE 80 as amended up to date. Earthing system should be designed such as to maintain earth resistance as specified in CPWD specifications. Earth resistance shall be checked/ tested in harsh climatic conditions. Types of earthing to be as per IS-3043 and as specified in Earth pit schedule stated hereunder.

12.1.3 GENERAL

All the non-current carrying metal parts of electrical installation shall be earthed as per IS: 3043. All equipment, metal conduits, rising main cable armour, switch gear, distribution boards, meters, all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes. Earthing shall be in conformity with the provisions of Rules 32, 61, 62, 67 and 68 of IER 1956.

12.1.4 G.I. PIPE EARTH STATION:

Electrodes shall be made of G.I. pipe of internal diameter of 40mm dia. The pipe electrode shall be as far as practicable embedded below permanent moisture level. The length of the pipe electrode shall not be less than 2.5 m. Except where rock is encountered, pipes shall be driven to a depth of at least 2.5mtr where rock is encountered at a depth of less than 2.5mtr. The electrode may be buried inclined to the vertical and the inclinations not more than 30 deg C from the vertical. The pipe electrode shall be made of one piece. Earth leads to the electrode shall be laid in a heavy duty GI pipe and connected to the pipe electrode with brass bolts, nuts and washers. GI pipe shall be terminated in a wire meshed funnel. The funnel shall be enclosed in a masonry chamber of 450mm x 450mm dimensions. The chamber shall be provided with C.I. frame and CI inspection cover. The earth station shall also be provided with a suitable permanent identifications label tag. The earth electrode shall conform to IS:3043 latest edition. The soil around the earthing electrode shall be treated to reduce the resistivity of the soil by filling the complete depth of electrode with alternative layers of charcoal and salt.

12.1.5 PLATE EARTH STATION

Plate electrodes shall be made of copper (CU) plate of 3mm thick and 600 x 600mm size. The plate shall be buried vertically in ground at a depth of not less than 2.5 meters to the top of the plate, the plate being encased in charcoal to a thickness of 300mm all round. It is preferable to bury the electrode to a depth where subsoil water is present. Earth leads to the electrode shall be laid in a heavy duty GI pipe and connected to the plate electrode with brass bolts, nuts and washers. A GI pipe of not less than 19mm dia shall be clamped with bolts vertically to the plate and terminated in a wire meshed funnel. The funnel shall be enclosed in a masonry chamber of 450mm x 450mm dimensions. The chamber shall be provided with GI frame and CI inspection cover. The earth station shall also be provided with a suitable permanent identifications label tag. The earth electrode shall conform to IS:3043.

12.1.6 EARTHING CONDUCTORS

All earthing conductors shall be of high conductivity copper / GI as mentioned and shall be protected against mechanical damage and corrosion. The connection of earth electrodes shall be strong secure and sound and shall be easily accessible. The earth conductors shall be rigidly fixed to the walls, cable trenches, cable tunnel, conduits and cables by using suitable clamps.

Main earth bus shall be taken from the main medium voltage panel to the earth electrodes. The number of electrodes required shall be arrived at taking into consideration the anticipated fault on the medium voltage network.

Earthing conductors for equipment shall be run from the exposed metal surface of the equipment and connected to a suitable point on the sub main or main earthing bus. All switch boards, distribution boards and isolators disconnect switches shall be connected to the earth, bus. Earthing conductors shall be terminated at the equipment using suitable lugs, bolts, washers and nuts.

All conduits cable armoring etc., shall be connected to the earth all along their run by earthing conductors of suitable cross sectional area. The electrical resistance of earthing conductors shall be low enough to permit the passage of fault current necessary to operate a fuse/protective device or a circuit breaker and shall not exceed 2 ohms.

12.1.7 PRECAUTIONS

Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance even after subjection to fault currents.

Joints shall be tinned, soldered and/or double rivetted. All the joints shall be mechanically and electrically continuous and effective. Joints shall be protected against corrosion.

12.1.8 TESTING

On the completion of the entire installation, the following tests shall be conducted

- i) Earth resistance of electrodes
- ii) Impedance of earth continuity conductors as per IS 3043.
- iii) Effectiveness of earthing as per IS 3043.

All meters, instruments and labour required for the tests shall be provided by the contractor. The test results shall be submitted in the prescribed tabulated form in triplicate to the consultants for approval.

12.1.9 MEASUREMENT

Mode of measurement is as follows:

Earth strips (GI/Cu), earth conductors are measured in linear meter (Rm).

Earthing station with all associated works (G.I pipe or copper plate) is measured in number (No).

13.0 AUTOMATIC POWER FACTOR CONTROL& HYBRID FILTER:

Scope

The scope includes Supply, Installation, Testing & Commissioning; wherein supply covers design, fabricate, integrate, pack, dispatch to site along with routine testing as per IS of Low Voltage Switch gear & Control gear Assemblies up-to 1000 V.

Automatic Power Factor Correction panel shall be totally enclosed, metal clad,

sheet steel fabricated, dust and vermin-proof, free standing, floor mounting type. The enclosure shall be powder coated and shade shall be RAL 7032. The panel should be built to ensure.

- Proper thermal design, by providing louvers and fans in appropriate location,
- Accurate selection of switchgear and capacitors-reactors combinations
- Safety during operation, inspection, and maintenance

BASIC DESIGN SPECIFICATIONS

Rated System Voltage	440 V
Rated Frequency	50 Hz
Short Circuit Rating	≥ 36 kA
Altitude	1000 m
Duty	Continuous
Ambient temperature	-5° C to 45° C
Power Supply	Three phase, four wire
Relay current input signal	-- / 5A, from CT on line
Enclosures	The load bearing structure is made of 2 mm sheet steel
	The front door and partition are made of 1.6 mm sheet steel
	The internal switchgear components are accessible on opening the front door and Capacitors & Reactors shall be accessed through back door
	Ingress protection - IP42
Installation	Indoor, wall mounted (up to 100 kVAr), floor mounted (100 kVAr and above) in a well-ventilated, non-dusty environment, cable entry from bottom
Control	Auto + Manual
Incomer	3 Pole MCCBs up to 630 A(400 kVAr) , 3 Pole ACBs above 630 A(above 400kVAr)

13.1.1 CAPACITOR BANK

Capacitor voltage shall be minimum 525V. Capacitors shall be Super Heavy Duty Cylindrical type only. The Capacitor should be MPP type and Resin Filled cylindrical type. The capacitor unit shall have over pressure dis- connector protection. Discharge resistance shall reduce the residual voltage to less than 50 volts within one minute General specifications:

- 3 phases, delta connected, 50 Hz
- Overvoltage +10% (for 8h / 24h), + 15% (for 30m / 24h), + 20% (5m/24h), +30% (1m/24h)

- Overcurrent: $2.5 \times I_n$
- Peak Inrush current withstand: $350 \times I_n$
- Total watt-losses: $< 0.45 \text{ W / kVAr}$
- Temperature category: $-40^\circ \text{ C to } 65^\circ \text{ C}$
- Nominal life: 200000 hrs at 65°C ambient
- 15000 switching operations per year
- IEC 60831

13.1.2 DETUNED FILTER

- Detuned harmonic filter reactors shall be used along with power capacitors to mitigate harmonics amplification and to avoid electrical resonance in LV electrical networks.
- The reactors shall be made of high-grade Copper windings or Aluminium and insulation shall be Class H.
- The reactor should conform to IEC 60076-6:2007 and IS 5553
- The permitted tolerance of inductance is $\pm 3\%$ of rated inductance value.
- Reactor tuning factor shall be 14% (133Hz) based on type of harmonic load and the current rating of the reactor shall include the effects of harmonics and other possible over-currents
- The limit of linearity of inductance of the filter reactor is: $1.8 \times I_n$ with $L=0.95 \times L_N$.
- The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuits in case of high operating temperatures.
- Power loss in each reactor shall be less than 5 W/kVAr

13.1.3 CONTACTOR

- All contactors shall be AC6b duty 3 pole air-break, magnetic, capacitor duty type. The rating of contactor shall be suitably assigned. Contactor should be with inbuilt damping resistors to limit capacitor charging current
- The minimum life expectancy of the contactor shall be one million switching operations
- Contactor should be with surge suppressor to minimize the impact of voltage surge during contactor operation
- Operation voltage up to 440V
- Insulation voltage 1 kV
- Rated impulse withstand up to 8 kV
- The individual capacitor bank/step shall be switched automatically / manually with selector switch

13.1.4 APFC RELAY

An automatic power factor correction relay shall be microprocessor based. The relay should decide optimum configuration of capacitor banks in order to achieve desired power factor by taking into consideration the kVAr of each step, no of operations, total usage time, re-connection time of each step etc. The relay should have automatic and manual mode of operation that makes it possible to turn the capacitor banks "on" and "off" manually regardless of the line value measured. In auto mode, the relay should offer power factor

correction without any need for manual intervention. The APFC Relay should be of maximum 16 step. Actual steps to be decided based on kVAR of panel

Parameters	(3CT)	
	Contactor logic	Thyristor logic – if applicable
Voltage input range (L-L)	50 - 760 VAC	
Aux. supply	85 - 300 VAC/ DC	
Current input	1A/5A	
Rated frequency	50 - 60 Hz	
No of output contacts	8, 16 (for Contactor)	8T+2R, 14T+2R, 8T+8R for Thyristor switching, R for Contactor switching)
Output contact rating	Relay, 250VAC @ 5A	Relay, 250VAC @ 5A Thyristor, 8 - 48 VDC @ 100mA
Communication interface	Inbuilt Modbus RTU (RS485)	
Cascading	Up to 64 steps in master slave configuration	
Display parameters	System PF, V, I, Required KVAR, Voltage angles, Current angles, KVA, KW, KVAR, V - THD, I - THD, Hz, Individual harmonics up to 31st order, Temperature.	
Control Power Factor range	0.3 Lag - 0.3 Lead	
Dual PF setting	Target PF 1 - Default Target PF 2 - Based on Digital input	
Digital input	2 Digital inputs, Programmable Range: 65 - 285 VAC	
Alarm	Over/ Under compensation, Over/ Under Voltage, Over/ Under Current, High V - THD, High I - THD, Over/ Under Frequency, Over temperature, Modbus fail alarm, Capacitor faulty alarm.	
Power consumption	5.0 VA	
Mounting	Flush	
Degree of protection	IP 20 (Front IP 54)	
Compliances	EN 61010 - 1, IEC/EN 61000 - 6 - 2, IEC/EN 61000 - 6 - 4, EN 61326.	

The APFC controller should have the following basic features.

- Backlit LCD display with multiple parameters displayed at the same time
- Individual capacitor's ON/OFF status
- It should have step failure detection.i.e. alarm if individual step fails
- It should provide counter for each step operation and give alarm if value exceeds a programmed value.
- Capable of measuring VTHD and ITHD values at least up to 31st order

- Automatic CT reversal sensing and correction
- Should be 1A / 5A CT selectable.
- Sensing shall be done at LT as well as HT side of the transformer.
- Display of average weekly power factor
- Keypad lock feature to prevent operation by unauthorized persons.
- Alarms for under/overcompensation, high VTHD/ITHD, over temperature, capacitor failure, capacitor over- current, over/under voltage
- Temperature sensing feature with alarm in case of panel over heating
- Should have RS485 communication protocol as optional.

13.5 **ACTIVE HARMONIC FILTER**

13.5.1 **Active Harmonic Filter to mitigate low voltage system harmonics**

The Active Harmonic Filter (AHF) is intended to remove harmonic distortion in a 3-phase electrical system resulting in reduced current harmonic distortion and hence also reduced voltage harmonic distortion.

AHF to be installed only post successful commissioning hospital. Before installing AHF Power Quality Audit is must, and the results must be shared with consultant / client before installing.

Principle of operation

. AHF should measure level of harmonics in supply line and eliminate it by generating the counter harmonics. It should employ a DSP which determines the harmonic current amplitude to be injected in the opposite phase angle of each harmonic order. -

The active filter shall not only provide harmonic mitigation, but also, power factor correction and load balancing. Harmonic correction, PF correction and Unbalance correction should be able to set with priority and filter should work to employ the priority as per the user settings

- The active harmonic filter shall mitigate harmonics from the 2nd harmonic up to the 49th harmonics and limit harmonic distortion at the point of connection to $\leq 8\%$ current Harmonics.
- The active filter shall be suitable for connection to a distorted voltage waveform up to 15%
- AHF should have high attenuation up to 95% of individual harmonics.
- AHF shall allow user to select any 20 orders of harmonics out off 2nd to 49th harmonics order.
- AHF shall do PF compensation both in leading as well as lagging.

BASIC DESIGN SPECIFICATIONS

Rated System Voltage	360 V to 440 V, 3ph 4 Wire/3 wire
Rated Frequency	50 Hz

Harmonic Cancellation Current	[30, 60, 75, 100, 150, 200, 300, 400, 600, 800 amps]. Multiple filter units for parallel connection may be used to achieve total current requirements for combined power factor correction and harmonic mitigation.
Surge withstand capability	ANSI/IEEE STD C62.41-1991.
Enclosures	Constructed on metal panel with minimum IP 20, suitable for indoor installations
	Ingress protection – IP20
Installation	Floor mounted in a well-ventilated, non-dusty environment, cable entry from bottom
Ambient temperature	0°C and 40°C. Shall be able to work up to 50° C with automatic de-rating of 20% in capacity
Storage temperature	0°C to 70°C.
Humidity	Up to 95% non-condensing.
Protection	Each power module shall have its own independent set of fuses for IGBT protection and MCCB for incoming protection.

The active harmonic filter shall meet the following basic requirements:

1. Active filters shall include input surge suppression.
2. Active filter shall be able to connect in both open loop and closed loop configuration.
3. Active filter should have an HMI touch screen display and should display Load side, supply side and filter parameters as mentioned below
 - (a) Voltage
 - (b) Current
 - (c) Power factor
 - (d) Filter Temperature
 - (e) Voltage and current waveforms
 - (f) Voltage and current Harmonic spectrum
 - (g) Active, Reactive & Apparent Power
 - (h) Alarm indications & log details
4. Each power module shall have its own independent set of fuses for short circuit protection and MCCB for isolation.
5. The correction time shall be 20 to 40 ms
6. AHF shall have inbuilt current limiting logic to avoid over-loading and tripping.

Following features are essential requirements for ease of maintenance.

1. For filters above 100A, the filter design should adapt modular construction for future expansion and for easy repair.

2. AHF shall be with touch screen HMI, with true RMS readout & FFT analysis and diagnostics. The waveforms & spectrum of load, source & filter should be visible on the display.
3. In case of future repair requirements, the same shall be done through card level replacement and not the whole module.

14.0 -AUTOMATION LIGHTING CONTROLS FOR SUITE ROOM:

14.1. Scope:

Supplying, installation, testing, commissioning & Programming of automation light system including all & required & necessary accessories and supports for smooth and satisfactory operation / functioning.

A) Switching Module

Switching module of 10A and above rating for Only On/Off operation of Lights	
PARAMETER	VALUE
Regulatory Approvals	Wireless Protocol Commission (WPC), Complies to IEC 60669-2-5
Power	Operating voltage: 220-240V – 50/60 Hz Standby power consumption less than 1.0 W
Lighting Current Rating	10A or more
Relay Life	5 Lac cycles or more
Environment	Ambient Operating Temperature: 0 -50 Deg C & Humidity: 0% to 90% non-condensing
Connection to Wireless Non-Mesh devices	At least 15 devices can be connected on one module within a radius of 9m through construction material

B) DALI Module

Single Zone DALI controller for dimmable DALI driver-based Fixtures	
PARAMETER	VALUE
Regulatory Approvals	Wireless Protocol Commission (WPC), Complies to IEC 60669-2-5
Power	Operating voltage: 220-240V – 50/60 Hz Current 50 mA Standby power consumption less than 0.5 W
DALI Link	Single Zone 1-4 drivers(address) connection with guaranteed supply current of 8 mA (Max

	250 mA)
Environment	Ambient Operating Temperature: 0 - 40 Deg C & Humidity: 0% to 90% non-condensing
Connection to Wireless Non-Mesh devices	At least 15 devices can be connected on one module within a radius of 9m through construction material
Daylight Controls	Module shall have dimmable capability of Electric light in response to available natural daylight automatically

c) Occupancy Sensor

Occupancy sensor to create automatic control of lights in a space based on Occupied/Unoccupied state	
PARAMETER	VALUE
Regulatory Approvals	Wireless Protocol Commission (WPC), Quality system ISO 9001:2008
Power	3V, 14 micro A nominal through lithium battery with at least 7 years and above rated battery life
Operation	Sensor shall be able to work as both Occupancy (Auto On/Auto Off) or Vacancy (Manual On/Auto Off) through on- board selectable button
Activity setting	On board selectable as Low (for fine minor motion sensing), medium and High (for major motion detection)
Environment	Ambient Operating Temperature: 0 - 40 DegC & Humidity: 0% to 90% non-condensing
Connection to Wireless Non-Mesh devices	At least 10 load controllers can be paired to one sensor within a radius of 9m through construction material

d) Keypads

Manual override keypads for on/Off or scene creation of Lights in the room	
PARAMETER	VALUE
Regulatory Approvals	Wireless Protocol Commission (WPC), Quality system ISO 9001:2015

Power	3V through lithium battery with at least 7 years and above rated battery life
Mounting Options	Shall have option of Wall mounted with suitable faceplate and at least 2 Gangs possibility. Can also be mounted on tabletop pedestal
Button Configurations	Single piece can start from 2 button and can go to 4 Button. Keypad with 3 buttons and additional Raise/Lower option also to be considered
Environment	Ambient Operating Temperature: 0 - 60 DegC & Humidity: 0% to 90% non-condensing
Connection to Wireless Non-Mesh devices	At least 10 load controllers can be paired to one Keypad within a radius of 9m through construction material

E) Daylight Sensor

Daylight sensor that senses amount of Daylight and dims/off the artificial light near the priphery	
PARAMETER	VALUE
Regulatory Approvals	Wireless Protocol Commission (WPC), Quality system ISO 9001:2008
Power	3V, 7 microA nominal through lithium battery with at least 7 years and above rated battery life
Operation	Sensor shall be designed to handle 0 to 1600 Lx (0 to 150 Fc) and provide daylight compensation on reliable open loop control. It shall give linear response to changes in viewed light level
Setup and Testing	On board test button shall be provided for easy setup of daylight values and intuitive test mode shall provide instant system verification
Environment	Ambient Operating Temperature: 0 - 40 DegC & Humidity: 0% to 90% non-condensing
Connection to Wireless Non-Mesh devices	At least 10 load controllers can be paired to one sensor within a radius of 9m through construction material

15.TUBING BASED FIRE SUPPRESSION SYSTEM FOR ELECTRICAL PANELS

Scope: - Scope includes Supply, Installation, Testing & Commissioning of tubing-based fire suppression system including all & required & necessary accessories & supports for smooth & satisfactory operation / functioning with statutor approvals, certifications, etc as required.

(SPECIAL CONDITIONS, TECHNICAL SPECIFICATION) **TUBING BASED SUPPRESSION SYSTEM**

Tubing based Suppression system comprising of MS Cylinder duly powder coated as per IS 15683 fitted with valve, pressure gauge and filled (with 2 kg of UL Listed with end fittings, Linear Pneumatic Heat Detection Tube (length depends upon panel size) and low-Pressure switch complete with mounting bracket)

Fire Alarm Panel for Indication for Single cylinder tubing system (complete with hooter cum strobe)

Following are the details description Tubing based suppression system

1) Direct Low-Pressure Fire Suppression. Extinguisher and Valve with Tamper proof seal & cross over panel fitting

- i) **Extinguishant:** - Minimum 2 Kg Clean Agent with NOVEC 1230 / FK-5-1-15 (UL listed for Gas)
- ii) **Cylinder-** Stored Pressure Type, deep drawn and Argon welded, sheet metal thickness and dia. as per standard, 100% Hydraulic Pressure tested, conform to is standard. Cylinder shall be manufactured as per IS: 15683 and complete tests of the body as per IS 15683, shall be demonstrated. (Vibration, tapping, drop test, cyclic pressure test, temperature range test) Burst pressure shall be greater than 35 bars.
Conforms to IS:15683 and CE
- iii) **DLP (Direct Low Pressure) Valve:** The valve would-be nickel-plated brass, equipped with a pressure gauge to monitor the system pressure, with a ball valve interfacing the tubing and the cylinder, and with a safety valve, working pressure 10-18 bar, leakage rate: 0.0001mbar l/s, valves would be pressure tested at 50 bar for no leak.

2) Liner Pneumatic Heat Detection Tube

Sensor tube for automatic fire detection and suppression system made by

special modified Polyamide (PA), Color Red, Black or specified, High grade quality, Inner diameter 4mm, Outer Diameter 6 MM, Melting Point approx. 220 degrees Celsius when heating up with 10 K/minute, Burst Pressure 100 bar at 20°C. Temperature range: minus 40°C to +80°C. Working Pressure 20 Bar at 20°C. Burst Temperature : when Pressurized with dry Nitrogen at 16 bar pressure approx. 100° C to 110°C.

UL Listed standards followed for manufacturing and testing of Heat sensing Tube.

3) End of Line Adaptor with Pressure Gauge (BSP / NPT Certified)

End of Line adapter with Pressure gauge for Automatic fire suppression tube used for fitting at the end of the tube for pressurizing and re pressurizing the tube includes check Valve, Pressure Gauge and fitting to connect to sensor tubing. Tube connection 6mm, Gauge scale: 0-28 bar. Fitting made by brass (plated), Copper Nickel plated, Temperature range - 200 C till + 800 C.

4) Pressure Switch

Pressure Switch to monitor Pressure drop in the tube, switch point 8 Bars. Switch Type SPDT, Normally Closed, Operating range 0- 25 Bar.

5) End of Line Plug

End of Line Plug for Automatic fire suppression tube used for fitting at the tube end to terminate the point. Tube connection Brass 6x4mm, Fitting made by brass nickel plated material, Temperature range TS -200 C till + 800 C, Maximum working pressure 50 Bars.

1. INTEGRATION WITH FIRE ALARM SYSTEM

1) Fire Alarm Panel (For Standalone System)

2 zone Operating Panel for exact indication of area with relay module provision with main fire alarm control panel Voltage 220 Volt Mains A.C. Input / 24V D.C.
Output No. of Zones: 2 Zones 1 per zone Sounder Output
EOL: -4.7 k ohm
Aux. Relay Output Common hooter output / One Each for Fire & Fault.

2) Sounder Cum Strobe (For Standalone System)

The **Sounder** cum strobe is designed to give the audio & visual indication in case of emergency & fire 85-100 dB

3) Monitor Module (for the direct Integration with main Fire Alarm Control Panel)

Addressable monitor modules shall be provided to connect alarm initiating devices (any N.O. dry contact device).

The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box or with an optional surface back box.

The IDC zone shall be suitable for Class A or Class B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel

16.0 Three phase Modular UPS, online double conversion (VFI) Modular UPS Systems (NOT APPLICABLE FOR THIS PACKAGE)

Scope:- The scope of work covers Design, manufacture, supply, erection, inspection, testing commissioning & liasioning and statutory approval, all types of licensing etc., transportation to site, receipt & unloading of material at site including all & required & necessary accessories and supports for smooth operation / functioning.

16.1 GENERAL REQUIREMENTS

Subject and agreement type

This tender it is asking the best offer to supply & installation testing, commissioning of three phase UPS with following technical specifications:

- Nominal Power: As mentioned in the BOQ's.(KVA/KW) Power Factor (cos): As mentioned in the BOQ's.
- Topology: On Line Double Conversion VFI;
- Technology: Hi frequency PWM.
- Passing through Neutral.
- Modular Architecture based on 25.000VA Power Modules.
- Possibility to configure the system in N+X internal redundancy in the inverter cabinet;
- Equipped with batteries type: lead acid, sealed, free maintenance, VRLA, installed into the system or in a dedicated external battery cabinet. Batteries must guarantee a minimum back up time of **15 minutes** at 90% of the applied load with specific characteristics described in **Chapter – 16.**

16.2 Conditions

The offer must comply with requirements presented in this tender, specifying eventual deviations. Deviations must be indicated in the offer documentation; on contrary the requirements will be considered full covered by offered equipment.

16.3 GENERAL SPECIFICATIONS

16.4 On Line Double Conversion VFI

The Topology of the UPS must be VFI (Voltage and Frequency Independent accordingly with classification mentioned in the EN- IEC62040-3 Standard), to guarantee filtered and stable output voltage to the load, independently from the input voltage. This means that the output is obtained by two converters in cascade. The first converter rectifies the AC input voltage, the second converter (Inverter) transforms the DC voltage, coming from the rectifier, in AC voltage to supply the load.

This double conversion allows to completely clean eventual disturbs from the mains.

In case of anomalies in the input voltage, the DC voltage, which supply the Inverter, can be obtained, through a booster circuit, from batteries. In this way the output is always guaranteed with continuity. In case of overloads or faults, the automatic static by-pass guarantees the load supply.

16.5 Modularity

The UPS must have modular architectures based on identical power modules which can be interchanged and connected in parallel, inside the UPS cabinet.

Similarly, also batteries must be contained in battery modules (Battery drawers) identical and interchangeable, to be installed in the system in series and parallel to obtain the correct battery voltage and required back up time.

It will be not accepted a system where one or more modules are kept in stand by just as spare to be used only in case of another module failure.

Power modules will be equipped with control and self-diagnostic circuits, to easily individuate the faulty module and the specific failure inside it.

Each Battery drawer will contain 24 batteries with nominal 12Vdc, shared in 4 packs each drawer to limit the weight of each block Each string is composed by two drawers (48 batteries).

Power Module must be lighter than 24kg and battery pack 16 kg to be managed, in service and maintenance, by only one person.

16.6 Redundancy N+X

The UPS must be configurable as N+X power redundant system, with modules of 12500VA contained in same cabinet.

This kind of redundancy must guarantee continuous supply and protection whenever one module fails. Redundancy must be obtained through the load sharing technology as explained in **paragraph 16.8**.

16.7 Scalability

The modularity of the UPS must allow to increase the back-up time on site, simply adding battery drawers. The upgrade will not require factory modifications and will not need dedicated special tools.

UPS should be connected in parallel with similar units to increase Power and redundancy.

16.8 Architecture

The architecture of the UPS must be **parallel distributed**, to be more precise, the load will

be shared between all power modules. In this way, during normal run, no power module is inactive or in standby. In a redundant configuration, if one module fails all the other ones will take the relevant load without any interruptions or transfer time at the output of the UPS. In case one module failure the power is guaranteed by the other modules and the supplied power will be as follows:

$$P(out) = P_{nom} (n-x)$$

in three phase configuration

where,

- P_{nom} is the nominal power of the UPS;
- P_{out} is the power supplied by the UPS with one module out of order;
- n is the number of installed power modules inside the UPS;
- x is the number of power modules out of order;

16.9 Adaptability

The UPS should be equipped with a distribution system, for cable connections, which allows the desired In/Out phase configuration by simple jumper connections, without any components replacement or factory settings.

Thanks to this system, it will be possible to set, independently, In/Out phase configurations as three/three, or three independent single-phase lines.

The In/Out phase configuration will be always possible on site accordingly with the application in terms of utility and loads.

16.10 DESCRIPTION OF THE SYSTEM

16.10.1 POWER MODULE

Each Power Module will be composed by following functional blocs:

- *Control*
- *Rectifier/PFC*
- *Inverter*
- *Booster*
- *Battery Charger*
- *Automatic Bypass*

16.10.1.1 Control

The Control must be equipped with microprocessor of suitable computation power. This control is included on each Power Module and must manage all functions of the UPS and will execute the following jobs:

1. automatic recognition of the number of connected modules;
2. automatic setting of the maximum reactive power that can be provided on the output;
3. individual serial communication with the power modules by a dedicated line;
4. recognition of a faulty module and diagnosis of the relevant fault;
5. synchronization of the output voltage with the input voltage;
6. generation of a reference sinewave curve to form the output voltage wave;

7. control of the PFC, inverter and booster circuits in each power module;
8. management of the automatic bypass;
9. management of the battery runtime (see relative section);
10. management and recognition of the signals and measurements from each module;
11. management of the user interface (see relative section);
12. management and memorizing of UPS history parameters and data;
13. alarm and events memory with association of the time and date of the events themselves.

16.10.1.2 Rectifier/PFC

The rectifier must include a control and regulating circuit (PFC), which in addition to normal rectifying functions will allow the:

- Automatic correction of the power factor to the at value $\cdot 0,99$ (since from the 50% of the nominal load);
- Reduce the Harmonic distortion of the input current obtaining $THDI_{in} = 3\%$ with nominal load

16.10.1.3 Inverter

The inverter must be based on a switching IGBT circuit with High Frequency PWM, and must be able to transform the DC supply, coming from rectifier/PFC or buster, in case of battery run, in AC voltage.

Furthermore, must be present also control circuits which guarantee:

- Arrest and protection of the inverter in case of strong and long overloads;
- Keep the harmonic distortion of the output voltage less than 1% ($THD_{uout} < 1\%$) either in normal run than in battery run;
- Arrest and protect the inverter in case of over temperature of power converters elements;
- Manage the speed of the Fans accordingly with internal temperature and applied load;

16.10.2 Booster

The “booster” must transform the battery DC voltage from the nominal value of 252 Vdc, to the dual, positive and negative buses, with middle point referred to the passing through neutral. From the positive bus the inverter will obtain the positive half period of the output voltage sine wave, from the negative bus the inverter will obtain the negative half period of the output voltage sine wave.

Protection circuits must be present on the booster to protect the booster circuit in case of strong overload.

Battery Charger

The Battery Charger must be equipped with control and regulation circuit both for charging voltage and current to batteries, to have a controller battery charge and optimize the battery

life.

The UPS must charge batteries with an early boost charge followed by a constant charge and, at the end, with a floating charge. During normal run the UPS will execute periodically a battery equalizing to recover natural charge leakages and keep all batteries at the same capacity. This battery charging cycle will increase the batteries life time, with relevant reduction of the maintenance costs.

The battery recharge must be available also when UPS is turned off.

16.10.3 Automatic Bypass

The Automatic bypass must be composed by following parts:

- Static switch with zero time for intervention, connected in parallel with an electro-mechanic switch which needs a transfer time but with zero heat dissipation among the time;
- Microprocessor Logic command and control which will attend to:
 - Automatically transfer the load to the mains, as soon as following anomalous events occur: overload, over temperature, voltage runaway on the DC buses, anomalies on the inverter;
 - Automatically transfer back the load from the mains to the inverter as soon the anomalous event expires;
 - Automatically disable the bypass function in case of output voltage and Mains are not synchronized.

16.10.4 Batteries

The hermetic, maintenance-free stationary lead batteries are housed in the UPS and/or in one of more cabinets of the same shape and size as that of the UPS itself. The positive and negative battery connections are protected by an adequate fuse-holder isolating switch.

16.10.5 Battery Module (Drawer)

The complete set of batteries consists of at least 48 units to obtain an overall ± 288 V nominal voltage (direct voltage) referred to 0 (middle point).

A drawer comprises 24 batteries of 12V 9 Ah or 11Ah connected in series. The drawer must comply with CEI-EN 60950 standards governing electrical safety, which requires the use of adequate protections and particular care when dangerous voltages higher than 50 Vdc are present and direct contacts are possible. The runtime can be increased to a further extent by adding more battery drawers in multiples of two, using both the housings in the UPS and those pre-engineered in the additional "modular cabinets".

16.10.6 Battery management

The following functions must be available:

Conduction of the battery test either automatically or upon the user's request.

Battery efficiency test conducted by making an automatic full discharge at programmed or

periodic frequencies, as required by the user. The battery is discharged by use of an appropriate algorithm with discharge curve control to monitor the performance and status of the batteries.

Calculation of the residue battery runtime during the discharge phase, depending on the load applied.

To protect the batteries from damage due to deep discharges¹ the minimum tolerated battery voltage limit² is automatically changed to suit the applied load (default setting), while allowing the user to select a type of management with fixed voltage limits.

The “average” battery life is 4-6 years.

16.10.7 Digital Display e Alarm signal

UPS will be equipped with a 10” touch screen display. This display is built into the front part of the UPS and should be able to rotate of 180° to facilitate all operations during commissioning and service. An ultra- bright operating status indicator, which shows the operating status and any alarm conditions by means of a traffic light code, should be present on this display.

The display allows the user to:

- 17.10.7.1 display the operating data (ref. sect16.25 Measurements);
- 17.10.7.2 enter the operating parameters (ref. sect.16.26 Adjustments);
- 17.10.7.3 select the language in which the messages are given;
- 17.10.7.4 set running parameters;
- 17.10.7.5 others.

-
- 1. prolonged discharges with a low load
 - 2. voltage that causes the inverter to switch off owing to end of runtime.

17.0 OPERATING PRINCIPLE

The purpose of this section is to define the various operating conditions of the UPS.

17.01 Normal service condition

In normal conditions, UPS runs in the double conversion on-line mode, thus the users are powered in an uninterrupted way by the inverter, which is powered by the electricity main through the AC/DC converter (rectifier/PFC) that automatically corrects the power factor on the UPS input as well.

The inverter is constantly synchronized with the electricity main to allow the bypass to function correctly during mains/inverter and inverter/mains commutations. These commutations may be necessary if an overload occurs or if the inverter stops.

The battery charger in each power module provides the power required to keep the battery charge at an optimum level.

17.1.1 Inverter stopping or overload

17.1.2 Inverter stopping

If the inverter stops, the user is automatically transferred without interruptions to the primary main by means of the automatic bypass.

17.1.3 Overload

When a temporary overload occurs on the load side of the UPS, current monitoring allows the UPS to withstand the situation within certain limits, without the automatic bypass having to be used: if the overload lasts a long time or exceeds the limits preset by the current monitoring device, the user is transferred without interruptions to the primary main by means of the automatic bypass and then returns to the inverter once the overload has terminated.

17.1.4 Bypass activation sensitivity adjustment

Bypass activation, based on the length of time "loss of voltage" on the output lasts, can be regulated by the user in discrete steps to facilitate use of UPS together with equipment characterized by frequent surge currents. This adjustment can be carried out by the user from the front panel or by means of the diagnostic software installed on an external PC.

17.1.5 Inverter stopping in a Power Module

The modular architecture, with N+X redundant configuration, allows energy to be supplied to the load even if the inverter of a power module stops.

The nominal power represented by the sum of the functional modules can always be supplied to the user, which can work at reduced load or full load in the case of a redundant configuration. The inverter stopped condition is detected by the monitoring logic, is transmitted to the microprocessor and is then signaled to the user on the frontal display or via software. Each power module also has a LED that immediately signals its operating status. This allows the damaged module to be immediately identified and facilitates the replacement operations.

17.2 Emergency condition (Mains failure)

In a blackout, or if the electricity main values are off range, the users are powered by the batteries via the booster-inverter pathway. The batteries function in discharged conditions in this operating mode.

The UPS informs the user about this operating status with clear visual and acoustic signals.

Thanks to a diagnostic-predictive algorithm, the microprocessor control can calculate the available residual runtime depending on the instantaneously applied load. This runtime is shown on the frontal display of the unit with a reasonable degree of accuracy.

17.3 After a blackout

When the electricity Mains power returns within the tolerated limits after a voltage drop or a blackout, the UPS automatically returns to operate in normal service conditions absorbing electricity from the Main.

Even after the end of autonomy, at the return of the Mains the battery charger automatically starts to charge batteries.

17.4 Smart Eco Mode

To save Energy in particular conditions the UPS must be easily set by the user to run in Eco

Mode. In this running mode the load is directly connected to the utility. In the meantime, the UPS is continuously checking the mains Energy supply, as soon the input Energy is out of tolerance, the UPS immediately switches in on line mode.

17.5 Cold Start

The UPS must be able to be start up without the input mains, just using batteries (Cold Start Function).

17.6 Start Up on Bypass

The UPS must be able to connect the load directly on bypass during the startup (start up on bypass) and then connect the load to the inverter output when the inverter is full synchronized with the input Mains.

17.7 Maintenance Bypass

The UPS will be equipped with a manual maintenance bypass to allow the service and the access to modules and battery, keeping the load powered. The maintenance bypass can be activated manually and must be protected by a door locked with a key.

A disconnectors system must isolate the internal parts of the UPS from any energy source allowing the UPS maintenance, service and access to modules without danger.

17.8 Operation with a genset or as a frequency converter

The output frequency of UPS is synchronized with the mains input frequency. This synchronizing process is guaranteed by the microprocessor control within a $\pm 2\%$ range of the nominal frequency (50 Hz or 60 Hz). Out of this range, the UPS stops the synchronizing with the input frequency and guarantees a strictly constant output frequency. (in this condition of asynchrony between the input and output, it is essential for the automatic bypass to be disabled).

17.9 Genset

To achieve optimum operation in combination with generators or gensets, typically characterized by frequency fluctuations exceeding the $\pm 2\%$ range, the UPS must have the possibility to guarantee synchronism between the input and output frequency for even wider frequency ranges, not less than 14% Normally, when the UPS runs in synchronism, the automatic bypass must be enabled.

17.10 Frequency converter

UPS can also works as a frequency converter, i.e. by working with a different input and output frequency without any type of synchronism. In other words:

50 Hz input - 60 Hz output;

60 Hz input - 50 Hz output.

17.11 Asynchronous operation

Because of characteristics 1.5.1 and 1.5.3, with the appropriate settings, the UPS can run in asynchronous conditions generating to the output a constant frequency, within a maximum $\pm 1\%$ range whenever the input frequency is variable.

This operating mode allows the UPS to work with input Mains supply with extremely variable frequencies, guaranteeing a constant output frequency at both 50 Hz and 60 Hz.

17.11.1 Data availability when UPS is Off

The UPS will allow the possibility to make settings, data readings and diagnostic checks also when it is turned off, activating the display in a temporary service mode.

17.12 Controls

The UPS has the following controls:

- UPS secure powering (protection against accidental powering);
- UPS stopping (to prevent accidental power-offs while allowing the UPS to be quickly shutdown in an emergency.);
- buzzer silencer;
- Different levels of password on the display to protect setting of advanced parameters.

17.13 Measurements

The UPS can manage the following measurements and show the relevant values on the display:

INPUT	OUTPUT	BATTERIES	MISCELLANEOUS	HISTORIC DATA
▪ Current: ▪ Root-mean-square value ▪ Peak value ▪ Peak factor ▪ Voltage: ▪ Root-mean-square value ▪ Power: ▪ Apparent ▪ Active ▪ Power factor ▪ Frequency	Current: ▪ Root-mean-square value ▪ Peak value ▪ Peak factor Voltage: ▪ Root-mean-square value Power: ▪ Apparent ▪ Active ▪ Power factor Frequency	▪ Charging current ▪ Discharging current ▪ Battery operation time ▪ Residue capacity ▪ Battery voltage ▪ Date/time of last battery calibration	▪ Internal temperature of individual power modules ▪ Ambient temperature	▪ N° of bypass interventions ▪ N° thermal protection interventions with date and time ▪ Number of battery commutations ▪ Number of total discharges Overall time of: ▪ Battery operation ▪ Mains operation

17.14 Adjustments

The will UPS allow the following adjustments to be made and shown on the display:

OUTPUT • Voltage • Frequency • Redundancy N+X	INPUT • Enable synchronizing • Extended synchronizing interval	BYPASS • Enabling • Forced • Actuation sensitivity • Off line mode • Load waiting mode	BATTERIES • Limits • Max. runtime with battery • Max. runtime with battery after reserve limit • Batterytest enabling • Auto-restart enabling

17.15 Signals and alarms

The UPS must be equipped with a lighted operating status indicator with traffic light coding on the display and on each Power Modules well as a buzzer able to immediately indicate the following operating conditions:

- normal operation (on line)
- output frequency not synchronized with the input
- battery operation
- bypass mode
- faulty power module
- overload
- generic fault
- programmed power-off warning
- programmed re-powering warning
- runtime reserve
- end of runtime
- etc.

17.16 Miscellaneous equipment

17.17 Interfaces

The UPS is also equipped with:

- 17.17.1.1 terminals for connecting the EPO (Emergency Power Off button);
- 17.17.1.2 outputs contacts to be set NC or NO by operator panel;
- 17.17.1.3 10 input contacts to be set NC or NO by operator panel;
- 17.17.1.4 slot for an SNMP interface that allows the UPS diagnostics, remote control via the network and computer remote shutdown within the battery runtime.
- 17.17.1.5 terminals of contact for external Back Feed protection, to be set NC or NO
- 17.17.1.6 The USB HOST port is needed for firmware updates.
- 17.17.1.7 The USB UART port is for maintenance purposes.
- 17.17.1.8 The input contact EXT TEMP for the external temperature
- 17.17.1.9 The input contact GENSET allows the UPS to know if there is an external generator. If the contact is closed, the generator is present.

17.17.1.10 E.P.O. (Emergency Power Off)

The UPS is equipped with an input for a normally closed button (NC). Use of this button immediately stops the whole UPS functions and immediately shuts off the output energy.

17.17.1.11 Communication port

The UPS must have USB port: The USB Port allows to connect the UPS to a Computer and remotely manage the UPS operating functions by a dedicated software.

The USB UART port also allows to connect the UPS to a Computer to execute service and maintenance operations as data reading, diagnostic checks, event memory download, firmware update.

17.18 Technical specifications for UPS distribution system

UPS Technical Specifications			
Sr. No.	Specifications	Requirement	Vendor's Offer
1	Capacity (in kVA / kW)	As mentioned in the BOQ's, 3-Phase Input / 3-Phase Output	
2	Technology and Capability	a) True Online configuration double conversion UPS. b) Modular & Scalable UPS with hot swappable Power Module of 25 kVA /25kW. c) Hot swappable Power module should have its own DSP controller (with Decentralized Parallel Architecture control systems), and Contains a Full rated rectifier, full rated inverter & battery charging circuit having inter module connectivity through Copper busbars (no internal cabling) d) UPS comprises a user replaceable continuous duty hot swappable bypass static switch module e) DSP (Digital Signal Processor) / Microprocessor based control, using IGBT devices and high switching frequency PWM.	

		f) PFC controlled IGBT rectifier with Active power factor Correction (APFC). g) Capability to operate in N+1 / N+X - Parallel Redundant Configuration. h) Capability of independent or common battery bank operation of the UPS when operated in PRS. i) UPS should be with Inbuilt MCCBs for Input , Output and Maint. Bypass mode .	
3	Model Name & Number		
	kW as mentioned in the BOQ's.	Make / Model / Part No must be specified	
4	Input		
4.1	Input facility -Phases / Wires	3-Phase / 4-Wire & Gnd (R, Y, B -Phases & Neutral + Ground) Frames should consists of internal Copper busbar (no cable connection) for module inter connectivity	
4.2	Nominal Input Voltage	380 / 400 / 415V AC	
4.3	Input Voltage Range	-20% +15%	
4.4	Input iTHd	<3% @ 100% load	
4.5	Nominal Input Frequency	50 / 60 Hz (Auto selectable)	
4.5	Input Frequency Range	45 to 55 Hz	
4.7	Input Power Factor	> 0.99 on Full resistive load Load	
4.8	Input Current Harmonic Distortion (THDi)	@ 25% load	<=8 %
		@ 50 % load	<=5 %
		@ 75% load	<=3 %
		@ 100 % load	<=3 %

4.9	Generator Compatibility	Compatibility to genset supply required	
4.10	Individual Module Protection	Micro Switches modules	
5	Output with		
5.1	Nominal Output Voltage	380 / 400 / 415V AC (Selectable)	
5.2	Output Voltage Regulation	+/- 1%	
5.3	Nominal Output Frequency	50 / 60 Hz (Selectable)	
5.4	Output Frequency Regulation	+/- 0.05 Hz (Free Running / Self Clocked Mode) + / - 5 % (Synchronized to Mains Mode, Selectable)	
5.5	Output Frequency Slew Rate	1 Hz / s	
5.6	Output Wave Form	Pure sine wave	
5.7	Output Voltage Distortion (THDu)	<= 2% (For 100% Linear / Resistive Load) <= 5% (For 100% Non-Linear / RCD Load)	
5.8	Crest Factor	3 : 1 On Full Load	
5.9	Unbalanced load on phases	100% unbalanced load should be allowed	
5.10	Voltage symmetry with 100% Unbalanced Load	+/- 1%	
5.11	Displacement angle for 100% balanced Load	120 deg +/- 3 deg	
5.12	Output Protection	Thru In-built 3P MCCB / Isolator	
6	Transient Response / Recovery		
6.1	Transient response: Dynamic regulation for	+/- 5%	

	0% to 90 % step load		
7	Transfer Time		
7.1	Transfer Time (Mode of operation)	Nil from Mains mode to Battery Mode Nil from Battery Mode to Mains mode	
7.2	Transfer Time (Inverter to Bypass / Bypass to Inverter)	< 1 ms (Synchronized Mode) < 10 ms (Asynchronized Mode)	
7.3	Automatic & Bi-directional static by-pass (In-built)	Should be provided to take care of uninterrupted transfer of load from Inverter to bypass (under overload / fault conditions) & automatic retransfer from bypass to inverter (on removal of overload / fault conditions)	

8	Efficiency (At Nominal Voltage & Resistive Load up to kW rating of UPS)			
8.1	Overall Efficiency (AC to AC) - Online (Double Conversion)	@ 25% load	95.5%	
		@ 50 % load	96 %	
		@ 75% load	96.4 %	
		@ 100 % load	96.5 %	
8.2	Inverter Efficiency (DC to AC) - Battery Mode of operation	> 97% (On Full Load)		
8.3	Eco mode efficiency	>98%		
9	Overload			
9.1	Inverter Overload capacity (Mains Mode & Battery Mode)	110% for 60 minutes 125% for 10 minutes 125% for 60 seconds		
10	Display Panel (In-built 10” LED portrait oriented touchscreen)			
10.1	Measurements (On LCD)	Input: Voltage (L-L & L-N)/ Current/Frequency/Power factor Bypass: Voltage (L-L & L-N)/ Frequency Output: Voltage (L-L & L-N)/ Current/Frequency/Power factor Battery: Voltage / Capacity/Backup time Load: In kVA / kW / Percentage/Crest factor		
10.2	Event Logging & Statistical Data (On LED Panel): UPS should capture and display up to 500 events	Events like: Over temperature / DC Bus Fail / Fan Fail / Fuse Fail / Overload / Short-circuit / Device Fail / Inverter Fail / Rectifier Fail / Bypass Fail, etc Data: No. of power failures / Transfers to Bypass / Total Running time, etc		
10,3	User Programmable Parameters & Settings (On LED)	Bypass: Voltage / Frequency Range Inverter: Voltage / Frequency / Eco Mode / Frequency converter / Redundancy selection Battery: Type / Banks / Chargers Current /		

		Manual & Automatic Testing Alarms: Buzzer & LED Test / Buzzer Mute Date & Time Setting Password: User / Administrator Setting Information: UPS Serial No. / Firmware Log & Statistical Data Reset & Firmware upgrade	
10.4	Indications (LED)	Rectifier Indicator /Battery Indicator /Bypass Indicator /Inverter Indicator/ Load Indicator / and Status Indicator	
11	Alarms		
	Audible Alarms	Mains Failure / Battery Low Alarm / UPS Overload / Fault / Shutdown	
12	Battery Backup / Battery Bank & Charger		
12.1	Backup Required	As per BoQ	
12.2	Battery Bank Voltage	528 to 624 V DC Selectable	
12.3	Battery Bank VAh (Vendor to include battery sizing calculations with tender)	Vendor To mention	
12.4	Batteries Type	VRLA (AGM) Sealed Maintenance Free (SMF) - 12V Cells, 2V,(FR/Non FR as per required),LiB(Samsung /Vision),Ni Cd, Tubular	
12.5	Battery Makes	Amara Raja / Exide /HBL	
12.6	Number of Batteries per Bank/UPS	44-52 nos (selectable)	
12.7	Minimum Charger Rating (Including internal / external)	10% of Battery Ah rating offered	
12.8	Charger type / Charging Method & Charging Voltages	Constant Voltage Constant Current Solid state IGBT charger designed for at least 10% of Battery Ah offeredFloat Voltage: 2.25 VPC Boost Voltage: 2.32	

		VPC Intelligent with boost charge and advanced management	
12.9	Battery recharge time (After complete discharge) to 90% capacity	8 to 10 hours to 90% capacity	
12.10	Battery Protection (Vendor to specify the rating)	External Battery Isolator /Breaker	
12.11	Battery Housing (Vendor to provide the GA drawings of the offered Battery Rack)	Should be compact and space saving MS steel open racks complete with interconnectors / Battery fuse box or isolator (in case of external protection)	
12.12	Battery End Cell Voltage	1.75 V / Cell	
13	Interfaces		
13.1	Serial Communication Port	RS232: Should be provided as standard	
13.2	USB port	Required X 1	
13.2	Interface to NMS (Network Management System) - To be quoted as option	SNMP Card for connecting the UPS to LAN thru Ethernet port & monitoring thru NMS	
13.3	Interface to BMS (Building Management System) - To be quoted as option	ModBus Card for connecting to UPS to BMS thru RS485 & monitoring thru BM	
13.4	Potential Free Contact – Relay Card	Required (Min 6)	
14	Restart / Testing Capability		
14.1	Cold start facility	UPS should be capable of start up on battery mode (when charged) even if Mains power is not available	
14.2	Battery Indication	User Friendly Battery Indications with	

		indicative colors shall be provided	
14.3	Parallel	UPS should be capable of paralleling minimum four numbers of similar rating UPS where in if communication connection failure ups still continue to work in right way without any repercussions on the load.	
15	Physical		
15.1	Operating Temperature	Regular as :0 to 40 deg C and also mention deration above 40 Deg C.	
15.2	Storage Temperature	-20 to 40 deg C	
15.3	Operating Humidity	0 to 95% RH (Non-condensing)	
1.4	Operating Altitude	< 1000 m above sea level	
15.4	Protection Class	IP – 20	
15.5	Type of Cooling	Forced Air	
15.5	Noise Level	< 70 dbA at I meter distance	
15.6	Form Factor	Free Standing Floor Mounted UPS	
15.7	Dimension (w x h x d) in mm	(600 x 1990 x 996) (mm)	
15.8	Weight - in kg	To be furnished by the vendor (Frame, Per Modules, Batteries & Isolation Transformer individually)	
15.9	Color	RAL 9003 gloss30 RAL 9017 gloss80 (front door is shared in 2 colors)	
15.10	Reliability	MTBF greater than 100000 hours	
15.11	Packaging Material	Recyclable (No CFC)	
15.12	Connections - Rectifier Input / Output / Bypass Input / Battery	Hardwired	

16	Conformity and Standards		
16.1	General and safety requirements for UPS used in operator access areas	EN50091-1-1/IEC62040-1-1/	
16.2	Electromagnetic compatibility (EMC) requirements for UPS	EN50091-2/IEC62040-2/	
16.3	Method of specifying the performance and test requirements of UPS	EN50091-3/IEC62040-3/	
16.4	Certification	CE/UE certified, PEP certified, Government Approved Labs Type Test to be done (e.g. NABL, Nisaki, IIT,Sameer) Suitable type test report to be furnished for offered model.	
16.4	Carbon Foot print Calculation	Vendor to furnish Co2 Emmission (approx. 61000 kgs not to be produced)	

Three Phase Solid State Uninterruptible Power Supply

Stand Alone UPS - Tender Specifications – Monolithic UPS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions, and other applicable specification sections in the Project Manual apply to the work specified in this Section.

1.2. SUMMARY

A. **Scope:** Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for a solid-state uninterruptible power supply (UPS) as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

B. **Section Includes:** The work specified in this Section includes, but shall not be limited to, a three-phase, on-line, double conversion, solid state UPS. The UPS shall operate in conjunction with the existing building electrical system to provide high quality power conditioning, back-up power protection, and distribution for electronic equipment loads. The system shall consist of a transformer-less solid state IGBT rectifier/inverter, power factor corrected rectifier, a 100 percent rated for continuous duty static switch, battery plant, LCD plus Synoptic status/control panel, possibility to parallel connection for Power and Redundancy and synchronizing circuitry as described herein.

1.3. REFERENCES

A. General:

The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

B. International Organization for Standardization (ISO):

ISO 9001, "Quality Management Systems - Requirements."

PART 2 - SYSTEM DESCRIPTION

2.1 Technical Characteristics

A. UPS Design Requirements:

1. **Output Power Continuous Rating:** The continuous output power rating of the UPS shall be as mentioned in the BOQ at PF as mentioned in the BOQ.
2. **Input Voltage: 400** volts AC, -20 percent +15 percent, three-phase, 5 wires 3Ph +N + PE.
3. **Output Voltage:400** volts AC, three-phase, 3 wires plus Neutral plus ground.
4. **Battery Autonomy:** UPS shall be capable of operating for as mentioned in the BOQ at PF mentioned as per BOQ, output at a temperature of 12 V battery /25 °C on battery power 40 °C
5. **Battery Type:** Valve regulated sealed lead acid (VRLA) 12 V

B. AC Input Characteristics:

1. **Voltage:400** volts AC, -20 percent +15 percent, three-phase, 5 wires 3Ph +N + PE.
2. **Frequency:** 50 hertz, $\pm 5/\pm 10\%$ adjustable.
3. **Power Factor:** Greater than 0.99 lagging.
4. **Total Harmonic Distortion:** Less than 7% at 100% load.

C. AC Output Characteristics:

1. **Voltage:400** volts AC, ± 1 percent steady state variation phase-to-phase voltage volts AC, three-phase, 5 wires.
2. **Frequency:** 50 hertz, ± 10 percent (Inverter Synch with Mains)
3. **Voltage Stability:** ± 1.0 percent for balanced load.
4. **Voltage Distortion:** Maximum 2 percent total (THD) linear loads, maximum 5 percent total (THD) not linear loads. .

SR	PARTICULARS		REQUIREMENTS	CONFIRMATION BY BIDDER
1	Model	:	IGBT Rectifier & IGBT	
2	Type	:	Inverter, Microprocessor base True on line Double Conversion	
3	Power rating at load pf 0.99 Lagging	:	As Indicated in BOQ	
4	Application	:	As per SLD	
5	Quantity	:	Refer BOQ	
6	Method of energy storage	:	Electrical – battery back-up	
7	Inverter	:	IGBT Type	
8	Rectifier	:	IGBT Type	
9	Installation	:	Indoor, AC ventilated	
10	Max permissible non liner load	:	*	
11	Max Unbalanced Load	:	*	
12	Enclosure			
a)	Material	:	Cold rolled sheet steel	
b)	Sheet thickness (mm)	:	2	
c)	Degree of protection	:	IP-20	
d)	Cable entry	:	Top / Bottom / Suite to site	

e)	Acoustic noise level	:	<70 dbA	
13	UPS system			
a)	Input- Supply voltage	:	415V, 3ph, 3w, 50Hz AC $\pm 10\%$	
14	Output			
a)	Output voltage	:	415V, 3ph, 4w, 50Hz AC $\pm 1\%$ effectively earthed	
b)	AC voltage accuracy (steady state) over entire load, load pf & dc voltage range	:	$\pm 1\%$ for balanced load	
c)	Transient voltage regulation	:	$\pm 8\%$ at 100% load step	
d)	Transient recovery	:	Return to steady state condition within 50ms after Disturbance	
e)	Voltage wave form	:	Sinusoidal	
f)	Range of adjustment of ac output voltage	:	$\pm 5\%$ at rated load	
g)	AC harmonic content	:	3% total, 3 for any single Harmonic	
i)	Nominal frequency	:	$120^\circ \pm 3^\circ$ for 20% unbalance Load 50 Hz	
j)	Frequency regulation	:	$\pm 0.5\%$	

15	DC link (battery)			
a)	No. of 100% capacity batteries	:	*	
b)	Type of battery cell	:	SMF, VRLA (2 V / 12 V)	
c)	Battery support time	:	As mentioned in the BOQ	
16	Battery charger (Rectifier unit)			
a)	No. Of units	:	As per standard	
b)	Rectifier unit	:	IGBT	
c)	Type	:	Float cum boost charger	
d)	Recharge time on boost charge	:	8Hrs	
e)	In rush current	:	Maximum 25% of full load current (energizing rectifier transformer with inverter at no load)	
17	Inverter			
a)	No of Unit	:	As per standard	
b)	Type	:	IGBT	
18	Built in static /Bypass	:	Required	
a)	Inverter and Static Bypass change over	:	To be specify	

	time			
b)	Short circuit Capability	:		
c)	Overload	:	125% for 10 mins 150% for 60 secs	
d)	Transfer time	:	Less than 5 milli secs.	
e)	Manual Bypass inside ups only(input/output)	:	Required	
	D.C. CHARACTERISTIC			
19	Battery backup to be calculated at .9 pf.			
a)	VAH	:	*	
b)	DC bus voltage	:	*	
c)	DC bus Current	:	*	
d)	No. of cells with AH	:	*	
e)	No. of cells with AH	:	*	
f)	End Cell Voltage	:	1.75V	
g)	Float voltage	:	*	
h)	DC current at 100% load	:	*	

i)	Charging current	:	*	
j)	Charging Time	:	*	
k)	True autonomy / measurement	:	Software on SNMP & UPS monitor panel	
l)	Temp. compensated charger	:	Required	
m)	Automatic battery load test Battery Breaker with protection	:	Mandatory	
n)	Required Battery Back Up	:	Mandatory 20 Min	
20	PROTECTION			
a)	Over Load	:	Required	
b)	Short circuit (SC)	:	Required	
c)	Input low voltage	:	Required	
d)	Output over voltage	:	Required	
e)	Battery charging over	:	Required	
f)	Battery Discharging over	:	Required	
g)	DC Over current	:	Required	
21	ENVIRONMENTAL			

a)	Ambient temperature range	:	Up 40 Deg C	
b)	Acoustic Noise	:	72db from 1 Meter	
22	Audio -Visual Display Audio	:		
a)	Over Load	:	Required	
b)	Short circuit (SC)	:	Required	
c)	Input low voltage	:	Required	
d)	Output over voltage	:	Required	
e)	Battery charging over	:	Required	
f)	Battery Discharging over	:	Required	
g)	DC Over current	:	Required	
h)	DC Over Voltage	:	Required	
i)	Battery On Load	:	Required	
j)	Battery Low	:	Required	
k)	Fuse failure	:	Required	
l)	Fan failure	:	Required	
m)	Inverter failure	:	Required	

	Visual Display			
a)	Input/Output voltage	:	Required	
b)	Output current.	:	Required	
c)	Input/ Output frequency	:	Required	
d)	Output power in KVA and KW	:	Required	
e)	Output load power factor	:	Required	
f)	Output load crest factor	:	Required	
g)	battery DC voltage	:	Required	
h)	Charging current	:	Required	
i)	Discharging Current	:	Required	
j)	Autonomy Time	:	Required	
k)	Event logs	:	Required	
l)	Software with LAN connect	:	Required	
m)	Auto Paging	:	Required	
n)	SNMP compatibility	:	Required	
o)	Diagnostic system	:	Required	

p)	Single line mimic diagram	:	Required	
q)	Telemonitoring with software	:	Required	
r)	Capability to parallel 1No similar UPS	:	Required	
s)	ventilation	:	forced air cooling with Integral axial fans	
t)	Battery management	:	Required	
u)	Power Transfer Mode	:	auto systems (during fault condition)	

5. **Slew Rate:** 1.0 hertz/second.

6. **Power Factor:** 1 at the rated volt amperes (VA).

7. **Inverter Overload Capability:** 125 percent of rated load for 10 minutes, 150 percent of rated load for 60 seconds min

8. **Bypass Overload Capability:** 1000 percent for one cycle; 150 percent continuously.

D. Battery:

1. **Battery Voltage:** 240Vdc

The battery charger is equipped with a temperature probe to enable temperature compensated charging.

E. Environmental Requirements:

1. The UPS shall operate under the following environmental conditions:

a. Temperature:

1) UPS Module Operating: 0 °C to 40 °C.

2) Non-Operating (Storage): -10 °C to 70 °C.

- b. **Relative Humidity (Operating and Storage):** 0 percent to 95 percent non-condensing.
- c. **Barometric Pressure:** Up to 1000 meters above sea level.
- d. **Audible Noise:** < 70 dBA at 1m.

DATA SHEET: UPS –

SR.NO	DESCRIPTION	QTY	UNIT
UPS SYSTEM (KVA)			
1	10 (monolithic)	1	Nos.
2	15 (monolithic)	1	Nos.
3	3 (monolithic)	2	Nos.

1.0 EXTERNAL LIGHTING

1.1 SCOPE OF WORK

External lighting shall be provided for internal roads, pathways, parking areas, roundabouts etc. This section has to be read in conjunction with landscaping part of the specification to understand about the lighting to be provided for landscape areas. IS/BS/ECBC/CPWD standards shall be referred to determine the required lux level for the above-mentioned areas.

Scope of work includes supply, installation, testing and commissioning of LED street.

lights, GI octagonal street light poles of various heights, tubular street light poles, decorative street light poles, power cabling from feeder panels, external street light control panel/, landscape lights such as bollard light/spike light/flood light etc., associated.

civil works.

The actual position of all fittings, the wiring details and cable routes shall be coordinated with other trades at site and submitted for the approval of the Engineer-in charge. All time and cost required for adjusting the layout or complete installation to suit site requirement is included.

1.2 STANDARDS

The complete wiring installation shall be engineered according to manufacturer data.

and constructed in accordance with the latest revision of the IS codes and the

appropriate BS/IEC/ECBC/NEC/CPWD guidelines In the adoption of standards and requirements, the Contractor shall take the following.

precedence:

- Clients'/Engineer's decision

- Local codes of practice
- Drawings
- Specification
- International standards and requirements

1.3 LED street light fixture

1. Ingress protection should be IP 66. The fixture shall have gasket designed for IP66 to prevent breakdown of the water and dust proof seal for both the LED & the driver compartments.

2. Internal Surge protection of 4KV with an External surge protection of 10KV

shall be put in the Luminaries to ensure protection against surge arising from

power line.

3. The fixture body temperature shall not exceed 40 Deg C from ambient even

after continuous operation for 24 hrs.

4. LED street light luminaire with system efficacy of more than 120 lm/W.

5. LED light shall be made up of die cast aluminium housing suitable to mounted bracket arm.

6. Luminaire shall have two separate compartments for LEDs and driver and both compartments shall be hermetically sealed to achieve IP 66 ingress protection.

7. Optical compartment shall be provided with heat resistant clear toughened glass of minimum 4mm thick to withstand IK 07 impact rating,

8. LEDs used in the product shall comply with EN 62471, IEC-61347-1, IEC

61347-2-13, IEC 61547, 61000-3-2, CISPR-1

9. The LED shall be compliant with LM80-08 standard with Useful L70 life of

50000 Hrs.

10. The LEDs used in streetlight shall have CCT of 5000 K and CRI of 70

(Minimum values).

11. Power factor greater than 0.95 and total harmonic distortion (THD) of less than 10% should be integral to the luminaire.

12. LED driver shall have output short circuit & over voltage withstanding protection inbuilt.

1.4 STREET LIGHT POLE, HIGH MAST & BOLLARDS:

Light poles shall be provided as per following details:

- The Street Light Poles shall be designed to withstand the maximum wind speed as per IS 875 Part-3-2015. The head loading i.e. windage area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BSEN 40-3-1 & 3.
- The pole shaft shall be made from hot rolled steel plate confirming to IS 2062/ BS EN 10025.
- All pole shafts shall be provided with the rigid base plate manufactured from MS steel confirming to IS:2062 of suitable thickness with provision for fixing foundation bolts.
- The pole shaft shall have circular/octagonal cross section and shall be continuously tapered with single longitudinal welding or shall be with two different diameters circumferential welding.
- The welding of pole shaft shall be done by Submerged Arc Welding (SAW) process.
- The base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside.
- The Poles shall have door of approximate 500 mm height at the elevation of 500 mm from the base plate.

- The pole shall be adequately strengthened at the location of the door to compensate for the loss in section. The hinged door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.
- The welding shall be carried out confirming to approved procedures qualified by third party inspection agency. The welders shall also be qualified for welding the circular/octagonal shafts.
- The Poles shall be in maximum single/double section up to 12-meter height and there shall not be any circumferential weld join except at base flange and at joint.
- The Manufacturing unit shall have in house galvanizing facility; the poles shall be hot dip galvanized as per BSEN ISO 1461 standard. Zinc used for galvanizing shall have purity of 99.995% as per IS 209. The galvanizing shall be done in single dipping. The galvanized mounting bracket shall be supplied along with the Octagonal Poles for installation of the luminaries.
- Provision should be provided in the bottom compartment to mount PVC /Bakelite sheet along with connectors for cable looping and single pole MCB to isolate individual luminaire.

		REQUIREMENTS	VENDOR CONFIRMATION
1.	CONICAL POLE-		
	Height of Pole	7/9 Meter	
	Make	KLITE/Bajaj/Keselec	
	Material construction of Shaft	Hot Rolled Steel Plate as per IS 2062 / BS EN 10025 Or Equivalent.	
	Grade of Steel	Hot Rolled Steel Plate as per IS 2062 / BS EN 10025 Or Equivalent.	
	Thickness	3 mm	
	No. of longitudinal welds	One	

	/section		
	Cross section of Pole	Circular/Conical(8-sided polygon)	
	Base diameter and top diameter (A/F)	As per structural design calculations. Base-	
	Metal protection treatment for Pole Section	Hot Dipped Galvanized, as per BS EN ISO 1461, with an average GI of not less than 60 micron.	
	Height of door	500 mm	
	Door type	Hinged door	
	Dimension of base plate	As per structural design calculations.	
	Thickness of base plate	As per structural design calculations.	
	Grade of Steel for Base Plate	As per IS 2062	
	Max. wind speed	As per IS 875 Part III – 2015	
2.	FOUNDATION BOLTS		
	Number of foundation bolts	4 nos.	
	PCD of foundation bolts	As per structural design calculations.	
	Grade of Foundation Bolts	As per structural design calculations.	
	Bolt diameter/Length	As per structural design calculations with J-Bolt	

1. Internal roads with vehicular traffic- Conical GI poles (Height may be decided as per design)
2. Pathways - Decorative pole to match the landscape
3. Vehicular parking areas - High mast conical pole (Height & no of lights as per the design)
4. RoundABOUTS - Same as item no.3
5. Landscape areas - Bollard light/flood light/ spike light/buried light to match the landscaping design (refer landscape part also) The manufacturing standards of light poles mentioned above shall comply relevant. codes as per IS/CPWD/NEC/IEC guidelines.

2.0 HIGH MAST LIGHTING

2.01 SCOPE: The scope of this specification covers the manufacture, transport, installation, testing and commissioning of the complete lighting system, using Raising and Lowering type of High mast Towers, including the Civil Foundation Works. The purchaser will provide the feeder cable of required size up to the base compartment of the high mast.

2.02 APPLICABLE STANDARDS:

Code No.

1. PLG 07 High Masts for Lighting and CCTV
2. SANS 10225 High Mast natural frequency calculation
3. IS 875 Part – 3 Wind Loading
4. IS 2062/ BS EN 10025 Hot Rolled Steel plates.
5. BS EN ISO 1461 Galvanization
6. IS 2266 Stainless steel Wire rope
7. IS 9968 Part – 1 Trailing Cable
8. IS 694 PVC insulated flexible copper cable.
9. IS 7098 Part-1 XLPE insulated Aluminium / Copper cable

10. IS 12615 Motor

11. EN-8 grade, IS 1367 (Part 3) Foundation Bolt

12 AWS Welding

3.0 HIGHMAST:

3.01 Structure:

The High mast shall be of continuously tapered, polygonal cross section, 12 / 20 sided, presenting a good and pleasing appearance and shall be based on proven In-Tension design conforming to the standards referred to above to give an assured performance and reliable service. The dimensions of the mast and other details are as per the enclosed data sheet.

3.02 Construction:

The mast shaft shall be manufactured from Hot Rolled steel plates confirming to IS 2062/ BS EN 10025. Each mast shaft section shall be without any circumferential weld joint except base flange. The mast base flange shall be free from any lamination or incursion and provided with supplementary gussets between the bolt-holes to ensure elimination of helical stress concentration.

The minimum A/F dimension of top shall be 100 mm / 150 mm and bottom as per the design and data sheet enclosed. The minimum section length except for the top section shall be 10 m and top shall depend on the length required to make the specified height. The masts sections shall be joined at site by slip-stress-fit method and minimum overlap distance shall be 1.5 times the diameter at penetration.

A door reinforced with welded steel section, vandal resistant, weather proof with Allen bolts and pad locking facility of dimension not less than 1050 mm x 225 mm shall be provided at a height 2 times the width of door from the base of mast to provide clear access to base compartment equipment's winch, motor, cable, connector etc;

For the environmental protection of the mast, the entire fabricated mast shall be hot dip galvanised internally and externally in single dip having the galvanisation thicknesses as per galvanisation standard BSEN ISO1461.

3.03 Dynamic Loading for the Mast:

The mast structure shall be suitable to sustain an assumed maximum reaction arising from a wind speed as per IS 875 part-3-2015 (three second gust) and shall be measured

at a height of 10 metres above ground level. The design life of the mast shall be 25 years, Topography factor K3 shall be 1 (Flat terrain) and Importance factor K4 shall be 1 (case 3). The force co-efficient taken for design of the twenty-sided polygonal structure is to be established from the wind tunnel test data.

3.04 Luminaries Carriage:

Hot dip galvanized Luminaries carriage designed to install luminaries as specified in data sheet or as per illumination design and junction box. The same is to be fabricated from ERW tubes in two halves and flanges joined at site with stainless steel bolts and nyloc nuts. Holes are to be provided in the bottom side of tubes to act as conduit for wiring cable. PVC lining is to be provided in the inner side of carriage to avoid metal contact with mast surface. Weather proof junction box shall be provided on the Carriage Assembly for terminating the trailing cable and power cable to luminaries.

Weather proof junction box shall be provided on the Carriage Assembly for terminating the trailing cable and power cable to luminaries.

3.05 Raising and lowering mechanism:

3.05.01 Winch:

The double drum winch shall be completely self sustaining without the need for brake shoe, springs or clutches and self-lubricating type by means of an oil bath. The worm gear ratio shall not be less than 53:1 and safe working load shall be as per data sheet. The drums are to be grooved to provide perfect seat for stable and tidy rope lay and arrangement for distortion free rope end termination. The winch shall have provision to operate manually by a handle or electrically through power tool. The capacity, operating speed, safe working load, recommended lubrication and serial number of the winch shall be marked on each winch. The winch shall be type tested through reputed institutions like IIT as consultants and the type test report shall be submitted along with offer. A test certificate is to be submitted along with supplies.

3.05.2 Head Frame: The hot dip galvanized head frame is to be designed as a capping unit of the mast is of welded steel construction and provided with guides and separators between the ropes and cable. The LM6 Aluminium pulleys with bush mounted through stainless steel shaft shall be suitable to accommodate wire ropes and multi core trailing cable. The head frame shall be provided with guides and stops with PVC buffer for the docking of luminaires carriage. The pulley assembly shall be covered by a hot dip galvanized canopy.

3.05.3 Stainless Steel Wire Ropes: The stainless-steel wire ropes shall be in 7/19 construction with central core in the same material of grade, diameter and breaking load

as given in data sheet. The end construction of rope for the winch drum shall be fitted with talurit and for two continuous ropes the end termination in luminaire's carriage shall be with stainless steel thimble and copper splicing and for others with stainless steel thimble and bull dog grips.

3.06 Electrical System, Cable and Cable Connections:

The multi core trailing cable from base compartment to junction box at luminaires carriage shall be 1.1 KV grade and type as specified in the data sheet of copper conductor with male female connectors of shall be as given in data sheet. Wiring from junction box to luminaries is to be done using 3 core 1.5 sq. mm PVC/ XLPE insulated, PVC sheathed, copper conductor flexible cable. Suitable arrangement is to be provided in the base compartment to receive and terminate incoming power cable and MCB in a box for isolation of incoming power supply shall be provided by purchaser.

3.07 Power Tool for the Winch: Three phase, single speed, 6 pole high-powered motor of rating suitable to lift the load mounted on adjustable plate to adjust the length of winch motor coupling chain is to be provided in base compartment. Mechanical torque limiter is to be mounted on motor shaft to stop transmission of motion from motor to winch in case of excess load and thus prevent the damage to winch and breakage of rope.

3.08 Lightning Finial One number heavy duty 1.2 m long hot dip galvanised lightening finial shall be provided for each mast for mast height $\geq 16\text{M}$ on the head frame to get a direct conducting path to the earth through the mast.

3.09 Aviation Obstruction Lights: One/Two number Low intensity RED coloured LED Aviation Obstruction Lights shall be provided on luminaires carriage as per customer requirement.

3.10 Earthing Terminals: Earth terminal using 12 mm diameter hot dip galvanized bolts shall be provided on the door stiffener of the mast for lightning and electrical earthing of the mast.

3.11 Feeder Pillar Each mast shall be provided with a feeder pillar housing Suitable TPN MCB incomer, single dial time switch and outgoing contactor for automatic switching on and off luminaries, 9A two contactors and raise lower push buttons for motor operation, incoming terminals of 50 sq. mm and out going terminals of 16 sq. mm for power cable and 2.5 sq. mm for motor.

3.12 Incoming Power Cable 1.1 KV grade, XLPE insulated, PVC sheathed, Aluminium conductor, armoured cable for power supply 4C x 10 Sqmm shall be provided from feeder pillar to the base compartment of the high mast. Cable shall be taken to the base

compartment of the high mast through the provision made in the foundation. Power cable of suitable size up to the feeder pillar from supply point shall be provided by purchaser.

Bollard Light

Extruded aluminium bottom pipe (grade 6063 with test certificate) Ø166 x 3mm thickness & die-cast aluminium top cover. SS fasteners. Pre treated silicone gaskets. Die-cast aluminium mounting plate Ø167 x 4mm thick with 4 elongated holes 20 x 14 to suit M12 bolts at PCD 110 with pure polyester powder coating. This mounting plate along with foundation bolts of suitable size to be used for ensuring firm grouting into the specially designed foundation. Hot dip galvanised foundation bolt. Mechanical resistance IK08.

Pure polyester powder coated process : Acid treatment & pure polyester powder coating.

LIGHTING PERFORMANCE

Optical grade clear polycarbonate diffuser with controlled downward light emission. Lamp fixed position.

This luminaire contains built-in LED modules. LED modules are engineered accordingly to the existing regulations of Lumen Maintenance (LM80) and Technical Memorandum (TM21), Lifespan of the luminaire > 60,000 hours at 40°C. Operating ambient temperature range is from -15°C to +50°C. Driver efficiency >87%, power factor >0.95, THD <8.2%, Surge protection 3KV.

4.0. Internal Electrification Works.

Scope: - The scope includes Supply, Installation, Testing & Commissioning.

The Internal Electrification work should be carried out only in accordance with **CPWD General specifications for Electrical Works Part – I (Internal)-2013 with latest amendments and revisions.**

5.0. FIRE SEALANT

5.1 Scope: - Providing and fixing of fire sealant including all required & necessary accessories and supports for smooth functioning / operation.

5.1.1 DESCRIPTION

Minimum 2 hours fire rating when tested in accordance with UL 1479/ASTM-E 814 standards, for vertical openings in walls made of concrete/ masonry or Gypsum after passing service lines like Cable trays , Conduits .

The Firestop product shall carry test certificate in accordance with IEC 60068-2-57:1999-11 (Environmental Testing) as per Part 2-57: Test for Vibration-Time-history method and VERTEQII for seismic zone 4.

The product shall be age tested as per Dafstb and DIBT standards.

The product shall carry test certificate for mold resistance rating of 0 as determined by ASTM G21-96.

The system shall be UL listed & classified and product shall bear the UL and FM approval logo on the packing.

If none of UL test certificate comply with actual application, an EJ document prepared by qualified personnel and based on nearest third party tested & approved systems like UL test certificates & in accordance with IFC guidelines shall be produced by manufacturer.

A firestop submittal shall be produced by manufacturer, in accordance with approved passive fire protection method statement, for technical approval.

Firestop Speciality Contractor needs to submit work completion certificate along with installation report The gaps around penetrants like plastic pipes or ducts with insulation shall be sealed with an appropriate intumescent technology like FS One Max Sealants, CP 648-E Wraps or CP 644 collars.

6.0 CABLE TRAYS, TRUNKINGS

6.1 SCOPE:

The specifications are given below to enable the Supply, Installation, testing & supplying of cable trays perforated /Cable ladder complete in all respect as reflected in layout & appearing in schedule of quantities.

6.1.1 CODES & STANDARDS:

NEC 2011	National Electric Code 2011
NEMA VE1, FG1,VE2	NEMA Standards for Manufacturing of Cable Trays

ISO 9000, ISO 9001, ISO 9002 or Equivalent IS Standard.	Cable Tray
ISO 9000, ISO 9001, ISO 9002 or Equivalent IS Standard.	Cable Ladder
IS 14927,	Cable Trunking
IS 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.

6.1.2 MATERIAL & FINISHES:

- A) **Cable Trays:** Cable trays and accessories shall be manufactured to comply with the specifications of Indian Standards. Cable trays and accessories shall be fabricated using mild steel sheets and hot dip galvanized in accordance with respective codes as specified in section 1.4 after fabrication. All bolts, nuts and washers shall also be hot dip galvanized. The zinc coating shall be uniform, smooth and free from imperfections such as flux & ash, black spots, blisters etc. Cable trays and accessories shall undergo a process of degreasing, pickling in acid & cold rinsing prior to galvanization.
- B) For all cable trays $\geq 600\text{mm}$ web height should be 75mm and all containment $<600\text{mm}$ web height should be 50mm.
- For all cable trays up to and Including 300mm , Thickness of Material to be 1.6mm and Trays above 300mm Thickness of material to be 2mm.
 - The zinc coating thickness for cable trays shall be minimum 65 microns
 - Cable trays shall be of the following type:
 - Ladder type with rungs
 - Perforated type.
- C) **Perforated cable trays** shall be generally of channel type and the perforations shall be 10x30 mm oval holes. Perforated cable trays shall also be hot dip galvanized. Galvanizing shall be in accordance with that specified above for ladder type cable tray.
- D) **Ladder type cable trays** shall be made from 2mm thick sheet formed in `C' section of 75mm height and inward flanges of 15mm as side runners and 30mm wide x 10mm high rungs (`C' shaped) from a 1.5mm thick sheet.

Perforations as mentioned above shall be provided in the width of the rungs. Pitch of the rungs shall not exceed 250 mm centre to centre. Rungs shall be tack welded to the side members. Perforated trays shall be of the formed channel shape.

E) Cable trays shall be of following dimensions:

1. Section Length 2500 mm
2. Width – as specified in BOQ & Drawings
3. Flange of perforated tray 25 mm

F) Following accessories and hardware, as required, shall be supplied with cable trays :

1. Coupler plates
2. Horizontal and Vertical
3. Tees
4. Reducers
5. 4-way cross
6. Fasteners (Hardware)
7. Earth Links.

G) **Trunking:** Unless noted otherwise, trunking and accessories shall be manufactured to comply with the specifications of Indian Standards. Trunking shall be hot dip galvanized. Cable/Wire trunking is proposed to be installed concealed under the floor finish or hung from ceiling. The zinc coating thickness for cable trunking shall be minimum 46 microns. Trunking shall be complete with partition plates and covers. Trunking of each size shall be supplied with following accessories:

1. 4 way junction boxes with removable covers
2. Vertical access boxes/ adaptor for conduits.
3. Couplers
4. End caps
5. Earth straps.

ELECTRICAL MAKE LIST		
SR.NO	Description	MAKE
1	PVC CONDUITS & ACCESSORIES	UNIVERSAL / PRECISION / DIAMOND/SUDHAKAR/BEC/
2	MS CONDUITS & ACCESSORIES	BEC/ AKG / STEEL KRAFT / RMCON / PRECISION
3	CABLES & WIRES- 1100 V LT FLEXIBLE /ARMOURED/CONTROL CABLES	POLYCAB / RRK /FINOLEX /KEI
4	MODULAR SWITCHES & SOCKET OUTLETS , BACKBOX & SWITCH PLATE	Siemens / Legrand (Arteor) / L&K (Englaze) / Havells / Schnieder / Wipro (North West)/ ABB
5	ACB	L&K (U POWER OMEGA), SCHNEDIER(MVS), SIEMENS(3WL), ABB(EMAX), LEGRAND(DMX3)
6	MCCB	L&K (D-sine), SIEMENS (3VA), Legrand(DPX3), ABB(TMAX), Schnedier(CVS)
7	CIRCUIT BREAKER (MCB / RCCB / RCBO)	LEGRAND / SCHNEIDER / ABB / SIEMENS / L&K
8	DISTRIBUTION BOARD	LEGRAND / SCHNEIDER / ABB / SIEMENS / L&T
9	CABLE TRAY	ASAWA / PROFAB / INDIANA
10	EARTH PITS	OBO / JEF TECHNO / TRUE POWER EARTHING
11	GI/CU EARTHING STRIPS / CABLE	OBO / JEF TECHNO / TRUE POWER EARTHING

12	EQUIPOTENTIAL BAR & TEST LINK	OBO / JEF TECHNO / TRUE POWER EARTHING
13	LIGHTNING PROTECTION /ARRESTOR	CAPE / OBO / JEF TECHNO / DEHN
14	CABLE GLANDS AND BIMETALLIC LUGS	DOWELLS / COSMOS / COMET
15	SENSORS	LEGRAND /SCHNEIDER / SIEMENS / L&K / ABB
16	LIGHT FITTINGS	PHILIPS / WIPRO / CROMPTON / HAVELLS / BAJAJ / LIGHTING TECHNOLOGIES
17	MAIN LT POWER PANLES ENCLOSURES (IEC 61439)	L&K / ABB / SCHNEIDER / SIEMENS / LEGRAND / RITAL or their Authorized Channel Partners Note: - Panels shall comply IEC 61439 spec
18	OTHER POWER/CONTROL PANLES ENCLOSURES IS 8623	NISTECH / MARINE ELECTRICALS / SHIVAM ELECTRICALS
19	CAST RESIN CURRENT TRANSFORMER (CT)	KAPPA / KALPA / L&K / AE / MECO
20	DIGITAL / ANALOGUE MULTIFUNCTION METERS	ELMEASURE / L&K / SCHNEIDER / SIEMENS / ABB / AE / SECURE / MECO / CONZERV
21	PUSH BUTTONS/ INDICATING LAMPS LED	SCHNEIDER / ABB / L&K / AE / KAYCEE / VAISHNAV / TECHNIC / SEIMENS
22	AUTOMATIC TRANSFER SWITCH (ATS)	SOCOMEK / L&K / VIZROTECH
23	RELAYS & TIMER	Siemens / L&T / ABB / Schnieder / Socomec / Areva
24	CONTROL FUSES	SCHNEIDER / ABB / L&K / SIEMENS
25	SURGE VOLTAGE PROTECTION	SCHNEIDER / ABB / L&K / SIEMENS /ZOTUP
26	MOTOR PROTECTION CIRCUIT BREAKER (MPCB) /CONTACTORS	SCHNEIDER / ABB / L&K / SIEMENS
27	OVER LOAD RELAY WITH INBUILT PHASE PREVENTER	SCHNEIDER / ABB / L&K / SIEMENS
28	INDUSTRIAL SOCKET	LEGRAND / MK / HAVELL / SCHNEIDER / ABB
29	UPS	NUMERIC / FUJI ELECTRIC CONSUL NEOWATT / EATON / VERTIV / SCHNEIDER
30	BATTERIES & BATTERY CHARGER	AMAR RAJA / EXIDE / HITACHI
31	INVERTER	UPSTRONIC / LUMINOUS / MICROTECK
32	FIRE SEALANT	HILTI / EQUIVALENT
33	CABLE TRAY SUPPORT, CABLE	GRIPPLE / ASAWA-GPL / MUPRO

	SUPPORTS/HANGERS	
34	VIBRATION ISOLATORS	RESISTOFLEX / DUNLOP / EASYFLEX
35	HEAVY SUPPORTS CLAMP	DIAMOND PIPE-SUPPORTS / HI-TECH
36	LIGHT CONTROLS SYSTEM	LUTRON / CRESTRON / DELMATIC
37	HAND GLOVES & RUBBER MAT	PREMIER POLYFIM LTD / POLYELECTROSAFE / CHALLENGER / ELECTROMAT / SAFE HOLD / VARDMN / DURATUF
38	JUNCTION BOX	HENSEL / CLIPSAL / MENNEKES
39	CAPACITORS WITH HARMONIC FILTER	L&K / SCHNEIDER / ABB
40	CEILING / EXHAUST / WALL FANS	CROMTON / USHA / ORIENT / BAJAJ / HAVELLS
41	CHEMICAL EARTHING GI /CU STRIP & EARTHING MATERIAL	JMV LPS Ltd. / PRAGATI / ERICO / JEF / VN
42	STREET LIGHT POLES	BAJAJ / KESELAC / K-LITE / ARGOS ARKAYA

ELV WORK

1.0 Addressable Fire Detection & Alarm System.

1.1 Scope

- A. A new intelligent reporting, microprocessor-controlled fire detection system shall be installed in accordance with the project specifications and drawings.
- B. Basic Performance**
1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Class A Signaling Line Circuits (SLC).
 2. Device Circuits (IDC) shall be wired NFPA Class A as part of an addressable device connected by the SLC Circuit
 3. Notification Appliance Circuits (NAC) shall be wired NFPA Class A as part of an addressable device connected by the SLC Circuit
 4. On Class A configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
 5. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

6. Speaker circuits may be controlled by NAC outputs built into the amplifiers, which shall function as addressable points on the Digital Audio Loop.
7. NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone whichever is greater.
8. NAC speaker circuits and control equipment shall be arranged such that loss of anyone speaker circuit will not cause the loss of any other speaker circuit in the system.
9. Two-way emergency telephone communication circuits shall be supervised for open and short circuit conditions.
10. Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the Audio Command Centre and up to **thirty (30)** remote Fire Fighter's Telephone locations simultaneously on a conference in multiple FFT Risers
11. Means shall be provided to connect FFT voice communications to the speaker circuits in order to allow voice paging over the speaker circuit from a telephone handset.
12. The proposed product shall not restrict the buyer to one single organization, nor shall it require any proprietary dongle or other programming tools for after sales & maintenance activity.

1.1.1 Codes, Standards and Rules

- A. The fire detection & alarm system shall comply with the requirements of NBC, IS, NFPA and relevant local regulations as applicable for protected premises signaling systems.
- B. The fire alarm manufacturer shall be of the highest caliber and quality. All software shall comply with OEM declared "End of support date" after the end of warranty of system from vendor.
- C. The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

Approvals

- The following standards shall be referenced when the system design of the application is basically made.
 - A. National Fire Protection Association (NFPA) - USA:

NFPA 12	Extinguishing Systems (low and high)
NFPA 12A	Halon 1301 Extinguishing Systems
NFPA 13	Sprinkler Systems

NFPA 15	Water Spray Systems
NFPA 16	Foam / Water Deluge and Spray Systems
NFPA 17	Dry Chemical Extinguishing Systems
NFPA 17A	Wet Chemical Extinguishing Systems
NFPA 2001	Clean Agent Extinguishing Systems
NFPA 70	National Electric Code
NFPA 90A	Air Conditioning Systems
NFPA 92A	Smoke Control Systems
NFPA 92B	Smoke Management Systems in Malls, Atria, Large Areas
NFPA 72	National Fire Alarm Code
NFPA 101	Life Safety Code

B. Underwriters Laboratories Inc. (UL) - USA:

UL 268, 7 th Edition	Smoke Detectors for Fire Protective Signaling Systems
UL 864, 10 th Edition	Control Units for Fire Protective Signaling Systems
UL 2572	Mass Notification Systems
UL 217	Smoke Detectors, Single and Multiple Station
UL 228	Door Closers - Holders for Fire Protective Signaling Systems
UL 268A	Smoke Detectors for Duct Applications
UL 521	Heat Detectors for Fire Protective Signaling Systems
UL 464	Audible Signaling Appliances
UL 38	Manually Actuated Signaling Boxes
UL 1481	Power Supplies for Fire Protective Signaling Systems
UL 346	Waterflow Indicators for Fire Protective Signaling Systems

UL 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
UL 1971	Visual Notification Appliances
UL 2017	Standard for General-Purpose Signaling Devices and Systems
UL60950	Safety of Information Technology Equipment

- C. Factory Mutual – USA
- D. Local and State Building Codes.
- E. All requirements of the Authority Having Jurisdiction (AHJ).
- F. The system shall be certified for seismic applications in accordance with the International Building Code (IBC). The basis for qualification of seismic approval shall be via shake table testing.
- G. The System shall be FM 6320 (Factory Mutual) approved as a Gas Detection system when employed with the 4-20 monitor module and industry standard 4-20 mA gas detectors.

1.1.2 System Description

- A. Main FACP or network node shall contain a microprocessor based Central Processing Unit (CPU) and power supply. The microprocessor shall be a state-of-the-art, high speed, at least 32-bit device and it shall communicate with, monitor and control all external interfaces. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system-controlled devices.
- B. In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:
 - 1. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
 - 2. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.
 - 3. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.

System Capacity and General Operation

- A. The FACP can communicate on a peer-to-peer, inherently regenerative communication format and protocol. The network shall support communication up to 32 panels / nodes per network.
- B. The control panel shall be capable of expansion via up to 10 SLC loops. Each loop shall support capability of supporting not less than 240 devices (including detectors) and minimum 120 detectors per loop. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit minimum 320-character liquid crystal display or Graphic display or Touch screen, color coded system status LEDs, and a keypad for the control of the fire alarm system. Said LCD shall also be capable of displaying the company name/site name.
- C. All programming or editing of the existing program in the system shall be achieved without interrupting the alarm monitoring functions of the fire alarm control panel.
- D. The FACP shall be able to provide the following software and hardware features.

1. Action: If programmed for Action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition.
2. Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.
3. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.
4. History Events: The panel shall maintain a history file of at least last 5000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 500 event Alarm History buffer, which consists of the 500 most recent alarm events from the 5000-event history file.
5. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.
6. Passwords and Users: The system shall support two password levels, master, and user.
7. Sensitivity Adjust: The system shall provide Detector Sensitivity Adjust.

E. Central Processing Unit

1. The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT, ANYX, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory and shall not be lost with system primary and secondary power failure.
2. The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.
3. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.
4. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Systems not offering degrade mode shall offer

Redundant CPU. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

F. Display

1. The system display shall provide minimum 320-character backlit alphanumeric Liquid Crystal Display (LCD) or Graphic display or Touch screen display. It shall also provide Light-Emitting-Diodes (LEDs) that indicate the status of the system parameters:
2. The system display shall provide a keypad for ease of operation.
3. The keypad shall have control capability to command all system functions, entry of any alphabetic or numeric information, and field programming without the use of any external equipment or laptop. Two different password levels (one Master and one User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

G. Loop (Signaling Line Circuit) Control Module:

1. The control panel shall be capable of expansion via up to 10 SLC loops. Each loop shall support capable of supporting not less than 240 devices (including detectors) and minimum 120 detectors per loop and loop length up to 2 KM.
2. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of failure in the main CPU.
3. Each loop shall maintain 20% spare capacity for future expansion.
4. Each Loop shall be capable of operating as an NFPA Class B circuit in case of single open circuit.

H. Cloud Based Facility Management Software

Remote health monitoring solution utilizing cloud-based software-as-a-service web application & supplementary network gateway hardware. System shall provide secure web access to cloud-based web application using any of the web browsers like Google Chrome (preferable), Internet Explorer etc. from any computer/ tablet/ smartphone connected over internet via defined credentials – username and password. Display of Events logs, and all basic control features should be possible in software. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable. The cloud-based web application shall capture all fire alarm system data as received from the system via supplementary gateway hardware. The owner shall receive login and

passwords at the first training session. The Owner shall have full licensing and full access rights for remote monitoring system.

I. Network Communication

The FACP shall communicate over a peer-to-peer communication network, inherently over a regenerative communication format and protocol. The network shall support communication speed up to 100 Mbps and support up to 200 Control Panels / Network Nodes, over a single medium (copper conductor / fiber optic), redundant ring, communication channel for fire alarm, voice evacuation and telephone talk-back system. The system shall support minimum 32 such networks in a single system.

The network card shall have inbuilt Fiber port for terminating Fiber Optic Cable without any third- party converters.

J. Digital Voice Command Center

- a) The Digital Voice Command Center located with the FACP, shall contain all equipment required for all emergency telephone system control, signaling and supervisory functions. control, telephone circuit indication and control, microphone, and main telephone handset.
- b) Operate as a supervised multi-channel emergency voice communication system.
- c) Operate as a two-way emergency telephone system control center.
- d) Audibly and visually annunciate the active or trouble condition emergency telephone circuit.
- e) Provide software utility capable of off-line programming for the DVC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the DVC shall not inhibit the emergency operation of other nodes on the fire alarm network.
- f) Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SLC controlled switching.
- g) Fire, Telephone data shall flow through single network cable.
- h) Failure of Fire Panel CPU shall not affect the operation of DVC. In case DVC are controlled by Fire Panel CPU, a separate panel with dedicated CPU shall be considered for each DVC.

K. Power Supply

1. The Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.
2. The Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 48 hours of standby power using dual rate charging techniques for fast battery recharge.
3. The Main Power Supply provides a battery charger for 24 hours of standby using dual rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 7-200 amp-hours within a 48-hour period.
4. The Main Power Supply provides a very low frequency sweep earth detect circuit, capable of detecting earth faults.
5. The Main Power Supply shall be power limited per UL864 requirements.
6. The Main Power Supply shall communicate power supply, line voltage, battery status and charger status to the local LCD display. Any abnormal condition shall be annunciated and logged to the system alarm history log.
7. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means. Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire.
13. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.
14. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of zero, two, eight or sixteen hours shall be programmable.
15. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be programmable.
16. The addressable power supply mounts in either the FACP back box or its own dedicated surface mounted back box with cover.
17. Each of the power supply's four output circuits shall be programmed- for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.

18. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of an end-of-line resistor. When the power supply's output circuit is selected as General 24 VDC power, the circuit shall be individually supervised when an end-of-line relay is used.
19. When selected for Notification Appliance Circuits, the output circuits shall be individually programmable for Steady, March Time, Dual Stage or Temporal.
20. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
21. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.
22. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.
23. 48 hours Battery back-up with 24 volts sealed maintenance free batteries with automatic charger.

L. GATEWAY AND WEB SERVERS

The system shall be capable of being interfaced to third party or BMS system via BACnet or Modbus interface gateway.

1.1.3 Special Requirements

The following systems shall be interfaced with Fire alarm system.

- Access control system - to automatically unlock Access controlled doors.
- PA system – to automatically announce the pre-recorded messages.
- Lifts - to return to the nearest floor lobby.
- HVAC Equipment's - AHUs, motorized fire dampers, Smoke extract fans; Make up air Fans, Lift pressurization fans, Ventilation fans, staircase pressurization fans etc.
- Fire Fighting Equipment's - Sprinkler flow switches and alarm valves, fire and sprinkler pumps.

1.1.4 Material Specifications

This section of the specifications includes the furnishing, installation, and connection of the microprocessor controlled; intelligent reporting fire alarm equipment required to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and specified herein.

Equipm ent:

All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment, and devices shall be tested and listed by a nationally recognized approval agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the Riser/Connection diagram for all specific system installation/termination/wiring data.

All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g. detectors shall not be supported solely by suspended ceilings). Fasteners and support shall be adequate to support the required load.

1.1.5 System Components

The system shall be electronically addressing each addressable device. Addressing of each addressable device by DIP switch is not acceptable.

Detectors shall be Analogue and Addressable and shall connect with two wires to the fire alarm control panel signaling Line Circuits.

The sensors should have the ability to reason and make decisions on their own, based upon real-time analogue sensing, on board historical data and decision algorithms which apply to known fire characteristics. This allows the sensors to accurately identify true fire whilst filtering out false alarms, before transmitting an alarm.

Detector sensitivity should be adjustable, and a separate sensitivity can be selected for day and night operation. Pre-alarm levels can also be

established to provide early warning of potentially dangerous conditions, allowing time to investigate before an actual threat to life safety occurs. The sensors maintain the specified sensitivity threshold despite aging, dirt build-up, and temperature or humidity changes. Frequently, automatic sensitivity adjustments are based upon environmental changes occurring over the last four to twenty-four hours.

As each sensor can transmit its identity and location on request, accurate documentation of the alarm circuitry is readily available. 'As-built' wiring diagrams can be displayed and printed out at any time. The display will highlight any wiring faults, sensor placement errors or software programming deviations.

The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7

A. Addressable Devices – General

1. Addressable devices shall provide a soft address setting
2. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
3. In the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance.
4. Detectors shall also store an internal identifying type of code that the control panel shall use to identify the type of device (PHOTO, THERMAL).
5. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/ normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
6. Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box or surface mount Lexan enclosure.

B. Intelligent Multi Criteria Detector

The intelligent multi-criteria detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device .

1. Designed to meet UL268, 7th Edition or EN 54
2. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.)
3. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

C. Addressable Rate of Rise Heat Detector

The intelligent thermal detectors shall be addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at (9.4 degrees C) per minute. A high-heat thermal detector rated at (78 degrees Celsius) shall also be available. The thermal detectors shall connect via two wires to the fire alarm control panel signaling line circuit.

1. Modern profile with White color for improved aesthetics.
2. Advanced thermal technology for fast response.
3. Fixed temperature model factory preset to 58 deg.
4. Rate of Rise model preset to 9°C/min
5. High temperature model factory preset to 78°deg
6. Low standby current. less than 300 micro-Amps @ 24 VDC
7. Two-wire SLC connection.
8. Soft addressing LEDs blink in normal condition and illuminate steady red on alarm
9. Built-in tamper-resistant feature.
10. Optional relay, isolator, and sounder bases.

D. Intelligent Addressable Aspiration Detector

The intelligent aspiration detector shall be an addressable aspiration detector that communicates directly with the fire alarm control panel via the SLC communication protocol, no modules or high-level interfaces shall be required. The aspiration detector shall have Infra- red laser optical smoke detection for a wide range of fire detection with enhanced immunity to nuisance particulates. The FACP shall be capable of monitoring and annunciating up to five smoke event thresholds and eleven trouble conditions. Each event threshold shall be capable of being assigned a discrete type ID at the FACP.

E. Intelligent Addressable Reflected Beam Detector.

The intelligent single-ended reflected beam smoke detector shall connect with two wires to the fire alarm control panel signaling line circuit (SLC). The detectors shall consist of a transmitter/receiver unit and a reflector and shall send data to the panel representing the analog level of smoke density. The detector shall be capable of being tested remotely via a key switch; It shall be equipped with an integral sensitivity test feature.

The Beam Detectors shall be long range, projected beam type smoke detectors which consist of a Transmitter and receiver in a single unit and reflector on the other side.

The Beam Detector shall have a range up to 100 mtrs. There shall be multiple sensitivity levels. Starting from 25 %, 30 %, 40 %, 50 % and acclimate levels also 30 % to 50 % and 40 % to 50 %. There shall be trouble alarm if obscuration block is more than 96 %.

F. Addressable Manual Call Point (MCP)

1. Addressable manual call point shall send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset

Sounders

Sounders shall operate on 24 VDC nominal. Sounders shall be field programmable without the use of special tools, to provide slow whoop, continuous, or interrupted tones with an output sound level of at least 90 dBA $\pm$ 2dBA @ 1 meters from the device, with a frequency response of 2000-8000 Hz with a lower power rating and shall also incorporate a suitable microphone for talk back to the control panel. Listed for fire services and protected against temperature effects. Failure of audio amplifiers shall result in trouble signal. Shall be flush or surface mounted as shown on plans.

Strobe cum Sounders

Strobe cum Sounder shall operate on 24 VDC nominal. A combined electronic sounder and flasher shall be capable of providing a minimum sound level of 90dBA $\pm$ 2dBA @ 1 meter. The sounder shall be capable of providing 4 different sound signals which are selected/configured from the device. The unit shall have its own microprocessor to handle loop communications and monitoring of the internal flasher element for faults in both the quiescent

and alarm conditions. The microprocessor shall also monitor the sound producing element during an alarm condition to ensure that faulty devices can be automatically identified during the weekly test procedure.

Addressable Dry Contact Monitor Module

Addressable monitor modules shall be provided to connect alarm initiating devices (any N.O. dry contact device).

The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box or with an optional surface back box.

The IDC zone shall be suitable for Class A or Class B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel

Addressable Control Module

Addressable control modules shall be provided to supervise and control the operation of one conventional notification audio/visual notification appliances.

The control module shall be wired with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation.

Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised remote power supply.

Addressable Relay Module

Addressable relay modules two form C relays rated at up to 24V 2 Amps resistive and up to 2.0 Amps inductive load.

Fault Isolator Module

Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on a loop Class A. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the loop segment or branch. At least one isolator module shall be provided for each set of detectors (max 20 numbers).

If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

Power Supply

1. The Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.

2. The Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual rate charging techniques for fast battery recharge.
3. The Main Power Supply provides a battery charger for 24 hours of standby using dual rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 7-200 amp-hours within a 48-hour period.
4. The Main Power Supply provides a very low frequency sweep earth detect circuit, capable of detecting earth faults.
5. The Main Power Supply shall be power limited per UL864 requirements.
6. The Main Power Supply shall communicate power supply, line voltage, battery status and charger status to the local LCD display. Any abnormal condition shall be annunciated and logged to the system alarm history log.
7. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means. Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire.
8. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.
9. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of zero, two, eight or sixteen hours shall be programmable.
10. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be programmable.
11. The addressable power supply mounts in either the FACP backbox or its own dedicated surface mounted backbox with cover.
12. Each of the power supply's four output circuits shall be programmed- for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.
13. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of an end-of-line resistor. When the power supply's output circuit is selected as General 24 VDC power, the circuit shall be individually supervised when an end-of-line relay is used.

14. When selected for Notification Appliance Circuits, the output circuits shall be individually programmable for Steady, March Time, Dual Stage or Temporal.
15. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
16. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.
17. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

Networking of Control Panels

The FACP shall communicate over a peer-to-peer communication network, inherently over a regenerative communication format and protocol. The network shall support communication speed up to 100 Mbps and support up to 200 Control Panels / Network Nodes, over a single medium (copper conductor / fiber optic), redundant ring, communication channel for fire alarm, voice evacuation and telephone talk-back system. The system shall support a minimum of 32 such networks in a single system.

The network card shall have inbuilt Fiber port for terminating Fiber Optic Cable without any third-party converters.

Batteries

The battery shall have sufficient capacity to power the fire alarm system for not less than 24 hours on standby plus 2 hours of alarm upon a normal AC power failure.

The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

If necessary to meet standby requirements, external battery and charger systems may be used.

Cables

- Supplying & laying of 2x1.5 sq.mm. Fire Survival Armoured cable, 600/1000V rated with annealed copper conductor having glass mica fire barrier tape covered by an extruded layer of Cross Linkable Ethylene Propylene Rubber (EPR) insulation and LSZH inner bedding, steel wire armouring & LSZH outer sheath complete as required.
- Supplying & laying of 4x1.5 sq.mm. Fire Survival Armoured cable, 600/1000V rated with annealed copper conductor having glass mica fire barrier tape covered by an extruded layer of Cross Linkable Ethylene

Propylene Rubber (EPR) insulation and LSZH inner bedding, steel wire armouring & LSZH outer sheath complete as required.

EXECUTION

Examination:

Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Proceed with installation only after unsatisfactory conditions have been corrected.

Installation:

Surface cabling should be neatly run and securely fixed at suitable intervals in accordance with the manufacturer's recommendations.

Joints in cables, other than those within equipment enclosures should be avoided wherever possible.

Where a cable passes through an external wall it should be contained in a smooth bore sleeve of metal or other non-hygroscopic material sealed into the wall. This material will slope downwards towards the outside and should be sealed with a suitable waterproof compound. Where cables, conduits or trunking pass through floors, walls, partitions, or ceilings the surrounding hole shall be made good with a fire stopping material with sufficient fire resistance to maintain the integrity of the construction.

Each junction box will include the legend "Fire Alarm System" on its cover.

All wires shall be provided with an identifying permanent label within 25mm of its termination.

A consistent color code for fire alarm conductors will be used throughout the installation. Wiring within enclosures will be arranged to allow accessibility to equipment for adjustment & maintenance.

Boxes, Enclosures & Wiring Devices

Boxes shall be installed plumb and firmly in position.

Extension rings with blank covers shall be installed on junction boxes where required. Junction boxes served by concealed conduit shall be flush mounted.

Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers installed. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.

Conductors

Each conductor shall be identified as shown on the drawings at each with wire markers at terminal points. Attach permanent wire markers within 5 cm of the wire termination. Marker legends shall be visible.

All wiring shall be supplied and installed in compliance with the requirements

of the Electrical Code and that of the manufacturer.

All splices shall be made using solderless connectors. All connectors shall be installed in conformance with the manufacturer recommendations.

Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.

The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.

Wiring within sub panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

Devices

Wiring within enclosures will be arranged to allow accessibility to equipment for adjustment & maintenance.

All devices shall be mounted to or in a suitable electrical box.

Commissioning

The entire system shall be inspected & tested to ensure that it operates in accordance with this specification and the country requirements. In particular that:

All manual call points & automatic fire detectors function correctly. All devices carry an accurate identification label.

All manual call points and automatic fire detectors when operated result in the correct text & zone indications at all necessary indicating equipment. That sound pressure levels meet as per requirements.

That the systems cause and effects match the requirements of this specification.

The sitting of all manual call points & automatic fire detectors meets the country requirements.

System shall be programmed as per approved cause & effect logic.

Documentation & Submittal

- Power calculations.
- Battery capacity calculations.
- Supervisory power requirements for all equipment.
- Alarm power requirements for all equipment.
- Justification showing power requirements of the system power supplies.
- NAC Circuit calculations.
- If external power supply is used than complete power requirement calculations should be submitted.
- Complete manufacturer's catalogue data including supervisory power usage, alarm power usage, physical dimensions, finish and mounting requirements.

- Submit panel configuration and interconnection of modules and all other data as required to make an informed judgment regarding product suitability. As a minimum, data shall be submitted on the following:
 - Main system including all fire detection with main and secondary control panels.
 - Circuit interface panels including all modules.
 - Power supplies, batteries and battery chargers.
 - Equipment enclosures.
 - Intelligent addressable manual pull stations, multi-criterion detectors, heat detectors, analogue smoke detectors, alarm monitoring modules, and supervised control modules.
 - Audible and visual evacuation signals and devices.
 - Software and firmware as required providing a complete functioning system.
 - Wiring.
 - System driven remote annunciators.
 - Interface module and wiring configuration from local system to Fire Command System
 - Submit copies of approval data showing compatibility of the proposed devices or appliances and the panels being provided
 - Submit the following shop drawings
 - Floor plans show all initiating, end of line, supervisory, indicating appliances, and output control devices; including circuit interface panels, enunciators, printers, Control panel location.
 - Raceways, marked for size, conductor count with type and size
 - Calculations and mathematical justification for audible devices shall meet the code Requirement of 15 dBA above ambient at 10 feet distance for audible warning signals
 - Wiring diagrams showing points of connection and terminals used for all electrical connections to the system devices and panels
 - Complete single-line riser diagram showing all equipment and the size and number of all conductors
 - Panel Network connectivity to be submitted.
 - Modbus Mapping List.
 - Cable Schedule for complete system.
 - Installation and Operation manual for the FAS system.
 - Cable Tray routing
 - Cause and Effect matrix to be submitted by vendor and to be validated by consultant.
 - FAT certificate

- SAT certificate
- Cable Glands sizes and back box drawings and details
- Submit Method Statement for systems component wiring, installation, testing, commissioning and operating
- Typical installation drawings
- GA diagram for all components
- Complete operation and maintenance manual with two sets of proposed installation drawings shall be submitted
- Warranty all system components, devices, peripherals, wiring, for Three years from date of practical completion Certificate
- Guarantee all wiring and raceways to be free from inherent mechanical or electrical defects for One year from date of practical completion Certificate

Training

Training shall be provided as follows:

The contractor shall provide full training on system operation & user responsibilities to at least two persons nominated by the customer.

Certification

Upon completion the contractor will provide the following certificates in accordance with the country regulation:

Installation certificate.

Commissioning certificate.

Acceptance certificate.

Verification certificate.

FAT certificate.

SAT certificate.

2. IP Closed Circuit Monitoring System

2.1 Scope

The scope of work shall include supply, installation, testing and commissioning of IP CCTV system which includes all indoor and outdoor cameras, indoor & outdoor Racks, Displays, External IR illuminator and control panels in accordance with the specifications, drawings and relevant tender documents, regardless of whether they are explicitly mentioned or not.

2.2 Codes, Standards and Rules

BSEN 50132-7 and any local regulations as applicable.

2.3 Approvals

CE Compliant FCC Class B

UL Listed

2.4 System Description

It is proposed to have Encoder based CCTV Surveillance system for the building. Only a Data point from NW Rack port shall be provided at the location of each encoder. The CCTV system installed will be integrated to the overall security management system & will provide a thorough level of coverage in and around the site while being seamlessly monitored from the security management system GUI.

The CCTV system will have the functionality be able to be utilized for described in BS-EN 50132-7 clauses 7.6.

- Identification (120% screen height)
- Recognition (50% screen height)
- Detection (10% screen height)
- Crowd Surveillance (5% screen height)
- Verification of Intruder Alarms and door contacts.

The CCTV system will be highly resilient with all the cameras providing high resolution images back to the Control Rooms for live viewing or digital recording on any of the high-resolution screens/ monitoring walls that will be installed. The lenses that have been specified within the specification will ensure optimum performance. Power over Ethernet has been considered for each camera with-in the building.

The CCTV system shall consist of;

- IP CCTV cameras (indoors and outdoors with housing), PTZ cameras.
- Network video Recorder.
- Client / Operator Workstations
- Monitors & Video modules/devices
- All interface elements, alarms GUI, wiring & cabling required to make system complete and fully functioning.

2.5 Special Requirements

A Fully networkable IP CCTV Surveillance system shall be installed throughout the facility as per requirement on IT Network. The Implementation Contractor shall provide a compact surge protection device for Ethernet lines. It should be

designed to protect Ethernet interfaces from damage caused by surges onto the line for outdoor cameras.

Design, Supply, installation of MS poles with proper red oxidized & steel grey colour/Guy Wire Supported and Self Support tower of adequate height as required at site. All accessories and fitting hardware such as brackets / poles together with associated masonry work are included in the scope of work.

The CCTV Rack will be placed as indicated in the drawings.

Apart from this CCTV monitoring room at Client specified area with P/T/Z joystick which would acts as a fall- back system for the CCTV surveillance system.

2.6 Material Specifications System Functionality

- The proposed CCTV System shall have IP Indoor / Outdoor, Dome / IR colour cameras connected to NVR on IP Network.
- The External cameras shall have Day/Night operation facility and automatic switching from Colour to black and white mode in the night.
- All equipment and materials used shall be standard components that are regularly manufactured and used in the manufacturer's system.
- All systems and components shall have been thoroughly tested and proven in actual use.
- All systems and components shall be provided with a one-day turnaround repair express and 24-hour parts replacement. The repair and parts express shall be guaranteed by the manufacturer on warranty and no warranty items.
- The Implementation Contractor shall ensure to upgrade the firmware and software of the latest version without commercial implications during Warranty period.
- The CCTV is required to supply the operator with the following information and facilities:
 - Display of images on monitors through commands given by the operator's keyboard.
 - Automatic camera selection, positioning and display to pre-set positions.
 - Remote camera, monitor and recording selection
 - Display of single and/or quadruplicated images on any selectable monitor. (Optional)

General Camera Requirements

- The camera shall provide automatic white balance, automatic exposure, automatic gain control, automatic electronic shutter, backlight

compensation, and motion detection. The camera shall also provide manual white balance

- The camera shall provide on-screen text displays. User and Administrator password protection levels shall be provided. A mechanical reset button shall be provided to return the camera to factory default settings.
- All cameras to be used with PoE feature and accordingly Network switch setup to be considered.

IR illuminator (Built-In or External) for applicable Camera

- Up to 75- & 100-meters IR range for external camera as applicable.
- Up to 20-meter range for internal camera.
- IR wavelength 850 nm & LED lifespan of minimum 20000 hrs
- Should improve image quality in complete darkness and/or in low-light conditions
- Must have Built-in sensor for automatically turn on illuminator at night and off during the daytime
- It Should have weather-proof design and IP66 rated.
- Should have 2-axis rotation for easy angle adjustment.
- It Must be designed to enhance low light performance.

2.6.1 Indoor IP Dome Camera

Parameter	Minimum Requirement	Specification	Compliance (Y/N)	Remarks
Type	IR Indoor IP Dome Camera			
Image sensor	1/2.8-inch CMOS Progressive Scan			
Focal length	4–10 mm (+/- 1 mm on each side) , MFZ			
Iris	P/DC-IRIS			
Resolution (No of Pixels)	2 MP			
IR distance	Smart IR 30m, Day and Night mode switching based on IR sensor or schedule.			
Removable IR-Cut Filter	Yes			
Minimum illumination	Color - 0.002 lux @ (color) B/W: 0Lux (@F1.4, IR on)			
Electronic Shutter	1/32000 ~ 1/30			
WDR	>120dB			
Video compression	H.265 HEVC / H.264 / MJPEG, Smart Codec			
Frame rate	25/30 fps			

Angle of View	H: 100° ~ 30°, V: 72° ~ 23°		
Protocols supported	IPv4, IPv6, TCP / IP, HTTP, HTTPS, UPnP, RTSP / RTP / RTCP, IGMP / Multicast, CIFS / SMB, SMTP, DHCP, NTP, DNS, DDNS, CoS, QoS, SNMP, 802.1X, UDP, ICMP, ARP, TLS		
Number of Streams supported	Primary, secondary and tertiary video streams; Each stream independently configurable with different resolutions and frame rate		
Features	Back light / High light compensation, Automatic white balance, Automatic Gain control, 3D Noise reduction, G-Sensor: Support camera direction OSD display		
Built-in Video Analytics	Video Tampering		
Event Type	Video motion detection, Periodically, Alarm input, System boot, Recording notification, Camera tampering detection		
Event Linkage	Event notification using digital output, HTTP, Email and MicroSD card		
Security	User account and password protection, HTTPS, IP Filter, Digest authentication, TLS1.2 only, Stream encryption, AES128 / 256, SSH / Telnet closed, PCIDSS compliance, FIPS Chipset Built-In		
Prohibited Protocols	Port 21 (FTP), Port 23 (Telnet), GB/T 28191, SSH. There should not be any provision to enable or disable these protocols in the default firmware from manufacturer. Any special firmware developed to disable these features will not be allowed.		
Defog	On/Off		
Privacy masking	5, Programmable		
Region of Interest	5, Programmable		

Local storage	Micro SD / SDHC / SDXC card slot (up to 256 GB), SD Card encryption		
Audio	Two-way (Line IN/OUT) supporting G.711A / G.711MU / G.726		
Built-in Microphone	Yes		
Alarm	2 In and 1 Relay out		
USB/ Micro-USB	Required		
Wi-Fi Dongle Support	Required for remote configuration of cameras for maintenance and troubleshooting		
IP	IP 67		
Impact protection	IK10		
Input voltage	12 VDC / 24 VAC, PoE (IEEE 802.3 af, Class 0)		
Power Consumption	Max 13-15 W		
Signal to Noise ratio	60dB		
ONVIF Compliance	ONVIF Profile S & G T Compliant		
Operating Temperature	-10°C to 60°C		
Operating Humidity	less than 90% (non-condensing)		
Certification	UL 62368-1 CE (EN 50130-4, EN 55032) FCC Part 15, NDAA and RoHS		

2.6.2 Indoor Mini Dome Camera

Parameter	Minimum Specification Requirement	Compliance (Y/N)	Remarks
Type	IR Indoor IP Mini Dome Camera		
Image sensor	1/2.8-inch CMOS Progressive Scan		
Lens	4–10 mm (+/- 1 mm on each side), MFZ		
Iris	P/DC-IRIS		
Resolution (No of Pixels)	2 MP (1920 x 1080)		
Minimum illumination	0.002 lux @ (color)		

	B/W: 0Lux (IR on)		
IR Illumination	Internal or External		
IR Illumination Range	15mtr distance from Camera to object		
Electronic Shutter	1/100000 ~ 1/3		
Back Light Compensation (BLC)	Required		
High Light Compensation (HLC)	Required		
Wide Dynamic Range (WDR)	WDR up to 120 dB		
Signal to Noise ratio	50dB		
Video compression	H.265+/H.265 / H.264 / MJPEG		
Frame rate	25 fps		
Angle of View	H: 110°, V: 58°		
Protocols supported	HTTP; HTTPs; TCP; ARP; RTSP; RTP; UDP; SMTP; FTP; DHCP; DNS; DDNS; PPPOE; IPv4/v6; QoS; UPnP; NTP; Bonjour; 802.1x; Multicast; ICMP; SNMP		
Event Type	Video motion detection, Periodically, Alarm input, System boot, Recording notification, Camera tampering detection		
Event Linkage	Event notification using digital output, HTTP, Email and MicroSD card		
Number of Streams supported	Triple video streams; Each stream independently configurable with different resolution and frame rate @ H.265. Should support minimum 2 streams at 1080p, 25 fps		

Features	Automatic white balance, 3D Noise reduction, Gain control, Color, Brightness, Sharpness, Contrast, fine tuning of behavior at low light, Rotation, Character overlay and all other Image Settings in Web UI		
Privacy Masking	Required, 4 areas		
Region of Interest	Required, 4 zones		
Edge Intelligence	Motion Detection, Camera Tampering,		
Event Type	SD card warning (Not present, Error, Capacity warning), Network disconnection, IP conflict, Illegal access		
Audio	Two-way (Line IN/OUT) supporting G.711A / G.711MU / G.726		
Event Linkage	Event notification by Email and MicroSD card recording, Snapshot (full resolution)		
Security and Encryption	User account and password protection, Digest authentication		
USB/ Micro-USB	AES 256 (Advanced Encryption System), TLS 1.2 (Transport Layer Security), HTTPS, IEEE 802.1x		
Wi-Fi Dongle Support	Hardware chipset for private key		
ONVIF Compliance	ONVIF Profile S & G T Compliant		
Prohibited Protocols	The Camera should not be complying with GB28181, GB/T 28181-2011; GBT 28181-2011; GB/T 28191 standards. There should not be any provision to enable or disable these protocols in the default firmware from manufacturer. Any special firmware developed to1 disable these features will not be		

	allowed.		
Local storage	There shall be no loss of recording during an event of connection failure between the edge device i.e. CCTV camera and the backend system. Each Camera should support 128GB Micro SDHC Card		
Ethernet	10 Base-T / 100 Base-TX Ethernet (RJ-45)		
Audio	Inbuilt Mic		
Environment	IP67 rated Ingress protection		
Impact Protection	IK10 rated Vandal resistance		
Defog	On/Off		
Input voltage	12 VDC, POE (802.3af, Class 0)		
Certification	UL 62368-1 CE (EN 50130-4, EN 55032) FCC Part 15, NDAA and RoHS		

2.6.3 Outdoor IP Bullet Camera

Parameter	Minimum	Compliance (Y/N)	Remarks
Type	Outdoor IR Network Bullet Camera		
Image sensor	1/2.8-inch CMOS Progressive Scan		
Focal length	4–10 mm (+/- 1 mm on each side) Autofocus MFZ lens		
Iris	P/DC-IRIS		
Resolution (No of Pixels)	2 MP		
Minimum illumination	0.002 lux @ (color)		
	B/W: 0Lux @F1.4 (IR On)		
IR Illumination	Internal or External		

IR Illumination Range	30 Mtr (+/- 5 Mtr) distance from Camera to object		
Electronic Shutter	1/100000 ~ 1/1		
Back Light Compensation (BLC)	Required		
High Light Compensation (HLC)	Required		
Wide Dynamic Range (WDR)	WDR up to 120 dB		
Signal to Noise ratio	50dB		
Video compression	H.265 HEVC / H.264 / MJPEG, Smart Codec		
Frame rate	25/30 fps		
Angle of View	H: 55° ~ 2° V:42° ~ 1.5°		
Protocols supported	IPv4, IPv6, TCP / IP, HTTP, HTTPS, UPnP, RTSP / RTP / RTCP, IGMP / Multicast, CIFS / SMB, SMTP, DHCP, NTP, DNS, DDNS, CoS, QoS, SNMP, 802.1X, UDP, ICMP, ARP, TLS		
Number of Streams supported	Primary, secondary, and tertiary video streams; Each stream independently configurable with different resolution and frame rate @ H.265		
Features	Automatic white balance, Automatic Gain control, 3D Noise reduction, G-Sensor: XYZ OSD display		
Built-in Video Analytics	Video Tampering		
Event Type	Video motion detection, Periodically, Alarm input, System boot, Recording notification, Camera tampering detection		
	User account and password protection, Digest authentication		

Security Encryption	and	Built-In encryption chip with Federal Information Processing Standard (FIPS)		
		AES 256 (Advanced Encryption System), Stream Encryption, TLS 1.2 (Transport Layer Security), HTTPS		
Prohibited Protocols		Port 21 (FTP), Port 23 (Telnet), GB/T 28191, SSH. There should not be any provision to enable or disable these protocols in the default firmware from manufacturer. Any special firmware developed to disable these features will not be allowed.		
Defog		On/Off		
Electronic Image Stabilization		Yes		
Privacy masking		24, Programmable		
Pan Range		360° endless		
Tilt Range		-20° to 90° (view above horizon) with auto flip		
Pan Speed		Very High Speed and quick response rotation up to 400°/sec		
Tilt Speed		Very High Speed and quick response Tilt up to 350°/sec		
Presets		256		
Auto Pan Mode		Required		
Auto Tracking		Required		
Local storage		There shall be no loss of recording during an event of connection failure between the edge device i.e. CCTV camera and the backend system. Each camera should support 256GB Micro SD Card		
Ethernet		10 Base-T / 100 Base-TX Ethernet (RJ-45)		
Audio		Two-way (Line IN/OUT)		

	supporting G.711 / G.726		
Alarm	2 In and 1 Relay out		
USB/ Micro-USB	Required		
Wi-Fi Dongle Support	Required for remote configuration of cameras for maintenance and troubleshooting		
Environment	IP66 and NEMA 4X rated outdoor protection		
Impact Protection	IK10 rated vandal protection		
Heater	Yes		
Gore Vent	Required		
Input voltage	24 VDC / 24 VAC, High POE		
Power Consumption	Max 55 W (Heater On)		
ONVIF Compliance	ONVIF Profile S & G T M Compliant		
Operating Temperature	-40°C to 60°C		
Operating Humidity	less than 90% (non-condensing)		
Compliance	UL 62368-1 CE (EN 50130-4, EN 55032) FCC Part 15, NDAA and RoHS		

2.6.4 Outdoor IP Bullet Camera

Parameter	Minimum	Compliance (Y/N)	Remarks
Type	Outdoor IR Network Bullet Camera		
Image sensor	1/2.8-inch CMOS Progressive Scan		
Focal length	8–80 mm (+/- 1 mm on each side) Autofocus MFZ lens		
Iris	P/DC-IRIS		
Resolution (No of Pixels)	4MP (2560 x 1440)		
Minimum illumination	0.002 lux @ (color)		
	B/W: 0Lux @F1.4 (IR On)		
IR Illumination	Internal or External		
IR Illumination Range	Min 60 Mtr (+/- 5 Mtr) distance from Camera to object		
Electronic Shutter	1/100000 ~ 1/1		
Back Compensation (BLC)	Light Required		

High Light Compensation (HLC)	Required		
Wide Dynamic Range (WDR)	WDR up to 120 dB		
Signal to Noise ratio	50dB		
Video compression	H.265 HEVC / H.264 / MJPEG, Smart Codec		
Frame rate	25/30 fps		
Angle of View	H: 55° ~ 2° V:42° ~ 1.5°		
Protocols supported	IPv4, IPv6, TCP / IP, HTTP, HTTPS, UPnP, RTSP / RTP / RTCP, IGMP / Multicast, CIFS / SMB, SMTP, DHCP, NTP, DNS, DDNS, CoS, QoS, SNMP, 802.1X, UDP, ICMP, ARP, TLS		
Number of Streams supported	Primary, secondary, and tertiary video streams; Each stream independently configurable with different resolution and frame rate @ H.265		
Features	Automatic white balance, Automatic Gain control, 3D Noise reduction, G-Sensor: XYZ OSD display		
Built-in Video Analytics	Video Tampering		
Event Type	Motion Detection, Video Tampering; Perimeter crossing, enter filed, follow route, Loitering, Emergency exit block, People counting, Crowd density estimation, Object classification such as (Persons, Bikes, Cars, Trucks)		
Security and Encryption	User account and password protection, Digest authentication		
Prohibited Protocols	Built-In Encryption Chip with Federal Information Processing Standard (FIPS)		
	AES 256 (Advanced Encryption System), Stream Encryption, TLS 1.2 (Transport Layer Security), HTTPS		

	Port 21 (FTP), Port 23 (Telnet), GB/T 28191, SSH. There should not be any provision to enable or disable these protocols in the default firmware from manufacturer. Any special firmware developed to disable these features will not be allowed.		
Defog	On/Off		
Electronic Image Stabilization	Yes		
Privacy masking	24, Programmable		
Pan Range	360° endless		
Tilt Range	-20° to 90° (view above horizon) with auto flip		
Pan Speed	Very High Speed and quick response rotation up to 400°/sec		
Tilt Speed	Very High Speed and quick response Tilt up to 350°/sec		
Presets	256		
Auto Pan Mode	Required		
Auto Tracking	Required		
Local storage	There shall be no loss of recording during an event of connection failure between the edge device i.e. CCTV camera and the backend system. Each camera should support 256GB Micro SD Card		
Ethernet	10 Base-T / 100 Base-TX Ethernet (RJ-45)		
Audio	Two-way (Line IN/OUT) supporting G.711 / G.726		
Alarm	2 In and 1 Relay out		
USB/ Micro-USB	Required		
Wi-Fi Dongle Support	Required for remote configuration of cameras for maintenance and troubleshooting		
Environment	IP66 rated outdoor protection		
Impact Protection	IK10 rated vandal protection		
Heater	Yes		
Gore Vent	Required		
Input voltage	24 VDC / 24 VAC, High POE		
Power Consumption	Max 55 W (Heater On)		
ONVIF Compliance	ONVIF Profile S & G T M Compliant		
Operating Temperature	-40°C to 60°C		
Operating Humidity	less than 90% (non-condensing)		

Compliance	UL 62368-1 CE (EN 50130-4, EN 55032) FCC Part 15, NDAA and RoHS		

2.6.5 Outdoor IP PTZ Camera

Parameter	Minimum Specification Requirement	Compliance (Y/N)	Remarks
Type	Outdoor IR Network Pan-Tilt-Zoom Camera		
Image sensor	1/2.8-inch CMOS Progressive Scan		
Focal length	4.9~148mm (+/- 1mm on each side) Autofocus MFZ lens		
Iris	P/DC-IRIS		
Resolution (No of Pixels)	5 MP (3072x1728)		
Minimum illumination	Color: 0.05 Lux @F1.4 B/W: 0Lux @F1.4 (IR on)		
IR Illumination	Internal or External		
IR Illumination Range	500 feet (+/- 10 feet) distance from Camera to object		
Electronic Shutter	1/100000 ~ 1/1		
Back Light Compensation (BLC)	Required		
High Light Compensation (HLC)	Required		
Wide Dynamic Range (WDR)	WDR up to 120 dB		
Signal to Noise ratio	50dB		
Video compression	H.265 HEVC / H.264 / MJPEG, Smart Codec		
Frame rate	25/30 fps		
Angle of View	H: 55° ~ 2° V:42° ~ 1.5°		
Protocols supported	IPv4, IPv6, TCP / IP, HTTP, HTTPS, UPnP, RTSP / RTP / RTCP, IGMP / Multicast, CIFS / SMB, SMTP, DHCP, NTP, DNS, DDNS, CoS, QoS, SNMP, 802.1X, UDP, ICMP, ARP, TLS		
Number of Streams supported	Primary, secondary, and tertiary video streams; Each stream independently configurable with different resolution and frame rate		

	@ H.265		
Features	Automatic white balance, Automatic Gain control, 3D Noise reduction, G-Sensor: XYZ OSD display		
Built-in Video Analytics	Intrusion, Loiter, Line crossing, Unattended object, Missing object, Face detection		
Event Type	Video motion detection, Periodically, Alarm input, System boot, Recording notification, Camera tampering detection		
Security and Encryption	User account and password protection, Digest authentication		
	Built-In encryption chip with Federal		
	Information Processing Standard (FIPS)		
	AES 256 (Advanced Encryption System), Stream Encryption, TLS 1.2 (Transport Layer Security), HTTPS		
Prohibited Protocols	Port 21 (FTP), Port 23 (Telnet), GB/T 28191, SSH. There should not be any provision to enable or disable these protocols in the default firmware from manufacturer. Any special firmware developed to disable these features will not be allowed.		
Defog	On/Off		
Electronic Image Stabilization	Yes		
Privacy masking	24, Programmable		
Pan Range	360° endless		
Tilt Range	-20° to 90° (view above horizon) with auto flip		
Pan Speed	Very High Speed and quick response rotation up to 400°/sec		
Tilt Speed	Very High Speed and quick response Tilt up to 350°/sec		
Presets	256		
Auto Pan Mode	Required		

Auto Tracking	Required		
Local storage	There shall be no loss of recording during an event of connection failure between the edge device i.e. CCTV camera and the backend system. Each camera should support 256GB Micro SD Card		
Ethernet	10 Base-T / 100 Base-TX Ethernet (RJ-45)		
Audio	Two-way (Line IN/OUT) supporting G.711 / G.726		
Alarm	2 In and 1 Relay out		
USB/ Micro-USB	Required		
Wi-Fi Dongle Support	Required for remote configuration of cameras for maintenance and troubleshooting		
Environment	IP66 and NEMA 4X rated outdoor protection		
Impact Protection	IK10 rated vandal protection		
Heater	Yes		
Gore Vent	Required		
Input voltage	24 VDC / 24 VAC, High POE		
Power Consumption	Max 55 W (Heater On)		
ONVIF Compliance	ONVIF Profile S & G T M Compliant		
Operating Temperature	-40°C to 60°C		
Operating Humidity	less than 90% (non-condensing)		
Compliance	UL 62368-1 CE (EN 50130-4, EN 55032) FCC Part 15, NDAA and RoHS		

2.6.6 IP Bullet ANPR (Automatic Number Plate Recognition) Camera

Parameter	Minimum	Compliance (Y/N)	Remarks
Type	IR Network Bullet camera		
Image sensor	1/1.8-inch CMOS Progressive Scan		
Focal length	8–80 mm (+/- 1 mm on each side) Autofocus MFZ lens		
Iris	P /DC-IRIS		
Resolution (No of Pixels)	4 MP		
Minimum illumination	Color: 0.005 Lux @ colour B/W: 0Lux @F1.4 (IR on)		

IR Illumination	Internal or External		
IR Illumination Range	30 Mtr (+/- 5 Mtr) distance from Camera to object		
Electronic Shutter	1/25000 ~ 1/1		
Back Light Compensation (BLC)	Required		
High Light Compensation (HLC)	Required		
Wide Dynamic Range (WDR)	WDR up to 130 dB		
Signal to Noise ratio	50dB		
Video compression	H.265 HEVC / H.264 / MJPEG, Smart Codec		
Frame rate	25/30 fps		
Angle of View	H: 55° ~ 2° V:42° ~ 1.5°		
Protocols supported	IPv4, IPv6, TCP / IP, HTTP, HTTPS, UPnP, RTSP / RTP / RTCP, IGMP / Multicast, CIFS / SMB, SMTP, DHCP, NTP, DNS, DDNS, CoS, QoS, SNMP, 802.1X, UDP, ICMP, ARP, TLS		
Number of Streams supported	Primary, secondary, and tertiary video streams; Each stream independently configurable with different resolution and frame rate @ H.265		
Features	Automatic white balance, Automatic Gain control, 3D Noise reduction, G-Sensor: XYZ OSD display		
Built-in Video Analytics	Video Tampering		
Event Type	Intrusion Detection, Loiter Detection, Line crossing, Face Detection, Object left unattended, Object Removed, Motion Detection, tampering detection; Should also support license-based edge processing for License plate recognition,		

	People recognition, Face recognition		
Security and Encryption	User account and password protection, Digest authentication		
	Built-In encryption chip with Federal Information Processing Standard (FIPS)		
	AES 256 (Advanced Encryption System), Stream Encryption, TLS 1.2 (Transport Layer Security), HTTPS		
Prohibited Protocols	Port 21 (FTP), Port 23 (Telnet), GB/T 28191, SSH. There should not be any provision to enable or disable these protocols in the default firmware from manufacturer. Any special firmware developed to disable these features will not be allowed.		
Defog	On/Off		
Electronic Image Stabilization	Yes		
Privacy masking	4, Programmable		
Local storage	There shall be no loss of recording during an event of connection failure between the edge device i.e. CCTV camera and the backend system. Each camera should support 256GB Micro SD Card		
Ethernet	10 Base-T / 100 Base-TX Ethernet (RJ-45)		

Audio	Two-way (Line IN/OUT) supporting G.711 / G.726		
Alarm	1 In and 1 Relay out		
USB/ Micro-USB	Required		
Wi-Fi Dongle Support	Required for remote configuration of cameras for maintenance and troubleshooting		
Environment	IP67 and NEMA 4X rated outdoor protection		
Impact Protection	IK10 rated vandal protection		
Heater	Yes		
Gore Vent	Required		
Input voltage	24 VDC / 24 VAC, High POE		
Power Consumption	Max 55 W (Heater On)		
ONVIF Compliance	ONVIF Profile S & G T M Compliant		
Operating Temperature	-40°C to 60°C (As per site condition)		
Operating Humidity	less than 90% (non-condensing)		
Compliance	UL 62368-1 CE (EN 50130-4, EN 55032) FCC Part 15, NDAA and RoHS		

2.6.7 Storage Capacity Calculations & Specifications:

Standard & Mega pixel IP Cameras:

- **The Standard & Mega pixel IP Cameras Must Record at a Resolution of Minimum 2 MP**
- **The Frame rate used for Recording must be 25 FPS.**
- **Recording Compression is H.265**
- **Duration of Recording is 31 Days**
- **Time Frame for Recording is 24 Hours**

Storage Capacity & Configuration:

- The implementation contractor is requested to Calculate & Size of Storage based on requirements and must give Compliance to the 31 Days Storage requirement based on the above-mentioned details. The Storage can be Within the NVR or as a Network Attached Storage with SATA HDD (maintaining block size of video file to be written / accessed).

- The storage shall have array with RAID-5 configuration and hot-spare hard disk provision.

2.6.8 Network Video Recorder

Recording Server shall operate with no performance degradation using the following minimum hardware and operating system configuration.

Details	Specification	Compliance	Deviation
Channels	32 channels		
Recording	32 channels @ 1920 * 1080 (1080P) @ 25fps (min)		
Processor & OS	Quad-core embedded processor, Linux Embedded/ Window based		
Video Compressing	H.265/H.264/MJPEG/MPEG4		
Audio Support	Yes, 1 Channel Input/1 Channel Output, RCA		
Recording Modes	Manual, Motion/Alarm Triggered		
Search Mode Support	Time/Date; Alarm; Motion Detection (MD); Exact Search (accurate to a second); Smart Search		
On board Storage slots	08 with SATA interface		
On board Storage Capacity	64 TB or higher over SATA		

HDD RAID Support	1,5,6,10		
Throughput/Bandwidth	312 Mbps		
Event Triggers	Recording; PTZ; Tour; Alarm; Video Push; Email; FTP; Snapshot; Buzzer		
Event Notification	email, FTP, and/or HTTP, still image upload		
Network Protocol Support	IPv4, IPv6, TCP, UDP, HTTP, DHCP, DNS, DDNS, RTP, RTCP, RTSP, PPPoE, FTP, NTP, SNTP, VSIP, ICMP		
Network Interface	1x Gigabit Ethernet (RJ45) (10/100/1000)		
POE Ports	16 POE Port to connect POE camera directly to NVR (IEEE802.3af/at)		
USB Ports	04 Ports		
HDMI out	2 HDMI (1 HDMI up to 3840 × 2160)		
VGA out	1 or more (1080p @ 60Hz)		
Display Split	1/4/8/9/16/25/36		
Smart Phone Remote Access	Android & iOS		
Form Factor	4U or less		
Operating Temperature range	-10°C to 55°C or wider range		
Operating Humidity range	10-90%		
Electrical System	220v @ 50Hz, tolerant to +- 40v		
Alarm Inputs	16 Potential Free I/P		
Alarm Outputs	6 Relay Output		
Remote Access	On Web Client and Mobile App		
Certification	UL, CE, FCC, RoHS		

CLIENT WORK STATION HARDWARE

- Workstation shall operate with no performance degradation using the following minimum hardware and operating system configuration.

Details	Specification	Compliance	Deviation
Make& Model	Vendor should specify, data sheet to be supplied.		
Processor	Intel core i7-8700 or higher		
Clock Speed	3.2 GHz or higher		
RAM	Minimum 8 GB DDR4		
OS	Genuine Microsoft Windows® 10 Enterprise 64-bit or latest		
Display Adaptor (GPU)	Integrated Intel UHD graphics 630		
Video Output	HDMI		
Optical Drives	DVD Writer (Optional)		
HDD	500 GB 7200RPM SATA3 /SSD		
Ethernet	min 1 nos of 10/100/1000, Auto Negotiating Ethernet controller		
USB Port	2 USB 2.0 and 2 USB 3.0		
Audio	Line In / Line Out, 3.5mm jack		
Regulatory	CE/EN, FCC, UL		
Approved Makes	DELL / HP/ IBM		
Warranty (Year)	Minimum 01 years or as per OEM standard whichever is higher		
OEM Authorization Letter - Manufacturer Authorization Form (MAF)	Vendor has to submit MAF along with the Technical Specification.		

2.6.9 42" Narrow bezel

2.6.10 LCD TV – For CCTV Monitoring

Professional 42 Inch LED Monitor/ Display Panel			
Sr.No	Specification	Compliance (Only Yes or No)	Deviation/Remarks

1	The Diagonal Size of the display should be 42"		
2	The Display should support true resolution of 1920X1080 pixels		
3	The display should have the following input terminals.		
	a) VGA Port		
	b) USB Port		
	c) HDMI		
	d) AV Port		
	e) Lan Port RJ45		
4	The LED should have in-built speakers (minimum 10Wx 2)		
5	The display should have the following standards certification		
	a) RoHS complaint - For environment		
	b) UL/IEC- For safety		
	c) FCC - For radiations regulation		
	d) Energy Star 5.0 Certified		

2.6.11 **ANPR MINIMUM SERVER SPECIFICATIONS**

- ANPR Server & Software using the following minimum hardware and operating system configuration.

Details	Specification	Compliance	Deviation
Make& Model	The vendor should specify, data sheet to be supplied.		
Processor	Intel Xeon Silver or i7/i9 (12th/13th Gen) At least 6–8 cores (more if multiple streams and heavy AI processing)		
RAM	16GB to 64GB DDR4/DDR5, 4GB per camera is a good starting point for AI/ANPR processing.		
Graphics (GPU)	(only if using GPU-based ANPR/AI models) NVIDIA RTX 3060/4060 or A6000 (for intensive deep learning inference) For basic Open		

	ANPR or plate-reading software, GPU is optional		
Storage	SSD (OS + ANPR software): 500GB – 1TB		
HDD (video storage):	Depends on retention: minimum 10–20TB - Use RAID 5/6 for redundancy		
Network Interface:	Dual 1GbE NIC (minimum) For high-density systems, consider 10GbE NIC		
Power Supply & UPS:	Redundant PSU if uptime is critical, UPS backup to handle clean shutdown or short outages		
Operating System:	Windows Server 2019/2022 or Linux (Ubuntu/CentOS) depending on the software, Some ANPR systems are built to run on Docker/Linux environments		
Warranty (Year)	Minimum 01 years or as per OEM standard whichever is higher		
OEM Authorization Letter Manufacturer Authorization Form (MAF)	- Vendor has to submit MAF along with the Technical Specification.		

2.6.12 Pole for Cameras (Double & Single Sided Arm)

Sr. No	Details	Specification	Compliance	Deviation
1	Octagonal Pole	9/6 Mtrs		
2	Overall height of Pole (mtrs)	9/6 Mtrs		
3	Dimension	Bottom Dia 200 mm, Top Dia 100 mm		
4	Base Plate & Thickness	240*240 mm, 16 mm		

5	Foundation Bolts	M24*750mm long with three Nut & 2 Plain washer 4Sets		
6	Metal Protection Treatment of Pole Sections	Hot Dip Galvanized as per BSEN ISO 1461		
7	Thickness of Galvanization (mm)	Average 70 Microns as per IS 2629		
8	Welding	Single longitudinal welding		
9	Size of Door opening the Base Section	100 mm * 400 mm		
10	Type of Door construction & locking arrangement	Close fitting door with suitable reinforcement to avoid buckling		
11	Material of construction of shaft	As per BSEN 10025/For Shaft, IS 2062 For Base Plate		
12	Cross Section of Pole	Octagonal		
13	Max. design of Pole	50m/sec as per IS 875 (Part - III)		
14	Gust Speed time considered	3 sec		
15	Height above ground level at which wind velocity is measured	6 to 9 Mtrs		
16	Factor of safety for wind load	1.25		
17	Factor of safety for others load	1.15		
18	Type of Foundation	M-24 (Nut Bolt 8N8 Grade) cement Concrete Foundation for 9 mtr Galvanized Octagonal Pole. Foundation Size 360*360*1000 mm including Excavation in Hard Murum or Tar/Metal Road as per requirement complete with the steel		

2.6.13 **Cables**

Internal Cameras – CAT -6 UTP cable.

External Cameras –

CAT -6 UTP Armoured cable.

Commissioning

The entire system shall be inspected & tested to ensure that it operates in accordance with this specification and the country requirements. In particular that:

All Cameras, NVR, VMS client workstations should function correctly. All devices carry an accurate identification label. That sound pressure levels meet as per requirements.

Documentation & Submittal.

- Power calculations.
- Coverage Diagram with selection of lens should be shown.
- Submit copies of approval data showing compatibility of the proposed cameras or appliances and the NVR's & VMS recording server being provided.
- Submit the following shop drawings.
- Raceways, marked for size, conductor count with type and size.
- Wiring diagrams showing points of connection and terminals used for all electrical connections to the system devices and panels.
- Complete single-line riser diagram showing all equipment and the size type and number of all conductors.
- Complete Network connectivity to be submitted.
- Cable Schedule for complete system.
- Installation and Operation manual for the CCTV system.
- Cable Tray routing
- FAT certificate
- SAT certificate
- Cable Glands sizes and back box drawings and details
- Submit Method Statement for systems component wiring, installation, testing, commissioning, and operating.
- Typical installation drawings
- GA diagram for all the components
- Complete operation and maintenance manual with two sets of proposed installation drawings shall be submitted.
- Warranty all system components, devices, peripherals, wiring, for Three years from date of practical completion Certificate

- Guarantee all wiring and raceways to be free from inherent mechanical or electrical defects for One years from date of practical completion Certificate.

Training

Training shall be provided as follows:

The contractor shall provide full training on system operation & user responsibilities to at least two persons nominated by the customer.

Certification

Upon completion the contractor will provide the following certificates in accordance with the country regulations:

Installation certificate.

Commissioning certificate.

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3. Public Address System

1.1 **Scope**

The scope of work shall include supply, installation, testing and commissioning of fully functional Public Address system which includes but not limited to Speakers, Amplifiers, other related hard wares, Control panels

etc. in accordance with the specifications, drawings and relevant tender documents, regardless of whether they are explicitly mentioned or not.

1.2 Codes, Standards and Rules

The system shall be designed and installed in accordance with NBC, IS and NFPA standards and relevant local regulations also shall be referred as applicable. All speakers should be designed to withstand operating at their rated power in accordance with Power Handling Capacity (PHC) standards. All samples shall be produced for approval before placement of order.

1.3 System Description

The Public address system shall provide digital audio signal processing & transmission of audio signals via a simple network. The Public Address Master Call station would be housed in PA rack which consist of Amplifier, Controller, AMG, Local call station etc.

The PA system shall consist of.

- PA Rack/Cabinets consists of Network Controller, Amplifier, Audio expander etc.
- Speakers.
- Local & remote Zone Call stations

The Public Address System shall serve to.

- Make general or emergency announcement.
- Transmit fire tone under fire condition.

Different levels of priorities as per following shall be allotted to different signals for transmission through the same speaker.

- Emergency announcements - highest priority.
- Fire tone/Paging – Next

A signal from Fire Alarm System shall initiate announcements of pre-recorded message in all the groups/zones in case of fire. This emergency announcement shall have highest priority.

The system shall be capable of broadcasting different pre-recorded messages to different zones or group of zones simultaneously. The system should be designed & programmed for systematic evacuation. The system shall be capable of sending messages automatically to any zone at any time interval, without affecting the other areas.

The speakers shall be distributed in the entire building and configured in different zones. The announcement shall be made in Individual mode i.e. one zone at a time or to all zones simultaneously in ALL CALL mode.

All system components shall be digitally monitored including and not limited to, Messages, Amplifiers, and back up amplifiers, Speaker Circuits, Control Unit, Paging Microphone, Battery Charger and the 230VAC line. Each amplifier

/ line circuit shall be monitored individually and shall report any faults back to the Network Control Unit as well as the Paging Microphone.

Each Zone shall have separate amplifier, system sharing of amplifiers to multiple zones are not acceptable. All amplifier gain shall be monitored and measured for open, short or earth faults. The systems shall be capable of broadcasting different pre-recorded messages to different zones or group of zones simultaneously. In addition, a FIRE DRILL, BOMB ALERT, EARTHQUAKE ALERT and an ALL-CLEAR message shall be incorporated into the operation. The System can provide any Cause & Effect programs after integrating with the Fire Alarm System, thus Alert/Evacuate messages can be programmed and delayed as well as played on any groups/ zone as per the Cause & Effect approved by the Consultant/Company/PMC.

The Battery Backup shall provide 48 hours of back up in standalone and 30 minutes of alarm operation. NICD type Battery shall be provided for complete PA system operation. Battery calculations shall be submitted by the Implementation Contractor.

1.4 Material Specifications

1.4.1 Speakers

Speakers shall be in metal enclosures with their line matching transformers. They shall be interconnected in the zone configurations.

1.4.1.1 Ceiling Mounted Speakers

The speaker shall be suitable for flush mounting to a false ceiling of any configuration. It shall be equipped with a multiple tapping matching transformer to provide easy control of speaker sound volume. Supporting brackets to mount the speaker onto false ceilings of different configurations shall be provided.

It shall satisfy the following performance characteristics.

Specification	6" two- way speakers
Frequency Response	70-15000 Hz
Power Handling Capacity	6W/10W
Tapping	Rated Power, Watts 6 @ 6/3/1.5/tapings
Sound Pressure Level	SPL @ 1m, 1Watt, dB, (SPL @ full power Octave Bandwidth shall be 96 dB, 1W/1M)

Mounting	Clamp Type

1.4.1.2 Wall Mounted Speakers

The Wall mount speaker should be with extended uniform frequency response & small in size. The speaker must be provided with a ball jointed uni-directional bracket enabling adjustment in both the vertical and horizontal plane. The speaker bracket must allow for easy access for adjustment before and after it has been installed. It shall satisfy the following performance characteristics.

Specification	6" two-way speakers
Frequency Response	200-15000 Hz
Power Handling Capacity	6W
Tapping	Rated Power, Watts 6 @ 6/3/1.5/tapings
Sound Pressure Level	SPL @ 1m, 1Watt, dB, (SPL @ full power Octave Bandwidth shall be 97 dB, 1W/1M)
Mounting	ABS Moulded Housing & Mounting Die-Cast Aluminum Swivel Bracket

1.4.1 Amplifiers

The main function of the amplifier is the amplification of audio signals for the loudspeakers. Each amplifier module is fitted with its own 220VAC/24VDC power supply for increase of system reliability. No fan / forced cooling is required.

The unit shall operate on minimum 85% efficiency. These amplifiers shall be designed to accept the input sources i.e., Microphone/CD player/Fire tone generator. The output is having a 100 Volts line to take care of line drop. The Amplifiers shall be stacked in the 19" rack system.

The amplifier must have the minimum following characteristics:

- 120W, 240W and 480W range of Booster amplifiers or 4x120W, 2X240W or 1x480W Digital Amplifier.
- 100V line output
- Thermostatic Ventilation
- Amplifier Status Led / contacts.
- Frequency response 40-20KHz

- Distortion at nominal power <1%
- Signal/noise ratio: >90dB.
- Resettable circuit breaker for protection against overload and short Circuit
- Tone controls: Bass and Treble
- Single Channel/ 2 Channel/ 4 Channel as per OEM configuration

1.4.2 Call station & keypad.

The call station shall be used for making a manual or pre-recorded call to any pre-assigned zones or executing a predefined action. The call station keypad should be used in combination with the call station basic unit for making a manual or pre-recorded call to any pre-assigned additional zones.

The call station shall have a fixed microphone to transmit speech over the network and a press-to-talk key. The call station shall also have a headset socket. Once the headset is connected the microphone will be muted.

1.4.3 Equipment Rack

- Rack assembly shall stack the public addressing amplifiers.
- Rack shall have different channels for AC mains cable and Audio Signal Cables.
- Rack shall be provided with wheels and with one lockable rear door.
- The rack shall be operating on 230 VAC.
- Internal power strip shall be provided.
- IU blank plate should be used for the ventilation between each the equipment installed in the rack

1.4.4 Switcher Console

- The heart of the entire public addressing system is the Switcher Console I.e. Network Controller.
- One microphone should be given for announcements.
- The selection of Music or Announcements shall be done by console through a hardware or software switching facility.
- The system shall make provision for dual channel output i.e. both music and audio announcement

shall be made for the entire system.

- The control console shall make announcement such as Music, Fire or announcements individual zone wise.
- The console shall have keypads on a sloped surface. The switches are having respective LED's.
- The Switcher should have individual Zone button, all zone button & respective LED for visual indication.
- The Switcher Console should have priority interface port.

1.4.5 The different modes of transmission in P.A System Announcements

Announcements can be made through the microphone and by selecting the required zones. Announcements can be made by individual or all call

mode.

Multiple sources of announcements (Call Stations) to be defined.

1.4.6 Spare Capacity

Each Speaker circuit shall have 20% spare capacity for adding additional speakers whenever required and each PA console should have 20% spare circuits.

1.4.7 Cables

2 Core X 1.5 sq.mm, 48/0.2mm (15 AWG). Multi-stranded shielded Insulated Straight Fire rated Armoured Cable from Amplifier to Speaker & between Speakers. (Colour: Yellow).

Commissioning

- The entire system shall be inspected & tested to ensure that it operates in accordance with this specification and the country requirements. In particular, that:
- All speakers, console & amplifiers should function correctly.
- All devices carry an accurate identification label.
- That sound pressure levels meet as per requirements.
- That the systems cause and effects match the requirements of this specification.
- The sitting of all speakers should meet the country requirements.
- The system shall be programmed as per approved cause & effect logic.

Documentation & Submittals

- Power calculations.
- Battery capacity calculations.
- Supervisory power requirements for all equipment.
- Power requirements for all equipment.
- Justification showing power requirements of the system power supplies
- Circuit interface panels including all modules.
- Power supplies, batteries and battery chargers.
- Equipment enclosures.
- Software and firmware as required providing a complete functioning system.

Wiring.

- Wattage Calculations.
- Amplifier power Calculations
- Interface module and wiring configuration from local system to Fire Command System
- Submit copies of approval data showing compatibility of the proposed devices or appliances and the console being provided.
- Submit the following shop drawings.
- Raceways, marked for size, conductor count with type and size.

- Wiring diagrams showing points of connection and terminals used for all electrical connections to the system devices and panels.
- Complete single-line riser diagram showing all equipment and the size type and number of all conductors.
- Console Network connectivity to be submitted.
- Cable Schedule for complete system.

Installation and Operation manual for the Pas system.

- Cable Tray routing
- Cause and Effect matrix to be submitted by vendor and to be validated by consultant.
- FAT certificate
- SAT certificate
- Cable Glands sizes and back box drawings and details
- Submit Method Statement for systems component wiring, installation, testing, commissioning and operating.

Typical installation drawings

- GA diagram for all the components
- Complete operation and maintenance manual with two sets of proposed installation drawings shall be submitted.
- Warranty all system components, devices, peripherals, wiring, for Three years from date of practical

completion Certificate

- Guarantee all wiring and raceways to be free from inherent mechanical or electrical defects for One years from date of practical completion Certificate.

Training

Training shall be provided as follows:

The contractor shall provide full training on system operation & user responsibilities to at least two persons nominated by the customer.

Certification

Upon completion the contractor will provide the following certificates in accordance with the country regulations:

Installation certificate.

Commissioning certificate.

Acceptance certificate.

Verification certificate.

FAT certificate.

SAT certificate

2.0 Exit Signages

The following Codes and Standards are being used for fire and safety Signage's IS 9457: 1980 Safety Color and Safety Signs IS 12349 1988 Fire Protection–Safety Signs

The Battery-Operated LED signages for evacuation of each floor level shall be provided in position. The LED sign boards made of Aluminum housing, Exit Legend with clear acrylic / engraved pattern to be fully compliant with requirements of Design & Installation to meet Fire & Life Safety Code of Practice.

2.1 Technical Specifications of Photoluminescent / Single Sided Exit Signages

Description – Flexile Photoluminescent Based Glow in the dark Sheeting with Luminous Properties enclosed in a weatherproof UV Screen printing with imported ink.

- Thickness - 0.2 mm (+/-10%)
- Service Temp.- -20 to +80°C.
- Application - Suitable for Indoor Use only
- Surface Color - Greenish yellow
- Visibility - Glow Visible up to > 24 Hours in Total Darkness
- Properties should have Fungistatic, Nontoxic, Non-Radioactive, Contains no Lead or Phosphorus, No Health, or Environmental Problems
- It must be simple to install & easy to maintain.
- Should be Self Extinguishing
- Life > 7-10 Years in Indoor Conditions

3.0 Approved Make List For ELV

ELV LIST OF MAKE RECOMMENDED		
A: FIRE DETECTION & ALARM SYSTEM		
Sr. No.	Item Name	Makes
1	FIRE ALARM CONTROL PANEL.	NOTIFIER, SIEMENS, MIRCOM, SIMPLEX
2	DETECTOR	NOTIFIER, SIEMENS, MIRCOM, SIMPLEX
3	BEAM DETECTOR	NOTIFIER, SIEMENS, MIRCOM, SIMPLEX
4	SOUNDER	NOTIFIER, SIEMENS, MIRCOM, SIMPLEX
5	STROBE CUM SOUNDER	NOTIFIER, SIEMENS, MIRCOM, SIMPLEX

6	STROBE	NOTIFIER, SIEMENS, MIRCOM, SIMPLEX
7	MANUAL CALL POINTS	NOTIFIER, SIEMENS, MIRCOM, SIMPLEX
8	ADDRESSABLE MODULES	NOTIFIER, SIEMENS, MIRCOM, SIMPLEX
9	RESPONSE INDICATOR	RAVEL OR EQUIVALENT
10	ACTIVE REPEATER PANEL	NOTIFIER, SIEMENS, MIRCOM, SIMPLEX
11	NETWORKING CARD	NOTIFIER, SIEMENS, MIRCOM, SIMPLEX
12	Modbus Integration Card	NOTIFIER, SIEMENS, MIRCOM, SIMPLEX
B: CCTV SYSTEM		
1	CAMERA	HONEYWELL, AXIS, HANWA, BOSCH
2	NETWORK VIDEO RECORDER	HONEYWELL, AXIS, HANWA, BOSCH
3	LCD MONITOR	SONY, LG, SAMSUNG
4	NETWORK RACK	NETRACK, VALRACK
5	CLIENT STATION & ANPR WORKSTATION	DELL, HP, IBM
6	VIDEO MANAGEMENT SOFTWARE & ANPR SOFTWARE	OEM PREFERRED, MILESTONE, GENETEC, MATRIX, SECURITY SHELLS, EQUIVALENT TO COMPLYING SPECIFICATIONS
8	POLES	EQUIVALENT MAKE COMPLYING TO SPECIFICATIONS
C. PUBLIC ADDRESS SYSTEM		
1	SPEAKERS	HONEYWELL, HEINRICH, BOSCH, AETIS
2	MIC	HONEYWELL, HEINRICH, BOSCH, AETIS
3	19" RACK MOUNTABLE AMPLIFIER	HONEYWELL, HEINRICH, BOSCH, AETIS
4	19" RACK MOUNTABLE SWITCHER CONSOLE	HONEYWELL, HEINRICH, BOSCH, AETIS
5	CALL STATION	HONEYWELL, HEINRICH, BOSCH, AETIS
6	VOLUME CONTROLLER	HONEYWELL, HEINRICH, BOSCH, AETIS
7	MUSIC PLAYER	SONY, PHILLIPS, SAMSUNG
8	RACK	NETRACK, VALRACK
D. EXIT SIGNAGES		
1	EXIT SIGNAGES	PROLITE, ALKALITE, AUTOGLOW, ACCULITE, TECKNOWARE
E: CABLES		
1	ELV CABLES	LAPP, KEI, POLYCAB, RALLISION, CALIPLAST
F: CONDUITS & CABLES TRAYS WITH ACCESSORIES		
1	CABLE TRAY	PROFAB, INDIANA, ASAWA
2	PVC/ GI/ MS CONDUIT	PRECISION, BEC, AKG

BMS WORK

1.0 BUILDING MANAGEMENT SYSTEM.

1.1 ARCHITECTURE

The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate both the ANSI/ASHRAE Standard 135-1995 BACnet, and Modbus technology communication protocols in an interoperable system.

The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-1995, BACnet, TCP to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet at all levels.

All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a Master / Global / Host to pass data shall not be acceptable.

Structured Query Language (SQL) or Java Database Connectivity (JDBC) or ORACLE compliant server database is required for all system database parameter storage. This data shall reside on a server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.

Two (2) level hierarchical topology is required to assure fast system response times and to manage the flow and sharing of data.

A. WEB BROWSER CLIENTS

The system shall be capable of supporting an unlimited number of users using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the DDC / client machine or manufacture specific Browsers shall not be acceptable.

The Web browser shall provide the same view of the system, in terms of

graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.

The Web browser client shall support at a minimum, the following functions:

- User log-on identification and password shall be required. If unauthorized user attempts access, a blank web page shall be displayed.
- Graphical screens developed for the GUI shall be the same screens used for the Web browser client.
- HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
- The Web page shall get automatically refreshed without any user intervention.
- Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - Modify common application objects, such as schedules, calendars, and set points in a graphical manner. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator and set holidays.
 - View logs and charts
 - View and acknowledge alarms.
- The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to adjust their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
- Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

B. SYSTEM DESCRIPTION & INPUT OUTPUT SUMMARY

The proposed system shall be a Direct Distributed Digital Control (DDC) system. It shall be a PC based system and shall combine latest state of the art technology with simple operating techniques. The entire Monitoring of Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers communicating on an open protocol communication network to a host computer within the facility and communicating via the Internet to a host computer in a remote location. The BMS shall communicate to third party systems such as Chillers, VAVs, Energy meters, UPS, DG, Lifts, VFDs & HT/LT circuit breakers, access control systems, fire-life safety systems and other building management related devices with open, interoperable communication capabilities.

The BMS framework shall utilize built-in Internet connectivity to a broad range of distribution partners in the building automation, energy services, power/utility,

and industrial sectors. The Framework shall bring together the ongoing computerization of control applications under single integrated system architecture. The features shall be distributed both physically and functionally over the field controllers. Microprocessor based Direct Digital Distributed Controllers (DDC) shall interface with sensors, actuators, and environmental control systems (i.e.

HVAC units, chillers, pumps, fans, lighting etc.) and carry out followings functions:

- a. Individual input/output point scanning, processing, and control
- b. Centralized operation of the plant (remote-control).
- c. Static / Dynamic graphic details of plant and building.
- d. Energy Management through optimization of all connected electrical and mechanical plants.
- e. Alarm Detection and early recognition of faults.
- f. Time, event, and holiday scheduling as well as temporary scheduling.
- g. Prevention of unauthorized or unwanted access.
- h. Communication interface and control.
- i. Suggestive preventive maintenance for all equipment as well as own error diagnosis.
- j. Report generation.
- k. Optimum support of personnel.
- l. Data Visualization Tool

These Controllers shall be capable of functioning on a stand-alone mode i.e.in case of loss of communication with the central control station / Server, these shall function independently. DDC shall have microprocessors built-in as standard, which control the respective operation centers based on the required logic and offer fast communication of data via the network communication system. The local access to these shall be either through an in-built display with keypad for each outstation or through a portable operator's terminal. The controllers shall be capable of executing advanced control algorithms like Optimum Start stop, PID control, auto PID tuning. and schedule management. They shall also execute logic functions based on time and/or event. Totalization and averaging functions shall be an inherent feature of the controller.

Each stand-alone intelligent DDC Controller shall have a 32-bit processor, on board Ethernet connectivity. These shall also control any other.

operations on the floor and shall be sized to suit the operation centers or system requirement. This shall help in reducing the site electrical installation. There shall be one BMS control station located in Control Room. The Operator Station should use a simple Web Browser in conjunction with the BMS Server software. The computer shall be sized to cover the graphic display memory, planning information, software & data storage requirement. The display shall be in the form of dynamic color graphics and text format with menu driven pop-up windows and help facility.

The following software packages shall be loaded into the system as minimum

standard:

- a. Complete system operational software
- b. Site specific data manipulation software
- c. Graphics software
- d. Alarm indication software
- e. Internet Enabled Remote Monitoring Package.

Vendor to refer the main excel sheet for detailed I/O Summary

The following are the governing guidelines to be followed for connection to DDC.

- DDC Panel for DG Set, Substation Equipment's, DG Synch. Panels, UPS
- DDC Panel for Ex Tube Axial Fan -Max 4 Fans per DDC

c. CENTRAL STATION SOFTWARE AND HARDWARE CENTRAL STATION SOFTWARE

A central server, located in the Control Room, shall be provided. The server shall support all DDC's connected to the customer's network whether local or remote.

Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, PSTN or dial-up connection.

CLT shall be possible to provide access to all DDC & 3rd party integration units via a single connection to the server. In this configuration, each DDC can be accessed from the Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the Local Area network.

The server software shall provide the following functions, at a minimum:

- Complete control and monitoring of IBMS system from color graphics pages on the machine, or from a remote web browser.
- Full client-server operation.
- SQL / JDBC / ORACLE Database.
- Comprehensive alarm handling with alarm retransmission and logging.
- Scheduled recording of logged data from DC.
- Management of multiple controller occupation times.
- Multilevel security system.

1) Monitoring

The system shall support data acquisition using periodic scanning, exception reporting or on operator request. The system shall support a range of scan intervals, ranging from less than 5 second up to several minutes as

desired / required. The system shall allow certain selected points to be

scanned more often / faster than other points.

The communication techniques shall be optimized to minimize network traffic while providing good system response and reliability. The system shall also provide utilities to compile aggregate statistics on communication link usage.

2) Control

Control transactions issued by the operator shall be communicated to control devices using a write followed by read to ensure the integrity of the transaction. If the read following the write to the device indicates that the control action has failed, the operator shall be informed by means of a control failure alarm. The priority of the control failure alarm shall be configurable by the user.

3) System Database

The system shall provide a real-time database incorporating data from analogue, logical or pulse inputs. The database shall be configurable by the end user without the need for any programming and shall be able to modify

on-line without interrupting operation of the system. In addition to point-based information, the database shall also provide historization capabilities for analogue, digital, pulse; event-based information and calculated values.

This information shall be accessible by all facilities of the system such as displays, reports, trends, user written application.

The real-time database shall use suitable data structures to collect and store the following categories of

data, as minimum.

- Access points
- Analogue points
- Status points
- Accumulation
- Historical data
- Event data

The facility shall also exist to accommodate user defined data structures.

Each of the point database structures shall be comprised as a composite point with a number of associated parameters that may be referenced relative to a single tag name. Specifically, each of these parameters shall be accessible by various sub-systems such as the graphical operator interface, report generation system and application program interface in a simple format without the need to know any internal storage mechanism.

The system shall maintain portions of the data base requiring frequent high

speed access as memory resident information and other less frequently accessed data as disk resident data. Database backup shall be possible with the system on-line including backup of historical based data. The database backup shall be part of GUI software & shall be possible to configure automatic backup at regular interval without any user interference / attention. All other backup such as graphic pages / drawing etc can be windows based where simple copy & paste should be enough for taking backup other than database. Long term storage of this data shall be possible using the zip drive. The system shall have the provisions for importing this data at later date for analysis and long terms MIS reports.

Point data shall be stored in a composite point database structure that provides a wide range of configurable information including but not limited to:

- Point name and description.
- Multiple locations for data storage and device scanning addresses.
- Scan period.
- Multiple dead-band or hysteresis settings
- Monitoring and control access restriction information.
- Location of operator alarm handling instructions
- Location of ancillary information associated with the point.

4) Historical data storage

Collection of historical point data shall be configurable as part of the point definition. Once configured, this data shall be collected automatically. Historical data collection shall be provided for both snapshots and averages.

with intervals ranging from 5 seconds to several hours.

The system shall provide the necessary means to easily locate the particular value of interest for any of the historical points. The graphical operator interface, trend, report generation and application interfaces shall be able to access historical data.

5) Trending

The system shall provide flexible trending allowing real-time, historical, or achieved data to be trended in a variety of formats. In addition, trend data types shall be able to combine to allow for comparisons between data e.g. current real-time data versus archived data. The system shall provide.

trending capability with following functions.

- Real time trending
- Historical trending

- Archived history trending
- Trend scrolling
- Trend zooms
- Export option / Copying of currently displayed trend data to the clipboard for pasting into spreadsheet or document.

The system shall allow the trending of a minimum of 5 points in a single trend display set. For each trend set display it shall be possible for operators to configure the number of historical samples and ranges displayed. Points configured in trend sets shall be changeable on-line. Operators shall be able to zoom in on information displayed on trend sets for closer inspection by dragging out an area of interest with the mouse or other pointing devices. From such a selection, it shall be possible to copy the underlying data to the windows clipboard for subsequent pasting into spreadsheet application such as Microsoft excel.

6) Alarm Management

The software shall include a well-organized alarm management facility to enable the operator to react quickly and efficiently to alarm conditions. Apart from the specific points identified for alarm annunciation in the I/O points schedule, the alarm types supported shall include:

- Very high value alarm
- Very low value alarm
- Large deviation alarm
- Rate of change alarm
- Unreasonable value alarm
- Delay avoiding nuisance alarm / short time change in value.

The system shall permit any of these alarm types to be applied to the analog and accumulated points. The software shall permit at least 90 levels of alarm priorities to be assigned to each alarm ranging from the lowest to the highest. These levels shall be easily distinguished by the manner in which they are presented such as the color of the alarm message, blinking of the alarm message, varying audible alarms, etc., All alarm shall be logged in the event / alarm file and / or on the alarm printer. On acknowledgement of an alarm, it shall be possible to automatically issue a reset command to the controller so as to attempt to reset the alarm point.

7) Reporting

The system shall support a flexible reporting package to allow easy generation of report data. The reports provided shall include pre-configured standard reports for common requirements such as alarm / event reports and custom report generation facilities that are

configurable by the user. The following pre- formatted reports shall be available on the system:

- Alarm / event report.
- Operator trail report.
- Point trail report.
- Alarm duration report.
- All point reports.
- Point attribute report.
- Lockout summary
- Over-ride summary

Configuration of these reports shall only require entry of the schedule information, and other parameters such as point name or wildcard, filter information, time interval for search and destination printer to fully configure the report. No programming shall be required.

The requirement of the above-mentioned reports shall be as follows:

8) Alarm/Event Report

This report shall be summary of all events of a specified type for nominated points occurring in a time period. The time period may be specified as an absolute start and end date and time, or as a period to the current time.

9) Operator trail report

This report shall be a summary of all operator actions relating to a specific operator in a specified period.

10) Point trail report.

This report shall be provided to produce a summary of all events of a specified type occurring in a period on nominated points.

11) Alarm duration report.

This report shall be provided to calculate the total amount of time a nominated point or group of points has been in an alarm condition over a given time period.

12) All point report.

A report shall be provided to produce a list of point information, including point name, description, point type, engineering units, and current values.

13) Point attributes report.

A report shall be provided for summaries of the points selected as per the following criteria:

- Out of service
- Alarm suppressed.
- Abnormal input levels
- In manual mode.

14) Over-ride summary

This report shall be used to provide the summary of all points / commands that have been over-ridden by the operator.

15) Time Schedules:

The system shall include the facility for time scheduling activities on both a periodic and one-off basis. All time schedules shall be configurable via the Operator workstation. Each time schedule entry shall consist of:

- Date
- Time
- Point name.
- Point Parameter
- Target Value
- Type of scheduling

The available time schedule type shall include:

- Daily – to be executed everyday
- Workday – to be executed on the weekdays.
- Holidays – to be executed on holidays.
- Individual days – to be executed on a particular day.

The system shall also have the provision for programming temporary schedules that over-ride the normal schedule.

16) Energy Monitoring & Analysis:

Energy Monitoring & Analysis should be integral part of GUI. It shall support minimum of 50 Energy points for analysis purpose. The software shall provide the following feature but are not limited to,

- a) It shall be possible to generate & view detailed Daily, Weekly & monthly graphs of the energy meter / point identified.

- b) It shall be possible to see and analyses the total energy usage in a building and also shall be possible to identify by which system is major user of the energy.
- c) It shall be possible to compare the energy points week against week, day against day in a month, identify Maximum, Minimum & average daily values & Energy usage for different periods of time of the day.
- d) It shall be possible to make cost and consumption analysis or CO2 reports on consumption.
- e) Based on the energy consumed it shall be possible to rank the systems or building (in case of

multi-location buildings)

- f) Software shall allow the user to compare the predicted / forecasted energy or based on historic performance with current performance.
- g) It shall be possible to create energy signature with respect to ambient / outside temperature of the day.
- h) Software shall allow the user to identify the exceptions happened in the system due to which energy consumption was increased.
- i) It shall be possible to compare the energy consumption after introducing an energy saving strategy for further fine tuning or to visualize the savings achieved.

17) Operator Interface:

The operator interface provided by the system shall through an intuitive graphical user interface and shall allow for efficient communication of operational data and abnormal conditions. It shall provide a consistent frame work for viewing of information. Critical areas (such as alarm icons) shall be visible all the times. A predefined area on the screen shall provide operator messaging, and this area shall also be visible at all times.

The operator interface shall be interactive and based on graphics and / or icons. Standard tool bar icons and drop-down menus shall be available on all standard and custom display to allow easy access to common functions.

The system shall provide an operator interface with the following minimum capabilities: Window re-size, zoom in, zoom out.

Dedicated icons and pull-down menus to perform the following:

- Associated display
- Alarm summary.
- Alarm acknowledgement.
- Previous display recall

- Graphical-up
- Trend call-up
- Point detail.
- Current security level
- Alarm annunciation.
- Communication fail annunciation.
- Operator message zone.

18) Area assignment / area profile

Each operator shall be assigned one or more specific areas / functions of the facility with the appropriate monitoring and control responsibility. An area shall be defined in this context as a logical entity comprising of a set of points in the system. This in turn may represent a physical space in the facility or a particular utility or a particular equipment.

The system shall provide the facility to create area profiles, which combine areas and time periods, and which can be assigned to operators with the same area access requirements. By using area profiles in this way, area access can be specified to apply during certain time periods, allowing different areas of access at different times of the day or week.

19) Command partitioning.

It shall be possible to assign to each operator a set of allowed commands / operating for each assigned area. With this feature, it shall for example be possible to configure an operator to set a digital point to On, but to disallow the same operator from setting the same digital point to OFF.

20) Standard system displays.

The following displays shall be included as part of the system:

- Alarm summary display.
- Event summary display
- Point detail template displays.
- Trend set template displays.
- Communication status displays
- System status displays
- Operator scratch-pad display.

21) System Status Displays

These shall display the following information.

- Points in alarm condition pending acknowledgement.

- Points which remain in an alarm condition state, but which have been acknowledged.
- Communication failure
- Printer Status
- Operator workstation status
- Controller status

22) Administrative Displays

The system shall provide the following full screen display Master system menu.

- Report summary.
- Alarm summary.
- Event summary
- Display summary.
- Area assignment
- Holiday assignment
- History assignment,
- Push-button assignment,
- Operator definition,
- Operator message
- board Events archive and
- Retrieval Time period summary

23) Other requirements

It shall be possible to launch any windows-based applications, such as Microsoft word or Microsoft excel, from within the operator interface.

24) Help Facility

Software shall be provided to facilitate programming and storage of the system operation manuals in the hard disk. The operation manual shall be retrieved by Online Help mode so as to enable the operator to self-learn the system operation, command, or function as and when needed. This 'help' facility shall be made available to the operator by use of a dedicated key or a single key click on the mouse. A minimum help shall be available for every menu item and dialogue box. The facility shall contain both text and graphics to provide information about the selected function directly.

The information provided shall be in simple clear language and shall be possible to search the help based on typical word included in the process. When a point is overridden by operator command from an operator workstation or a local workstation, an alarm message shall be output to the appropriate alarm printer and to respective operator workstations Alarm

messages shall require operator acknowledgement.

When a point returns to normal, the event shall be recorded in control stations as Return to Normal.

The Operator workstations shall be capable of displaying a list of all points in alarm for the building in a single summary. Systems which require the operator to make a separate summary for alarms shall not be acceptable. The software shall also provide details of particular alarm occurred on a point.

25) 3rd Party System Integrator Units:

- A. The 3rd party Integration unit shall provide the interface between Ethernet LAN and the 3rd party field control devices such as DDC or PLC or any other devices which need to be integrated. These shall also provide supervisory capability of functions over the devices connected to it. The purpose of using these units should be limited to integrate devices only, not for any DDC interface with GUI, provided by others.
- B. The Unit must provide the following hardware features as a minimum:
 - a. One no. on board RS-232/USB port
 - b. One No. on board RS-485port
 - c. Provision to include / add additional communication card.
 - d. Battery Backup
- C. The Unit must communicate over TCP/IP with communication speed of 10/100MBPS.
- D. The Integration unit shall have built in drivers for open protocol such as;
 - a. BACnet over MSTP
 - b. BACnet over IP
 - c. Modbus over MSTP
 - d. Modbus over IP
 - e. Lon FTT
 - f. LonIP
 - g. M BUS over TCP
 - h. MBUS Serial
 - i. SNMP

If the above drivers are add-on products, it shall be made available / considered while selecting the unit & the same to be confirmed in writing.

- E. The Integration unit shall provide flexibility of adding communication ports (RS485) by adding communication cards, minimum one slot, when required rather than adding additional unit itself.

- F. The Integration unit shall have inbuilt JAVA engine and it shall be possible to configure the IO, if required, of the 3rd party devices.
- G. The Integration unit should be capable of handling multiple protocol.
- H. The Integration unit should have inbuilt memory for program storage.
- I. The Integration unit should automatically backup its database for the user defined interval.
- J. User authentication should be integral part of the unit.
- K. All vendors are required to provide the documentation highlighting the capabilities mentioned above.
- L. All units shall have LEDs for fault / status identification such as
 - a. LAN active (one per port in case of multiport units)
 - b. LED to display proper functionality / Status of the unit.
 - c. LED to display healthiness of CPU of the unit.

D. DIRECT DIGITAL CONTROLLER

- a) DDC controllers shall be capable of fully "stand- alone" operation i.e. In the event of loss communication with other DDC"s or Control Station, they shall be able to function on their own.
- b) The controllers shall consist of 32bit microprocessors for reliable throughput, with EEPROM based operating system on BACNET.
- c) The memory available to the controller board should serve as working space and there should not be any limitation of using particular function block other than the memory.
- d) The controllers shall be UL listed and conforming to CE.
- e) The controller shall have support programs built in RAM for a minimum of 120 hours in the event of a power failure and it shall be possible to fit any battery thus expanding the time limit to 5 years. An alarm shall be generated on low battery voltage. The battery shall not be required to supply power to actuators, valves, dampers etc.
- f) DDC shall communicates in BACnet/ IP Protocol.
- g) Network (LAN) provided by the client / can be on dedicated network created by the vendor. Each DDC can be accessed from the Graphical User Interface (GUI) or from a standard Web browser (WBI) by connecting to the server.
- h) Controller shall have the capability to communicate with other controllers for any interlock or data
- i) sharing using peer to peer technology. The Controller which route the messages or data sharing through the system or any intermediate hardware / controller shall not be acceptable.
- j) Vendor demonstrates this capability during the commissioning time and the same shall be verified at the time of handing over.

- k) Each controller shall have RS232/USB port built on to it so that any trouble shooting required at field level can be carried out without removing the controller from the network (LAN).
- l) Controller shall support DHCP addressing over Local Area Network (LAN) so that the static IP requirements are reduced. However, a single static IP shall be provided for system so that it can be hosted on to internet in consultation with end user.
- m) The Controllers shall have proportional control, Proportional + Integral (PI) Control, Proportional plus Integral plus Derivative (PID) Control, Two Position Control and Time Proportioning Control and algorithms etc., all in its memory and all available for use by the user, i.e. all the control modes shall be software selectable at any time and in any combination. The analog output of Proportional Control, PI Control, and PID Control shall continuously be updated and output by the program shall be provided. Between cycles the analog output shall retain its last value. Enhanced integral action in lieu of Derivative function shall not be acceptable. Automatic loop tuning facility should be available to tune the loop at regular interval and adjust the gain or the integral / derivative time.
- n) The controllers shall have a resident real time clock for providing time of day, day of week, date, month and year. These shall be capable of being synchronized with system/ time master clocks in the network. Upon power
- o) restoration all clocks shall be automatically synchronized to the time master controller which will be set during the commissioning phase.
- p) The microprocessor based DDC"s shall be provided with power supply, A/D and D/A converters, memory and capacity to accommodate a maximum of 192 input/output (I/O) hardware points (with or without an expansion board).
- q) The DDC"s shall have 15% spare capacity for each type of point (digital/analog input/output) to give flexibility for future expansion.
- r) All DDC controllers shall have 10 / 12-bit A/D resolution and be capable of handling voltage, milli- ampere, resistance or open and closed contacts inputs in any mix, if required.
- s) Analog inputs/outputs of the following minimum types shall be supported:
 - i. 4-20 mA.
 - ii. 0-10 volts.
 - iii. 2-10 volts.
 - iv. Resistance Signals (either PTC or NTC such as PT 100, PT 1000, PT3000, NTC20K) Modulating outputs shall be true proportional outputs and not floating control type.

- t) Digital input/output types to be supported shall be, but not limited to the following:
 - i. Normally open contacts.
 - ii. Normally closed contacts.
 - iii. Pulse inputs.
- u) Modulating outputs shall be true proportional outputs and not floating control type.
- v) t) It shall be possible to change the analog inputs to accept any of the above depending upon the site condition or system requirement using a jumper. The DDC which is configured using software trigger / switch shall not Be acceptable.
- w) The controller's packaging shall be such that, complete installation and check out of field wiring can be done prior to the installation of electronic boards.
- x) All board terminations shall be made via plug-in connectors to facilitate trouble- shooting, repair, and replacement. Soldering of connections shall not be permitted.
- y) Controllers shall preferably be equipped with diagnostic LED indicators with at least indication for Power up Test OK, Watch dog and Bus Error. All LED's shall be visible without opening the DDC cover.
- z) It shall be possible for the controllers to accept regulated uninterrupted.

power supply to maintain full operation of the controller functions (control, logging, monitoring, and communications) in the event of a localized mains failure. Controllers requiring fan cooling are not acceptable.

- aa) There shall be the facility for accessing controller data information locally, via a portable plug-in color LCD display which will be common to all controllers and normally removed to prevent unauthorized tampering. In either case, access to the system thus provided shall be restricted by passwords in the same way as at the main operator terminal.
- bb) In case the Portable operator Terminals (POT) are required to programmed the controllers, sockets shall be provided for same. Attachment of POT shall not interrupt or disable normal panel operation or bus connection in any way.
- cc) The controllers shall be housed in vandal proof boxes to protect them from tampering by any unauthorized personnel. All DDC controllers used in plant room spaces and external applications shall be housed IP66/IP54 rating enclosures.
- dd) It shall be possible to add new controllers to the system without taking any part of the system off-line.

- ee) All DDC should have XML web service option which can be enabled in later stage for any higher interface with IT infrastructure or any other service.
- ff) Individual DDC should be BTL (BACnet Testing Lab) tested.

E. DIRECT DIGITAL CONTROLLER'S CAPABILITIES:

- 1) The Controllers shall have a self-analysis feature and shall transmit any malfunction messages to the Control Station. For any failed chip the diagnostic tests, printout shall include identification of each and every chip on the board with the chip number/location and whether the chip "Passed" or "Failed" the diagnostic test. This is a desired requirement as it would facilitate troubleshooting and ensure the shortest possible down time of any failed controller. Controllers without such safety feature shall be provided with custom software diagnostic resident in the EEPROM. The tenderer shall confirm in writing that all controllers are provided with this diagnostic requirement.
- 2) Operating system (O.S.) software for controllers shall be EPROM resident.
- 3) Controllers shall have resident in its memory and available to the programs, a relevant library of algorithms, intrinsic control operators, arithmetic, logic, and relational operators for implementation of control sequences.
- 4) In the event of failure of communication between the controllers and/or Control Station terminal, alarms, reports, and logs shall be stored at the controllers and transmitted to the terminal on restoration of communication.
- 5) In the event of memory loss of a Controller or the expiration of back-up power, on start- up of the unit the necessary database shall be downloaded. manually so that the logic built are verified by the user. However, controllers requiring a manual intervention for the re-boot of software are not desired.
- 6) Where information is required to be transmitted between controllers for the sharing of data such as outside air temperature, it shall be possible for global. points to be allocated such that information may be transmitted either on change of incremental value or at specific time intervals.
- 7) Controllers must be able to perform the following energy management functions as a minimum,
 - Time & Event programs
 - Holiday Scheduling
 - Maximum and Distributed power demand
 - Optimum start and stop program.

- Night purge
 - Load reset.
 - Zero energy band
 - Duty cycle
 - Enthalpy analysis and control
 - Run Time Totalization
 - Sequencing and Optimization
 - Exception scheduling
- 8) Detailed description of software features and operating sequence of all available energy management software shall be submitted as part of technical submittal.
 - 9) The DDC Controllers have Adaptive Control capability whereby the control software measures response time and adjusts control parameters accordingly to provide optimum control. The software shall allow self-tuning.
 - 10) of the variable control loops (all or any of P, P+I, P+I+D) of the AHU's and chiller system so as to provide the most efficient and optimized controls at different load conditions. The energy management programs shall update their parameters based on past experience & current operating conditions.
 - 11) Alarm Lockout shall be provided to prevent nuisance alarms. On the initial start-up of air handler and other mechanical equipment a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating an alarm comparison logic.

Tenderers shall indicate their proposed system alarm handling capability & features.

- 12) Run time shall be accumulated based on the status of a digital input point. It shall be possible to total either ON time or OFF time. Run time counts shall be resident in non-volatile memory.
- 13) It shall be possible to accommodate Holiday and other planned exceptions to the normal time programs. Exception schedules shall be operator programmable up to one year in advance.
- 14) All DDC shall have trend / log storing capacity built into it. It shall be possible to have stored the data for at least 40 days @ 1-hour sampling time for all the points of the DDC (used or unused). Minimum communication should be 10MBPS for each of the controllers.
- 15) DDC should be forward compatible type so that any expansion or upgrade of the system required in the future is easily taken care of without scrapping / removing / disturbing the existing working system.

- 16) DDC Should allow user to include graphics, if required, however it shall be of static in nature. Email & SMS facility to be available.

F. DATA COMMUNICATION

The communication between controllers shall be via a dedicated or customer provided Ethernet communication network as per standards. Controller's microprocessor failures shall not cause loss of communication of the remainder of any network. All networks shall support global application programs, without the presence of a host PC.

Each controller shall have equal rights for data transfer. There shall be no separate device designated as the communication's master. Those systems using dependent controllers shall be pointed out by the contractor and a dual Hot redundant transmission media with automatic switching and reporting in the event of line faults will have to be provided.

The communication network shall be such that:

- 1) Every DDC must be capable of communicating with all DDC's on its own.
- 2) Network connected devices shall be capable of sending message after successive retries shall constitute a communication or device failure.
- 3) Each controller is to be provided with a communication watchdog to assure that the failure is reported to the central station. Error recovery and communication initialization routines are to be resident in each network connected device.
- 5) The communication protocol shall incorporate CRC (Cyclic Redundancy Check) to detect transmission errors.

Single or multiple standalone controller failures shall not cause loss of communication between active DDCs connected on the communication network. Full communication shall be sustained as long as there are at least two operational standalone control panels active on the communication network.

All the System Integration Units shall be linked together on a Local Area Network.

The communication network shall include provision for automatically reconfiguring itself to allow all operational equipment to perform as

efficiently as possible in the event of single or multiple failures. The BAS supplier shall be required to provide details of standards to which their system conforms.

G. FIELD DEVICES

All controls shall be capable of operating in ambient conditions varying between 0-55 deg. C and 90% R.H. non-condensing.

All Control devices shall have a 20 mm conduit knockout. Alternatively, they shall be supplied with adaptors for 20 mm conduit.

I. Ancillary Items

When items of equipment are installed in the situations listed below, the BAS contractor shall include the following ancillary items:

i. Weather Protection

All devices required to be weatherproofed are detailed in the Schedule of Quantities. IP ratings for the equipment are mentioned in the respective section.

ii. Pipework Immersion

Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed 1/2" (13 mm) or 3/4" (20 mm) NPT suitable for the temperature, pressure and medium.

II. Temperature Sensor

Temperature sensors for space, pipes, and ducts, shall be the Resistance Temperature detector (RTD) type or thermistor. These shall be two wire types and shall conform to the following specifications:

- 1) Immersion sensors shall be a high accuracy type with high resistance versus temperature change. The accuracy shall be at least ± 1.33 deg C.

- 2) Immersion sensors shall be provided with separate Brass thermowell. These shall be manufactured from bar stock with hydrostatic pressure rating of at least 10 kgf/cm.
- 3) The connection to the pipe shall be screwed type. An aluminum sleeve shall be provided to ensure proper heat transfer from the well to the sensor. Terminations to be provided on the head. Flying leads shall not be acceptable.
- 4) The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections.
- 5) Duct temperature sensors shall be with rigid stem and of averaging type. These shall be suitable for duct installation.
- 6) Outdoor air temperature sensor shall be provided with a sunshield.
- 7) The sensors shall not be mounted near any heat source such as windows, electrical appliances.
- 8) The temperature sensors may be of any of the following types:
 - i. PT 100, PT 1000, PT3000
 - ii. Thermistor

III. Humidity Sensor

Space and duct humidity sensors shall be of capacitance type with an effective sensing range of 10% to 90% RH. Accuracy shall be + 3% or better. Duct mounted humidity sensors shall be provided with a sampling.

chamber. Wall mounted sensors shall be provided with a housing. The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections. The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

IV. Pressure Transmitter for Water

Pressure transmitters shall be piezo-electric type or diaphragm type. (Bourdon Tube type shall not be acceptable). Output shall be 4-20mA or

010V DC and the range as specified in the data sheet depending on the line.

pressure. Power supply shall be either 24 V AC, 24 V DC or 230 V AC. Connection shall be as per manufacturer's standards. The pressure detector shall be capable of withstanding a hydraulic test pressure of twice the working pressure. The set point shall fall within 40%-70% of the sensing range and detector shall have sensitivity such that change of 1.5% from the stabilized condition shall cause modulation of the corrective element. The sensor must be pressure compensated for a medium temperature of -10 to 60 degree with ambient ranging between 0 degree to 55 degree.

V. Differential Pressure Transmitter for Water

These shall be diaphragm operated. Switches shall be supplied with air connections permitting their use as static or differential pressure switches.

The switch shall be of differential pressure type complete with connecting tube and metal bends for connections to the duct. The housing shall be IP 54 rated. The pressure switches shall be available in minimum of 3 ranges

suitable for applications like Air flow proving, dirty filter, etc. The set point shall be concealed type. The contact shall be SPDT type with 230 VAC,1A rating.

The switch shall be supplied suitable for wall mounting on ducts. It should be mounted in such a way that the condensation flow out of the sensing tips. Proper adaptor shall be provided for the cables.

The set point shall fall within 40%-70% of the scale range and I has differentials adjustable over 10%-30% of the scale range. The switches shall be provided with site adjustable scale and with 1 NO/NC contacts.

VI. Air Flow Switches

Air flow switches shall be selected for the correct air velocity, duct size and mounting attitude. If any special atmospheric conditions are detailed in the Schedule of Quantity the parts of the switches shall be suitably coated or made to withstand such conditions. These shall be suitable for mounting in any plane. Output shall be 1 NO/NC potential free. Site adjustable scale shall also be provided.

VII. Water Flow Switches

These shall be paddle type and suitable for the type of liquid flowing in

the line. Output shall be 1NO/1NC potential free.

VIII. Level Switches

The level switches shall have to meet the following requirement:

- Type: Float Type/Capacitance type/Conductivity type
- Mounting: To suit application.
- Connection: Flanged ANSI 150 lbs. RF
- Carbon steel Float material: 316 SS
- Stem Material :316 SS
- Output: 1 NO, 1 NC
- potential free Switch Enclosure: IP 55

IX. Flameproof Level Transmitter for Diesel Tanks

Media: Diesel

- Mounting: Top mount
- Type: Submersible
- Tank height (level range): 0-1meter or as per tank height
- Output: 4-20mA/0-10V
- Accuracy: $\pm 0.5\%$ of F.S.
- Diaphragm & housing material: SS316L.
- Cable material: PTFE/Polyethylene
- Protection: IP66
- Power supply: 24VDC
- Approval: CE/UL

X. Oil Temperature Transmitter

- Media: Oil
- Sensing element: PT or NTC
- Temp. range: 0-50°C
- Output: 0-10VDC/4-20mA
- Accuracy: $\pm 0.2^{\circ}\text{C} \sim 0.5^{\circ}\text{C}$

- Probe length & diameter: 200mm & 6mm.
- Protection class: IP65
- Storage Temperature -30 to 85°C
- Housing material: ABS
- Probe material: SS304.
- Power supply: 24VAC/24VDC
- Approval: CE/UL

XI. Enclosures for Controller and Electrical Panels

All the controllers shall be housed in Lockable Vandal proof boxes which shall either be floor mounted, or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.

The panel shall be metal enclosed 18 SWG CRCA sheet steel cubicle with gaskets between all adjacent units and beneath all covers to render the joints dust proof. All doors and covers shall be hinged and latched and shall be

folded and braced as necessary to provide a rigid support. Joints of any kind in sheet metal shall be seam welded with welding slag grounded off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with nuts. Self-threading

screws shall not be used in the construction of control panels. Knockout holes of approved size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. Lamp shall be provided to support the weight of the cables. The dimension of the boxes shall depend on the requirement with the colour decided in consultation with the CPWD.

Note: All panel enclosures used in plant room spaces and external to building shall be suitable for outdoor application (IP 54/IP55 protection).

XII. Signal Cabling & Communication Cabling

The signal cable shall be of the following specifications:

- a. Wire: FRLS Over all shielded Annealed Tinned Copper
- b. Size: 2C & 4C 1.5 sq. mm, stranded type
- c. No. of conductors: ATC Two (One pair) & Four (Two Pair)
- d. Shielding: Overall beld foil Aluminum polyester shield.
- e. Jacket: Insulated Chrome PVC
- f. Nominal DCR 17.6 ohm/km for conductor 57.0 ohm/km for shiel
- g. Nominal capacitance :130 pF/m between conductors 180 pF/m between one conductor and other Conductors connected to shield, at1 KHz.
- h. Alu Mylar Tape with tinned copper drain wire size 0.5 sq.mm GI Wire

List of Approved Makes

SR No	Details of Materials / Equipment	Manufacturer's Name
1	Industrial Grade Server with Attached storage Hardware for Video recording	Dell / HP/ Lenovo
2	Integrated Building Management Software	Tridium/JCI /Honeywell
3	Customized reports using analytics points license	Tridium/JCI /Honeywell
4	TCP/IP based 32- bit DDC controller	Tridium/JCI /Honeywell
5	Duct Temperature Sensor	Greystone / Dwyer / Omicron
6	Immersion Temperature Sensor	Greystone / Dwyer / Omicron
7	Co2 Sensor	Greystone / Dwyer / Omicron
8	Room Temperature & RH Sensor with Display	Greystone / Dwyer / Omicron
9	Differential Pressure Switch - Air	Greystone / Dwyer / Omicron
10	Pressure Transmitter-Water	Greystone / Dwyer / Omicron
11	48 Port Layer-2 Managed Network Switch	Cisco/ Juniper/ HP/ Extreme
12	4C & 2Cx1.5 sq.mm FRLS Armoured cable,	Polycab / Caliplast / KEI
13	4-pair, CAT6	CommScope/AMP/Belden/Panduit/Legra

		nd
14	4 C Fibre Cable	Systemax, Molex, Panduit

ICT / IT WORK

1. GENERAL INTRODUCTION:

Construction of SMRT IIT KANPUR: Construction of External infra–Master plan phase 4 including various blocks (Substation & transformer block, BMW, OWC, STP, MGPS, Common toilet, Security Cabin & gate) Where the Building Network & Telecom systems are designed to provide the facility with the Internet, Telephone to all kinds of Administrative & Healthcare areas.

Since facility is going to be a critical healthcare infrastructure; substantial improvement in productivity and efficiency of the premises can be achieved by utilizing the benefits of Information Technology for seamless integration of activities of various departments. This can be made possible by setting up a Local Area Network of computers, which would enable ELV, MATV, internet & Online sharing of Information amongst various facilities. A dedicated Local Area Network connecting all users, based on high bandwidth fiber optics backbone, is therefore considered essential.

The Complete Network is divided into two parts Administration Network and Security Network, Administration network includes Network for Hospital, IP telephone, WIFI. And Security Network includes Network for CCTV, BMS, Nurse Call, Patient Call System etc.

2. TECHNOLOGY OVERVIEW

It is to be ensured that high-end Gigabit Standard components & telecom infrastructure are to be ready to provide end-to-end connectivity. The following factors are to be considered while quoting for Passive:

- Support to 10 Gigabit speed and latest product line
- Support for latest technology full Convergence
- Support for high bandwidth and future scalability
- Inter-Operate with all high-end technology
- 20 to 25 Years Warranty on passive cabling
- Good vendor support and infrastructure
- Manufacturing site/distributors in India to control
- Proof of Concept and TCO / ROI into account.

1. STRUCTURED CABLING

1.1 DATA and LAN Networking horizontal cabling - copper

In addition to meeting the 250 MHz category 6 specifications outlined in ANSI/TIA/EIA-568-C.2, the requirements in this section must also be met for all applicable balanced twisted-pair products as listed below.

1.2 Outlets

All 250 MHz category 6 information outlets designed for termination of 4-pair balanced twisted-pair category 6 copper cable must possess the following characteristics at the minimum:

- Exceed category 6 component compliance with usable bandwidth to 250 MHz
- Provide full integration of cable shielding through the termination process of the outlet.
- Be available in black, white, red, gray, yellow, blue, green, orange, ivory, bright white, Light ivory and alpine white
- Universal design allows the same outlet to be mounted in flat or angled orientation.
- Terminates with an ergonomic and easy to use tool to ensure fast and simple terminations.
- Have a Spring door to minimize exposure to dust and other contaminants
- Have a lacing module that offers zero-cross termination, which eliminates pair crossing
- Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity
- Support industry standards for T568A or T568B wiring options on each individual outlet
- Allow installation from the front or rear of the faceplate, and allow for the jack to pass through the faceplate without re-termination
- Provide color-coded, snap-in icons available for circuit identification
- Allow for a minimum of 5 terminations without signal degradation below standards compliance limits
- Be constructed of high impact, glass reinforced nylon.
- Have, as an option, an outlet, which can be mounted into an IEC 60603-7 compliant opening(keystone)
- It shall be certified by Underwriters Laboratories to United States Standards and C22.2 Canadian Telecommunications Standards

Outlet Standards and Compliance

The outlet shall comply with

- ANSI/TIA-568-C.2
- ISO/IEC 11801 Ed 2.2

- ETL Tested
- IEEE 802.3an
- IEEE 802.3af (PoE)
- IEEE 802.3at (PoE+)
- ANSI/TIA 1096-A
- IEC 60603-7-51
- IEC 60512-99-001 (3rd party verified)

MECHANICAL – TERMINATION	
Wire Size Range (nominal)	22-26 AWG solid and stranded
Wire Insulation Diameter Range (max)	1.48mm (0.058 in.)
Conductor OD Size (max)	0.60mm (0.023 in.)
Cable OD (max)	9mm (0.354 in.)
Reterminations	5
Wiring	T568A/B

Product Characteristics

ELECTRICAL	
Contact Resistance	20 mΩ
Input to Output Resistance	200 mΩ
Min. Dielectric Withstand Voltage (contact to contact)	1000 V DC or AC peak
Min. Dielectric Withstand Voltage	1500 V DC or AC peak
Insulation Resistance	500 mΩ
Compatibility	Backwards to cat 5e and cat 6
Current Rating	1.5 A
PoE	Suitable for PoE and PoE+
MECHANICAL – GENERAL	
Operating Temperature	-10 to 60 °C (14 to 140 °F)
Flammability Rating	UL 94 V-0
Green Features	RoHS, lead-free, halogen-free, PVC free
Housing Material	Zinc die cast
Contact Materials	Copper alloy, plated with 50 micro inches (1.27 micron) minimum thick gold or equivalent at contact interface
Plastic Materials	Flame retardant thermoplastic
Dimensions (LxWxH)	41.2x14.5x21.1mm (1.6x.570x.832 in.)
Shield	360 degree enclosure
MECHANICAL – JACK	
Number of Plug Insertion Cycles	2500
Min. Plug Retention Force	50N (11.24 lbf)
Plug Compatibility	Compatible with RJ45 (8-position) or RJ11 (6-position) plugs

1.3 Faceplates

All faceplates installed, as part of this specification, shall have these minimum features listed below:

- Be applicable to both fiber and copper applications.
- Be available in 2 and 4 port single-gang configurations.
- Allow modules to be removed from the front of the faceplate.
- Allow FUTP modules to pass through faceplates even after termination.
- Have write on designation labels for circuit identification together with a clear plastic cover.
- Feature easily removable designation label covers which can be removed without use of tools.
- Be available in single-gang and double-gang configurations.
- Have as a minimum the standard colors of white, bright white, and alpine white.
- Have optional modular furniture adapters available.
- Have surface mount boxes single gang faceplates.
- Be manufactured using UV resistant, high impact thermoplastic to prevent color fading and provide additional durability.

1.4 Patch cords

All 10G 6 modular equipment cords shall conform to the following minimum performance standards:

Category 6 component compliant with operational bandwidth to 250 MHz

factory assembled and 100% transmission tested with laboratory grade network analyzers for proper performance up to 250 MHz

Utilize Category 7 S/FTP stranded screened cable for optimal transmission performance to eliminate Alien Crosstalk, with a round low smoke zero halogen jacket

Backwards compatible with lower performing categories

Equipped with identical modular 8-position plugs on both ends, wired straight through with standards compliant wiring

It shall Have full 360° shield coverage and metal plug housing to provide durability and resistance to damage. Having a PCB based plug to enable high levels of performance.

It shall Have fixed position front contacts to ensure plug quality and consistent mating with outlets. It shall Have internal rear contacts to maintain cable pair symmetry to the point of termination.

It shall Have a boot that features an ultra slim design for high density applications and snag free operation.

Use modular plugs, which exceed FCC CFR 47-part 68 subpart F and IEC 60603-7 specifications, and have 50 micro-inches minimum of gold plating over nickel contacts

It shall Have a dual jack construction for excellent alien crosstalk performance.

It shall be available in standard lengths of 3, 5, 7, 10, 15 and 20 ft. with lengths Have optional coloured clips to allow field colour coding even when cords are already installed i.e. Black, White, Red, Gray, Yellow, Blue, Green and Orange and with coloured jackets, Black, White, Red, Gray, Yellow, Blue, Green and Orange

It shall Be certified by Underwriters Laboratories to United States

MECHANICAL — PLUG	
Number of Plug Insertion Cycles	2500
Min. Plug Retention Force	58N (11.2 lbf)
Plug Compatibility	Compatible with RJ45
Cable to Plug Tensile Strength (min.)	20 lbs.
MECHANICAL — CABLE (STRANDED)	
Wire Size Range (Nominal)	28 AWG to 22 Stranded tinned copper
Cable Construction	S/FTP
Cable O.D. (nominal)	8.25mm (0.32 in.)
Wiring	T568A/B
Jacket Type	CM/LSOH
Bend Radius	50mm (2.0 in.)

Standards and C22.2 Canadian Telecommunications Standards

Standard Compliance:

ISO/IEC 11801-1 Ed 1.0 ANSI/TIA- 568.2-D,

1096-A IEC 60603-7, 60603-7-51

LSOH: IEC 60332-1, IEC 60754, and IEC 61034 CM - UL Listed 1863

Anatel Resolution No.242,2000 (may not apply to all assemblies listed)

Application Support

10GBASE-T

1000BASE-T

100BASE-T

10BASE-T

IEEE 802.3af (Type 1 PoE) IEEE

802.3at (Type 2 PoE) IEEE 802.3bt

(Type 3 PoE) IEEE 802.3bt (Type 4 PoE)

Power over HD BaseT (PoH)

ELECTRICAL	
Contact Resistance	20 mΩ
Input to Output Resistance	200 mΩ
Min. Dielectric Withstand Voltage (contact to contact)	1000 V DC or AC peak
Insulation Resistance	500 mΩ
Compatibility	Backwards to Cat 5e and Cat 6
Current Rating @ 25° C	1.5 A
Power over Ethernet	Suitable for PoE and PoE+
Power over Ethernet	< 10 mW/m @ 10 MHz
MECHANICAL — GENERAL	
Operating Temperature	-10 to 60° C, (14 to 140° F)
Flammability Rating	UL 94 V-0
Green Features	RoHS, lead-free, halogen-free, PVC free
Plug Housing Materials	Polycarbonate
Contact Materials	50 microinches gold plating or equivalent
Plastic Materials	Flame retardant thermoplastic
Screen	360 degree enclosure
Marking	P/N, length, performance level, etc.

Product Characteristics

1.5 Cable

All Category 6 UTP cables shall conform to the following minimum performance standards:

Have a round LSOH cable jacket available with a nominal cable O.D. of less than or equal to 7.4mm. Have a construction comprised of 4-pairs of 0.57mm (0.02 in) (23AWG) solid bare copper conductors utilizing a center isolation member to maintain pair geometry for optimal NEXT performance

Have a Foil tape surrounding the cable pairs with a drain wire with an aluminum foil tape surrounding the drain wire

Have a rip cord installed under the jacket for jacket removal and is shall be available in 305m reels

It shall be available in jacket with – LSOH

Cable Standards and Compliance

The cable shall

compliant with;

ISO/IEC 11801

(Class EA)

IEEE 802.3an ANSI/TIA-568-C.2 (Category 6) UL CM and IEC 60332-1 UL CMR and CSA FT4

LSOH: IEC 60332-1, IEC 60754, IEC 61034

Application Support

10GBASE-T

1000BASE-T

100BASE-T

10BASE-T

IEEE 802.3af (Type 1 PoE) IEEE 802.3at (Type 2 PoE) IEEE 802.3bt

(Type 3 PoE) IEEE 802.3bt (Type 4 PoE)

Power over HD BaseT (PoH)

Electrical Properties (at 20°C ± 5°C)	DC loop resistance		≤ 19.0 Ω / 100 m
	Resistance unbalance		≤ 2 %
	Test voltage	DC, 1 min, core/core	1000 V
	Insulation resistance	500 V	≥ 5000 MΩ * m
	Capacitance unbalance		≤ 1600 pF / km
	Mean characteristic impedance	At 100 MHz	100 ± 5 Ω
	Nominal velocity of propagation		Approx. 70%
	Propagation delay	At 1 MHz	≤ 570 ns / 100 m
	Delay skew		≤ 40 ns / 100 m
	Coupling attenuation	30MHz ~ 100MHz	≥ 40dB
		100MHz ~ 250MHz	≥ 40-20log(f/100)
	Balance TCL	At 1 MHz	≥ 40 dB
		At 10 MHz	≥ 30 dB
		At 100 MHz	≥ 20 dB

Mechanical Properties	Bending radius	≥ 25 mm during operation (without load)
		≥ 50 mm during installation (with load)
	Temperature range	During operation -20°C...+ 60°C
		During installation 0°C...+ 50°C

Product Performance up to 500 MHz

Typical transmission characteristics (at 20°C)												
f (MHz)	Attenuation (dB/100 m)		NEXT (dB)		PS-NEXT (dB)		ACR-F ¹⁾ (dB/100 m)		PS-ACR-F ¹⁾ (dB/100 m)		Return loss (dB)	
	Max	Typ	Min	Typ	Min	Typ	Min	Typ	Min	Typ	Min	Typ
4	3.8	3.8	66.3	69	63.3	66	58	70	55	68	23	23
10	6.0	6.0	60.3	63	57.3	60	50	62	47	56	25	25
20	8.5	8.5	55.8	59	52.8	56	44	56	41	54	25	25
62.5	15.5	15.1	48.4	51	45.4	48	34.1	46	31.1	44	21.5	21.5
100	19.9	19.1	45.3	48	42.3	45	30	42	27	40	20.1	20.1
250	33	32	39.3	42	36.3	39	22	34	19	32	17.3	17.3

1.6 Field termination Plug

- Be compatible with Cat 6 UTP, 6 UTP and F/UTP Systems
- Be UL listed for plenum environments
- The ability to color code the plug clips in black, white, red, gray, yellow, blue, green, orange and violet
- Terminates with an ergonomic and easy to use Z-tool-ZP to ensure fast and simple terminations.
- Compliant to IEC 60603-7 & 61156

- Have a lacing module that offers zero-cross termination, which eliminates pair crossing
- Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity
 - Support industry standards for T568A or T568B wiring options on each individual plug allow installation for tight spaces
 - Allow for a minimum of 5 terminations without signal degradation below standards compliance limits
 - Must be certified by Underwriters Laboratories to United States Standards and C22.2 Canadian Telecommunications Standards

1.7 Backbone Cabling

1.7.1 Multi-Mode Optical Fiber Cable (OM3)

Multimode OM4 optical fibre cables shall be utilized for backbone distances up to 300 mtrs. In addition to meeting the applicable performance specifications, all optical fiber cable shall be appropriate for the environment in which it is installed.

Have an Aqua-coloured round lead-free cable jacket available in LSOH-3 constructions. Shall contain a Rip Cord applied longitudinally under the cable jacket for easy cable jacket removal Shall contain a lightweight Central Strength member located in the middle of the fiber bundles. Shall contain both colour-coded buffered fibers as well as colour-coded buffer tubes. Cables shall have length markings in 2 ft. increments and 72. Shall meet these minimum performance parameters:

Fibre will be available in strand counts of 4, 6, 8, 12, 16, 24, 48

Minimum Performance Parameters for Qualified Cables					
Minimum Bandwidth h (MHz-km)		Maximum Attenuation (dB/km)		Group Index of Refraction	
850 nm	1300 nm	850 nm	1300 nm	850 nm	1300 nm
Laser - 4700 OFL - 3500	OFL - 500	3.0	1.0	1.483	1.479

Ethernet Applications Supported:

Application	Distance (m)
10GBASE-SX (850 nm)	550

10GBASE-LX4 (1300 nm)	300
1000BASE-SX (850 nm)	1100
1000BASE-LX (1300 nm)	600
Fibre Channel 266 (1300 nm)	1,500
ATM 622 (1300 nm)	500
ATM 155 (1300 nm)	2,000
ATM 52 (1300 nm)	3,000
FDDI (Original 1300 nm)	2,000
100BASE-FX (1300 nm)	2,000

Physical Characteristics 50/125µm:

Core Size (Microns)	Cladding Size (Microns)	Coating Size (Microns)	Buffer Size (Microns)	Core Cladding Concentricity (Microns)
50 ± 3	125 ± 2	245 ± 10	900 ± 50	≤3.0

Standard Compliance

ISO/IEC 11801:2002 OM3

ISO/IEC 11801:2002

Amendment 2 OM4ANSI/TIA 568.3-D ANSI/TIA-598-D ANSI/TIA-492 AAAD IEC 60793-2-10 Fiber Type A1a.3 Telcordia GR-409-COREIEC 60332-3, IEC 60332-1-2 (Single strand)IEC 60754-2 (Acid gas) IEC 61034-2 (Smoke density)

Application Support

APPLICATION	DISTANCE (m)
▪ 10GBASE-S (850 nm)	550
▪ 10GBASE-LX4 (1300 nm)	300
▪ 1000BASE-S (850 nm)	1100
▪ 1000BASE-LX (1300 nm)	600
▪ Fiber Channel 266 (1300 nm)	1500
▪ ATM 622 (1300 nm)	500
▪ ATM 155 (1300 nm)	2000
▪ ATM 52 (1300 nm)	3000
▪ FDD1 (Original-1300 nm)	2000
▪ 100BASE-FX (1300 nm)	2000

PHYSICAL SPECIFICATIONS (All Values Are Nominal)

Fiber Count	Nominal Cable Diameter mm	Maximum Pulling Tension Newtons		Nominal Net Weight kg/km
		Installation	Long Term	
4	5.3	1500	495	24
6	5.3	1500	495	26
8	5.8	1500	495	31
12	6.6	1500	495	37
16	7.8	1500	396	52
24	8.8	1500	495	62
48	18.3	4200	1400	255
72	21.9	5400	1800	384

Fiber Count	Maximum Crush Resistance (N/mm)	Operation Temperature °C (°F)	Installation Temperature °C (°F)	Storage Temperature °C	Minimum Bend Radius	
					Installation	Long Term
4-12	5	-40 to 70 (-40 to 158)	-10 to 60 (-14 to 140)	-40 to 70 (-40 to 158)	20 x DIA.	10 x DIA.
16-72	10	-20 to 70 (-4 to 158)	-10 to 60 (-14 to 140)	-20 to 70 (-4 to 158)	20 x DIA.	10 x DIA.

1.7.2 Single Mode Optical Fiber Cable

Single mode OS2 optical fiber cables shall be utilized for backbone distances greater than 550 mtrs

Single mode cables should be ideal for campus, building-to-building interconnections, lashed aerial, duct or underground conduits and direct burial with proper sand back filling

Water blocking, gel-filled loose tubes

The cable should utilize a corrugated steel tape for rodent protection

The cable elements should be SZ stranded FRP strength member and retained with two contra- helically applied binders

Loose tube which carries the optical fibres are manufactured from high strength, low shrinkage PBT, and also contain a thixotropic to prevent water ingress and to protect the fibers against shock.

The cable should be sheathed with an Outer jacket UV resistant black MDPE (Medium Density Polyethylene)

The cables Shall contain a Rip Cord applied longitudinally under the cable jacket for easy cable jacket removal

Fibre will be available in strand counts of 2, 4, 6, 8,12,16, 24, 36, 48, 72, 96 and 144.Shall meet these minimum performance parameters:

Fiber Type	Wavelength (nm)	Maximum Attenuation (dB/km)
Singlemode (OS1/OS2)	1310	0.40
	1550	0.30
	1310 - 1625	<0.40

The cables shall meet the following standards:

ISO/IEC 11801: Ed 2.0 Amendment:1:2008

IEC 60794-3-10 ANSI/TIA-568.3-D ANSI/TIA-598-D ANSI/TIA-492 CAAB Telcordia GR-20-COREITU-T G.652 C/D

Ethernet Applications Supported

Application	Distance (m)
10GBASE-L (1310 nm)	8,000
10GBASE-E (1550 nm)	30,000
10G Fibre Channel (Serial-1310 nm)	10,000
10G Fibre Channel (WDM-1310 nm)	10,000
1000BASE-LX (1300 nm)	5,000
Fibre Channel 266/1062 (1300 nm)	10,000
ATM 52/155/622 (1300 nm)	15,000

Physical Characteristics:

Mode and Fiber Type	Core Size (Microns)	Cladding Size (Microns)	Coating Size (Microns)	Buffer Size (Microns)	Core Cladding Concentricity (Microns)
Single mode	8.3 ± 1.0	125 ± 1.0	245 ± 10	900 ± 50	≤ 0.8

Physical & Mechanical specifications

PHYSICAL SPECIFICATIONS (All Values Are Nominal)

Fiber Count	Nominal Cable Diameter mm		Maximum Pulling Tension Newtons				Net Weight kg/km	
			Installation		Long Term			
	Non Armour	Armour	Non Armour	Armour	Non Armour	Armour	Non Armour	Armour
2	8.5	10.7	1500	2700	450	810	55	109
4	8.5	10.7	1500	2700	450	810	55	109
6	8.5	10.7	1500	2700	450	810	55	109
8	8.5	10.7	1500	2700	450	810	55	109
12	8.5	10.7	1500	2700	450	810	55	109
16	11.0	10.8	1500	2700	450	810	99	118
24	11.0	11.4	1500	2700	450	810	97	131
36	11.2	11.4	1500	2700	450	810	100	152
48	11.2	12.3	1500	2700	450	810	100	151
72	11.2	12.3	1500	2700	450	810	100	151
96	12.7	13.8	1500	2700	450	810	126	186
144	15.7	16.8	1500	2700	450	810	189	263

Fiber Type	Maximum Crush Resistance (KN)		Operation Temperature °C (°F)	Installation Temperature °C (°F)	Storage Temperature °C (°F)	Minimum Bend Radius	
	Non Armour	Armour				Installation	Long Term
2 - 144	short term: 1.5 long term: 0.75	short term: 2.2 long term: 1.1	-30 to 60 (-22 to 140)	-10 to 60 (-14 to 140)	-40 to 60 (-40 to 140)	20 x DIA.	10 x DIA.

1.7.3 Outlets/Adapters

All optical fiber outlets/adapters shall meet the following characteristics:

- Be provided in options that offer interfaces to LC terminated jumpers and pigtails.
- Provide for a maximum of a 6-Quad LC on a single adapter plate.
- Should be Erika Violet Adapters for OM4 and Blue Adapters for Single Mode
- Have pending integrated latch, which provides single-finger access to fiber even in fully populated enclosures and makes installation and updates easier
- Include Red, Blue, Black and Clear colored icons for port identification
- Be made of high impact flame-retardant thermoplastic.

1.7.4 Pigtails

All optical fiber connectors or pigtails shall meet the following characteristics:

1.7.5 LC Multimode Fiber Pigtails

Be available in standard lengths of 1 meter with lengths Feature premium 50/125 micrometer fiber that meets IEEE 802.3ae 10 Gigabit Ethernet requirements as well as IEC 60793-2-10 and TIA 492AAAC specifications for laser bandwidth Differential Modal Delay (DMD) specifications

Offer a superior connector polish that meets Telcordia and ISO/IEC specifications for end-face geometry (including radius of curvature, apex offset, and spherical undercut)

Use connectors that are complaint with colour coding specifications as listed in ANSI/TIA-568-

C.3 and ANSI/TIA-598-C

Should be Erika Violet Pigtails for OM4

Utilize precision zirconia ceramic ferrules on connectors

- Include dust caps on all connectors
- Be 100% optically tested to meet the following performance specifications:

	50/125µm

Parameter	850nm	1300nm	850nm*
Min. Cable Bandwidth (MHz km)	1500	500	2000
Max. Insertion Loss (dB)	0.25 (0.10 Typical)		
Min. Return Loss (dB)	30 (35 Typical)		

** Laser bandwidth*

1.7.6 LC Single mode Fiber Pigtails

Be available in standard lengths of 1 meter with lengths offer a superior connector polish that meets Telcordia and ISO/IEC specifications for end-face geometry(including radius of curvature, apex offset, and spherical undercut)

Use connectors that are complaint with colour coding specifications as listed in ANSI/TIA- 568-C.3 and ANSI/TIA-598-C

Utilize precision zirconia ceramic ferrules on connectors

- Include dust caps on all assemblies
- Be 100% optically tested to meet the following performance specifications:

Parameter	Singlemode
Max. Insertion Loss (dB)	0.40 (0.10 Typical)
Min. Return Loss (dB)	55 (60 Typical)

1.7.7 Patch Cords

Fiber equipment cords shall possess the following characteristics:

1.7.8 Multi-Mode LC Patch Cord

Be available in standard lengths of 1, 2, 3 and 5 meters with Lengths Utilize 50/125-m duplex multimode fiber cable that is available in LSOH grade and meets

the requirements of NEC/NFPA 70 Section 770-51(B)

Have a push-pull boot design to enhance installation and removal in high density patching environments. Have a rotating latch design to aid in polarity changes that do not damage the connector or the cable.

Clear identification when the polarity has changed. Should do Violet for OM4

Feature premium fiber that meets IEEE 802.3ae 10 Gigabit Ethernet requirements as well as IEC 60793- 2-10 and TIA 492AAAC specifications for laser bandwidth Differential Modal Delay (DMD) specifications

Offer a superior connector polish that meets Telcordia and ISO/IEC specifications for end-face geometry (including radius of curvature, apex offset, and spherical undercut)

Use cables and connectors that are complaint with colour coding specifications as listed in ANSI/TIA-568-C.3 and ANSI/TIA-598-C

Utilize precision zirconia ceramic ferrules on connectors

- Include dust caps on all assemblies
- Be 100% optically tested to meet the following performance specifications:

Parameter	50/125 µm OM4		
	850nm	1300nm	850nm*
Min. Cable Bandwidth (MHz km)	3500	500	4700
Max. Insertion Loss (dB)	0.15 (0.10 Typical)		

1.7.9 Single Mode LC Patch Cord

Be available in standard lengths of 1, 2, 3 and 5 meters with lengths utilize duplex single mode fiber cable that is available in LSOH grade and meets the requirements of NEC/NFPA 70 Section 770-51(B)

Have a push-pull boot design to enhance installation and removal in high density patching environments. Have a rotating latch design to aid in polarity changes that does not damage the connector or the cable.

Offer a superior connector polish that meets Telcordia and ISO/IEC specifications for end-face geometry(including radius of curvature, apex offset, and spherical undercut)

Use cable and connectors that are complaint with colour coding specifications as listed in ANSI/TIA-568-C.3 and ANSI/TIA-598-C

Utilize precision zirconia ceramic ferrules on connectors

- Include dust caps on all assemblies
- Be 100% optically tested to meet the following performance specifications:

Parameter	Single mode
Max. Insertion Loss (dB)	0.25 (0.10 Typical)
Min. Return Loss (dB)	55 (60 Typical)

1.8 EQUIPMENT ROOMS

1.8.1 Patch panels.

All Category 6-termination panels shall facilitate cross-connection and inter-connection using modular patch cords and shall conform to EIA standard, 19-inch relay rack mounting requirements.

- Be made of .060" thick cold rolled steel in 24-port, configurations in black and metallic colors
- Allow the use of other multimedia outlets including optical fiber and coaxial
- Be made of lightweight, high strength steel with durable black finish in 24 port, flat and angled, 1U configurations
- Have resilient ground tabs and ground lugs to assure that each outlet and cable is properly grounded
- Have a quick release lever that allows individual outlets to be easily removed even in tight installations.
- Have port identification numbers silk-screened on the front of the panel
- Accommodate 24 ports for each rack mount space (1RMS = 44.5 mm [1.75 in.])
- Have built-in cable management and strain relief integrated onto the rear of the panel
- Be provided with self-adhesive, clear label holders and white designation labels.

1.8.2 Fiber Enclosures-1u

All interconnect centers, panels and trays (units) shall provide cross-connect, inter- connect, splicing capabilities and contain cable management for supporting and routing the fiber cables/jumpers.

- Not be bigger than one rack mount space and accommodate up to 36 ports for LC adapter plates.
- Have preloaded adapter plates with 12 port version for LC adapters.
- Have blank adapter plates for future growth of the fiber infrastructure.
- Have six and eight port fiber adapter plates, which allow for color coding connectors.
- Have fiber adapter plates with snap-in installation and one-finger removal.
- Be modular in design with internal fiber managers that provide slack storage to comply with fiber bend radius and the recommended slack storage length.
- Have a Snap-On front shield to be used as a labeling surface and to protect jumpers. This shield can also relocate to another position during termination to maintain circuit identification.
- Accommodates a splice tray for mechanical or fusion splices.

- Must be certified by Underwriters Laboratories to United States Standards and C22.2 Canadian Telecommunications Standards.

1.8.3 Fiber Enclosures-2u

- Be available in black and constructed of 0.08 thickness aluminum alloy with 18-gauge steel cover.
- Feature compact 2 RMS (89.0mm [3.50 in.]) design
- Not be bigger than 2 rack mount space and accommodate up to 48 ports for LC adapter plates.
- Have blank adapter plates for future growth of the fiber infrastructure.
- Incorporate dual-level fiber managers to effectively store fiber cable slack in both the front and rear of the enclosure.
- Have integrated key-lockable front and rear transparent doors with single-finger latches and spring release hinges for removal.
- Accommodate up to four 24-fiber fusion splice trays.
- Have a sliding tray that can slide out the front and rear of the enclosure and be secured at multiple working positions as well as be fully removable for increased access.
- Have cable access points for fiber jumpers entering and exiting the unit with rotating grommets to facilitate cable loading and to minimize micro bending stress.
- Have anchor points for securing fiber cable(s) entering the unit.
- Have labeling that can be viewed with doors open or closed and meets or exceeds ANSI/TIA-606-A requirements and also be laser printable.
- Be able to mount both 19-inch and 23-inch rack/cabinets.
- Must be certified by Underwriters Laboratories to UL 1863 United States Standards and C22.2 Canadian Telecommunications Standards.

Approved Make List for ICT / IT

ICT /IT NETWORK LIST OF MAKE RECOMMENDED		
S.N.	Item Name	Makes
1	PVC/ GI/ MS Conduit	Precision/BEC/ AKG
2	CAT-6 Cable	Systimax, Molex, Panduit, R&M
3	1-meter Cat-6 Patch cord	Systimax, Molex, Panduit, R&M
4	3-meter Cat-6 Patch cord	Systimax, Molex, Panduit, R&M
5	Faceplate and GI Back Box for RJ-45 I/O	Systimax, Molex, Panduit, R&M

6	RJ-45 I/O	Systimax, Molex, Panduit, R&M
7	24 Port Cat-6 loaded patch Panel	Systimax, Molex, Panduit, R&M
8	6 cores outdoor MM-OM3 OFC.	Systimax, Molex, Panduit, R&M
9	6 Port Loaded LIU	Systimax, Molex, Panduit, R&M
10	12 Port Loaded LIU	Systimax, Molex, Panduit, R&M
11	24 Port Loaded LIU	Systimax, Molex, Panduit, R&M
12	5-meter SC-LC ofc patch cord	Systimax, Molex, Panduit, R&M
13	42U server Rack	Rittal / APW President / Valrack, Netrack
14	42U Network Rack	Rittal / APW President / Valrack, Netrack
15	9U Outdoor Rated Enclosure	Rittal / APW President / Valrack, Netrack
15	27U Network rack	Rittal / APW President / Valrack, Netrack
16	24 Port SFP+ L3 switch with 10G uplink	Cisco / HPE / Allied Telesis/Netgear/Extreme
17	24 Port Gigabit L2 switch with 10G uplink	Cisco / HPE / Allied Telesis/Netgear/Extreme
18	48 Port Gigabit L2 switch with 10G uplink	Cisco / HPE / Allied Telesis/Netgear/Extreme
19	24 Port POE+ Gigabit L2 switch with 10G uplink	Cisco / HPE / Allied Telesis/Netgear/Extreme
20	10G SFP+ MM Module	Cisco / HPE / Allied Telesis/Netgear/Extreme
21	10G stacking cable	Cisco / HPE / Allied Telesis/Netgear/Extreme
25	Cable Tray & Accessories	Profab/ Indiana/ Asawa

PASSIVE SECURITY SYSTEM WORK

1. GENERAL INTRODUCTION:

Construction of SMRT IIT KANPUR: Construction of External infra–Master plan phase 4 including Main Security Canin where the Building Passive Security systems are designed to provide the facility with the physical security system to all kinds of Administrative & Healthcare areas.

This specification lays down the general, functional, and technical specifications of Automatic/ Manual (in case of Power failure) Boom Barriers.

2. FUNCTION

The barriers are used at entrances / exits to give access to authorized vehicles & person in and out of the premises.

The operation of Boom Barriers can also be linked to access control systems (If provided) with safety systems.

3. SYSTEM CONFIGURATION

The system shall consist of fixed housing and a movable arm. The housing shall contain the motor, spring, and control unit. Remote Control, Push Button for security cabin, Manual Clutch Key for boom arm opening in case of power failure.

4. GENERAL FEATURTES

Electromechanical barriers for Entry and Exit up to 6m intensive use.

Housing finish: Powder Coated Orange/ /Painted in a combination of grey & yellow colour. (As per requirement)

The Housing base frame is Concrete Plinth of (200mm x 200mm x 20mm) to protect the housing from rusting from the bottom.

Boom: Powder Coated White with refractor strips

and LED flashing lights on top Boom Length: 6 m for extra wide lane.

Protection: All housing and internal parts have rust & corrosion free metals / alloys of high strength with suitable epoxy coating as applicable.

Easy to use external manual unlock device.

Slowing down setup with two adjustable limit switches.

Soft start and slowing down functions adjustable in opening and closing.

3.5 m white painted aluminium arm to be provided with two red rubber profiles. Flashing lights on the arm ensure barrier visibility especially at night.

Auto close with timer (1.5s to 6s)

Single / 2 Channel loop detector with programmable features (accessory) **Opening & Closing Time**

For 3 Meter: 1.5 seconds or

less for 4 Meter: 2 seconds or

less for 5 Meter: 3 seconds or

less for 6 Meter: 4 seconds or

less for 7 Meter: 6 seconds or

less Electronic module which allows the synchronized movement of two Barriers.

Painted fixed support for bars.

5. **Technical Datasheet for Boom Barrier**

TECHNICAL DATA	BOOM BARRIER
Power supply	230VAC
Motor supply	By vendor
Absorbed power	By vendor
Max. absorbed current	By vendor
Torque	By vendor
Opening speed	6 sec
Operation cycle	Intensive use
Protection level	IP 54
Operating temp.	-25°C + 55 °C
Lubrication	Grease
Weight	By vendor

Note: The Technical data given above in the table is for information only.
The vendor shall submit their technical data for boom barrier for

approval before quoting.

6. **RFID Reader & Tag-**

➤ **Environmental Specifications**

- Temperature: -40 C to +60 C (Operating), -40 C to +60 C (Storage)
- Protection Class: IP 68
- Weight: 2800 gm
- Interfaces: Rs232, RS485, Weigand26/34 (TCP/IP & WIFI Optional)
- Indicators: LED & Buzzer
- Housing: Aluminum Housing with Engineering Plastic Cover

➤ **Architecture**

- Processor: Arm 9 (Linux OS)
- POE: Power Over Ethernet (Optional)
- Power Supply Wide Voltage Input (+9V to +24V)

➤ **RFID Tag (Vendor can submit datasheet compatible with reader & controller to complete system functionality)**

- Frequency Band 865 – 868 MHz (ETSI)
- Dimension 105mm x 28mm.
- Chip Higgs-3 /4

7. **Reader Controller**

- Controls 1-2 doors (DIP switch controlled)
- Two IN/OUT readers, with tamper switch and LED control/buzzer
- Four inputs, selectable as supervised or non-supervised
- Four relay outputs (rated 5 A)
- Built-in sounder generator for chime, bell, and siren signals
- Panel configuration DIP switch
- Up to 32 access control panels in every network (64 doors in every network)
- 30,000 users
- 20,000 log events
- RS-232 or RS-485 serial communication (up to 115200 bps)
- On-board TCP/IP communication
- Remote firmware upgrades
- Removable terminal blocks

1. Approved Make List for Passive Security Works (Boom Barrier System)

PASSIVE SECURITY SYSTEM LIST OF MAKE RECOMMENED		
S. N	Item Name	Makes
1	ELECTROMECHANICAL BOOM BARRIER	FAAC, MAGTECH, DORMAKABA
2	RFID Controller with reader	ROSSLEAR, IDCUBE, EQUIVALENT TO COMPLYING SPECIFICATIONS
3	Windshield Tag	FAAC, MAGTECH, DORMAKABA
4	Cables For Boom Barriers (3Cx0.75 Sq.mm & 2C X 0.75 Sq.mm)	LAPP, KEI, POLYCAB, RALLISION, CALIPLAST

PART -F

HVAC COMPONENT

Name of work: "Construction of Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage system, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."

1 GENERAL DESCRIPTION FOR HVAC SYSTEM

1.1 **INTRODUCTION**

The proposed HVAC system has been designed for ANCILARY BLOCK & ENGINEERING YARD, INDIAN INSTITUTE OF TECHNOLOGY, KANPUR. The requirement is for providing air conditioning & ventilation system for year-round thermal environmental control.

The specifications to follow cover general requirements of design, preparation of detailed drawings, supply of material, manufacture, testing, inspection, packing, forwarding, transportation, transit insurance, and delivery at site, installation, testing and commissioning at site and carrying out acceptance test of the equipment, materials and services as per enclosed documents.

1.2 SCOPE OF WORK

The scope shall include development of a total system and design of their sub-systems as per concepts and parameters given herein, providing engineering drawings and data for approval by Engineer In-charge

This will consist of supply, installation, balancing, testing & commissioning of the following in conformity with the tender, General Terms & Conditions, Special Conditions, Specifications, attached drawings, drawings to be submitted by the Contractor and approved by the Engineer In-Charge. The Contractor shall carry out the said work under the Contract in every respect in conformity with the Contract documents and with the directions of and to the satisfaction of the supervisor. The Contractor shall furnish all labor, materials and equipment (except those to be supplied by the owner) as listed under ' ' and specified otherwise, transportation etc., for supply, installation, testing and commissioning of complete HVAC system as described in specifications and

shown on drawings. This also includes any material, equipment, work not specifically mentioned in the drawings / documents but which are necessary to make a complete installation. In general, the work to be performed under this Contract shall comprise of supply and installation of the following: -

- a) Chilled water system
- b) HVAC system pumps (Condenser water, Primary Variable CHW)
- c) Ventilation fans
- d) Filters as per requirements.
- e) Air handling unit
- f) Refrigerant & drain piping inclusive of all valves and fittings.
- g) Sheet metal ducts inclusive of canvass connections, volume control dampers and smoke dampers/Fire damper as required.
- h) Supply and return / exhaust air grills and diffusers.
- i) Insulation of all cold surfaces like, associated piping, ducts, pipes
- j) Vibration isolators for air conditioning equipment.

- k) Automatic controls and instruments.
- l) Packing and transportation from manufacturer's works to site.
- m) Receipt, unloading and conservation of equipment at site. Transportation to erection site.
- n) Pre-assembly wherever required, erection of system. The contractor shall arrange all tools, tackles and erection equipment required.
- o) Balancing, testing and commissioning of entire HVAC installation.

- p) Test reports, list of spares, as built drawings and O&M manuals for entire installation
- q) Fixing of wooden frames for Grills and Diffusers.
- r) Any kind of masonry and structural work e.g., making openings in roofs, slabs, walls for passage of ducting and piping, AC plant room, other equipment rooms, foundations for AC equipment. Cuttings holes, chases and the like through all type of non-structural walls and finishing for all service crossings including sealing, frame work, fire proofing, providing sleeves, cover plates, making good the structure and finishes to an approved standard
- s) Hoisting of equipment to require locations shall be in scope of HVAC contractor.

- t) Any kind of MS structure etc. required for successful installation of the system

1.3 ITEMS REQUIRED FOR HVAC SYSTEM BUT NOT INCLUDED IN SCOPE AND TO BE ARRANGED THROUGH OTHER AGENCIES.

- a) HVAC system shall be complete in all respects in conformity with requirements given in the tender with exception of following items, which shall be provided by other agencies. However, for these, the Contractor shall timely supply detailed drawings duly approved by the Engineer In-Charge for the provisions to be kept and shall supervise that the provisions required are correctly kept.
- b) Providing main power supply and earthing at AC equipment panels incoming as per detailed requirements given in Appendix-2 with cabling and earthing of adequate strength & length for termination in main incomers of above panels.
- c) Electric power for construction and tests of HVAC system at one point and thereafter the same shall be extended by contractor, if required.
- d) Make up water tank & piping beyond bidder's scope of work. Water in makeup water tank (Contractor shall furnish requirement of makeup water)
- e) False ceiling and boxing to cover the ducts, wherever required.
- f) Floor traps in AHU Room.

1.4 CONSULTANT'S DRAWINGS

- a) The same are as enclosed as a part of tender documents.
- b) Spaces allocated for equipment and openings as shown in the drawings are fixed and no deviation will be allowed. The drawings indicate a feasible scheme based on spaces available and equipment may be rearranged in the spaces allocated subject to Consultant's prior approval.

- c) Contractor will need to develop shop drawings duly coordinated with other services, Structural and interior drawings etc. and get prior approval on the drawings from Engineer In-Charge before start of actual installation.

1.5 BASIS OF DESIGN

The basis of design and proposed scheme are detailed in tender drawings and BOQ.

1.6 ELECTRIC SUPPLY

415 • 10%, 3 phase, 50Hz AC electric power requirements for system will be as per details given in specifications.

1.7 CODES AND STANDARDS

- a) All Equipment's, systems and works covered under this specification shall comply with all currently applicable statutes, regulations, standards and safety codes in the locality where the equipment will be installed. All equipment and systems comply in all respects with the requirements of latest editions of codes and standards as indicated in various sections.
- b) Other National Standards established to be equivalent or superior to the codes and standards specified are also acceptable. The tenderer shall furnish English translation of all standards specified in this specification.
- c) In the event of any conflict between codes and standards referred to in the specification and the requirements of this specification, the more stringent of this requirement shall govern.

LIST OF BUREAU OF INDIAN STANDARD CODES

IS 1239 (Part- I) 1979	Mild Steel Tube
IS 1239 (Part – I) 1982	Mild Steel Tubular and Other Wrought Steel Pipe Fittings
IS 4736 – 1986 (Reaffirmed)	Hot Dip Zinc Coatings of Steel Tubes
IS 778-1980	Copper Alloy Gate, Globe and Check Valves For Water Works Purpose
IS 1536-1976	Flanges Configuration

IS 5312 (Part –I) 1984	Swing Check Type Reflux Non Return Valves For Water Works
IS 2379-1963	Color Code For Identification of Pipelines
IS 554-1975	Dimension For Pipe Thread Where Pressure Tight Joints Are Required On Threads
IS 655-1963 (Reaffirmed 1991)	Metal Air Ducts
IS 277-1992	Galvanized Steel Sheet For Fencing
IS 4064 Part II-1978	Specific Requirements For Direct Switches of Individual Motors
IS 3854-1969	Switches For Domestic & Similar Purpose
IS 732 (Part III-1902)	Inspection and Testing of Installation
IS 659 – 1964 (Reaffirmed 1991)	Air Conditioning Safety Code
IS 660 – 1963 (Reaffirmed 1991)	Mechanical Refrigeration (Safety Code)
IS 4894 – 1991	Test Code For Centrifugal Fan
IS3103–1975 (Reaffirmed 1994)	Code of Practice For Industrial Ventilation
IS 7240 – 1981	Application & Finishing of Thermal Insulation Material
IS 325	Specifications For Three Phase Erection Motor

IS 3142 – 1993	V Grooved Pulley
BS-EN-779 – 1993	Particulate Air Filters For General Ventilation
IS 702 – 1988	Industrial Bitumen
IS 8183 – 1993	Bonded Mineral Wool
IS 2494 – 1993	V Belts For Industrial Purposes
IS 2062 – 1992	General Purpose Steel

ASHRAE Hand Books	American society of heating, refrigeration and air conditioning books - Applications 1999 - Fundamentals 1997 - System and equipment 1996 - Indoor air quality 62 – 1999 - ASHRAE 170-Latest Edition -

SMACNA Standards as mentioned below:

- SMACNA – HVAC Duct Construction Standards.
- SMACNA – Rectangular Industrial Duct Construction Standards.
- SMACNA – Round Industrial Duct Construction Standards.
- SMACNA – HVAC Air Duct Leakage Test Manual.

AMCA rating codes as mentioned below:

Popular Standards	
AMCA 200	APPLICATION MANUAL - AIR SYSTEMS
AMCA 200-3	FAN APPLICATION MANUAL
AMCA 201	FANS AND SYSTEMS
AMCA 202	TROUBLESHOOTING-FAN APPLICATION MANUAL PART 2
AMCA 203	FIELD PERFORMANCE MEASUREMENT OF FAN SYSTEMS
AMCA 204	BALANCE QUALITY AND VIBRATION LEVELS FOR FANS
AMCA 211	CERTIFIED RATINGS PROGRAMME - PRODUCT RATING MANUAL FOR FAN AIR PERFORMANCE
AMCA 261	DIRECTORY OF PRODUCTS LICENSED TO USE THE AMCA CERTIFIED RATINGS SEAL
AMCA 300	REVERBERANT ROOM METHOD FOR SOUND TESTING OF FANS
AMCA 302	APPLICATION OF SONE RATINGS FOR NON-DUCTED AIR

	MOVING DEVICES
AMCA 303	APPLICATION OF SOUND POWER LEVEL RATINGS FOR FANS
AMCA 311	CERTIFIED SOUND RATINGS PROGRAMME - PRODUCT RATING MANUAL FOR FAN SOUND PERFORMANCE
AMCA 410	RECOMMENDED SAFETY PRACTICES FOR USER AND INSTALLER OF INDUSTRIAL AND COMMERCIAL FAN
AMCA 500	TEST METHODS FOR LOUVERS, DAMPERS AND SHUTTERS
AMCA 501	APPLICATION MANUAL FOR AIR LOUVERS
AMCA 502	DAMPER APPLICATION MANUAL FOR HEATING, VENTILATING AND AIR CONDITIONING
AMCA 503	FIRE, CEILING (RADIATION), SMOKE AND FIRE/SMOKE DAMPERS APPLICATION MANUAL
AMCA 510	METHODS OF TESTING HEAVY DUTY DAMPERS FOR RATING
AMCA 520	LABORATORY METHODS FOR TESTING ACTUATORS
AMCA 610	METHODS OF TESTING AIRFLOW MEASUREMENT STATIONS FOR RATING
AMCA 611	CERTIFIED RATINGS PROGRAM - PRODUCT RATING MANUAL FOR AIRFLOW MEASUREMENT PERFORMANCE
AMCA 99	STANDARDS HANDBOOK
AMCA 99-2404	DRIVE ARRANGEMENTS FOR CENTRIFUGAL FANS
AMCA 99-2405	INLET BOX POSITIONS FOR CENTRIFUGAL FANS
AMCA 99-2406	DESIGNATION FOR ROTATION AND DISCHARGE OF CENTRIFUGAL FANS
AMCA 99-2407	MOTOR POSITIONS FOR BELT OF CHAIN DRIVE CENTRIFUGAL FANS
AMCA 99-2412	IMPELLER DIAMETERS AND OUTLET AREAS FOR CENTRIFUGAL FANS
AMCA 99-3001	DIMENSIONS FOR AXIAL FANS
AMCA 99-3404	DRIVE ARRANGEMENTS FOR AXIAL FANS
AMCA B201-3	AMCA FAN APPLICATION MANUAL
AMCA INDEX	AIR MOVEMENT AND CONTROL ASSOCIATION PUBLICATIONS

2 VENTILATION FANS

2.1 **GENERAL (FANS)**

Fans shall be of the type, size, arrangement and capacity as indicated in the schedule and/or as shown on the drawings.

Unless specified, fan performance rating data shall be tested accordance with AMCA Standard 210-85(Air Moving and Conditioning Association), ANSI/ASHRAE Standard 51-1985 "Laboratory Methods of Testing Fans for Rating". Sound ratings shall conform to AMCA Standard 300-85, "Reverberant Room Method for Sound Testing of Fans".

A computer printout of fan performance rating corresponding to the AMCA licensed data, with corrected ratings for altitude and temperature, fan operating speed, bearing life, etc. shall be submitted for approval.

All fans shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade after assembly. A computer printout with the vibration spectrum analysis shall be attached to the fans.

Fan motors shall comply in all respects with continuous rating in accordance with IEC34 or equivalent. Motor bearings shall be of ball or roller type, grease or lubricant sealed for life. Fan and drive shall be earthed to prevent accumulation of static charge.

Kitchen exhaust fan shall be of Bifurcated Axial or SISW Centrifugal direct or belt driven type. DIDW Centrifugal and Direct Drive Axial Flow Fan where belts or motor are in the air stream are not acceptable.

Fans shall be installed at staircase or lobby where fresh air intake is free from any obstruction and shall be energized only by fire alarm system. Fan shall be of Axial Flow Fan or DIDW Centrifugal Fan. Protective wire mesh with MERV-7 fresh air filter at the suction of the fan is required.

Fans for elevated temperature (Smoke Extraction Fans) with components rated for high temperature (250C, 2Hrs) service, with belt drive assemblies exposed to the

air stream are not acceptable.

For Smoke Extraction Fans where motor is in the air stream with electrical/electronic temperature limit switch for motor protecting shall not be used.

Anti-condensation heater is recommended to be installed for all Pressurization and Smoke Spill Fans, and the control circuit shall be arranged such the way that the heater is off when the starter is on and vice versa. Heaters shall be wired from the respective local motor control panel or motor control console.

Fan should be of G-90 high grade galvanized steel or carbon steel with epoxy coat.

If fan is open to atmosphere, Fans shall be with pure polyester powder coating for minimum thickness of 60 microns.

2.2 IN-LINEFANS

Circular/Cabinet Inline fans shall be complete with DIDW forward/backward curved centrifugal impeller fitted with external rotor motor of galvanized steel, insulated or un-insulated housing ,belt/direct driven motor, vibration isolators, direction of discharge and rotation position shall be as per the job requirement and shall be marked on the fan assembly.

Housing shall be constructed of hot rolled GSS sheet metal construction. Housing metal parts shall be either spot- welded or screwed or mounted together with rivets. Indication showing rotation arrow and make, model number and duty conditions of the fan shall be available on the housing. The fan shall be of double skin construction with 20 gauge GI outer skin with 25 mm glass wool wrapped tissue paper and covered with 20 gauge perforated GI sheet from inside shall be as specified in schedule of quantities.

Fan wheel shall be DIDW forward/backward curved type, statically and dynamically balanced.

The fan shall be provided with ball bearings can be used in any mounting position at maximum indicated temperature. The bearing lubricant shall be suitable for a minimum ambient temperature of minus 150C (admissible for a short time without reaching dew point at minus 300C). For applications at maximum indicated ambient temperature life expectancy shall be 40000 hours minimum.

Motor shall be with minimum IE2 rating. Fan motor, fans shall be supplied with built-in-thermal contact (TK) at the critical high temperature point ("B" = 1300C.

The thermal contact shall open and break the power supply to the fan; Fan motors have insulation class "B" and protection class IP54. Motor shall be suitable for external power supply 200~220V/50Hz/Single Phase OR 415+10% v/50Hz/Three Phase.

Fans shall be belt/direct driven type.

Fan should be provided with factory made built in hanging clits bolted firmly on fan body with the holes for installation.

Direction of rotation to be marked firmly on fan body.

All fan shall be electronic speed regulator & wiring with 3 pin plug top between fan & speed regulator for single phase fans. In case of 3-phase fan with DOL starter panel & FRLS power cabling, earthing etc. between starter panel & fan. The incoming power supply to speed regulator/ starter panel shall be provided by electrical contractor. Wire guard and bird-screen

Gravity louvers at fan

discharge duct outlet.

Single-phase preventers

for 3 phase fans.

Wiring between regulator and fan motor including termination at both ends.

2.3 PROPELLER FANS

Propeller fans shall be direct driven, three or four blade type mounted on a steel mounting plate with orifice ring.

Mounting plate shall be of steel construction, square with streamlined venture-inlet coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge steel sheet depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

Fan blades shall be constructed of aluminum or glass reinforced polypropylene. Fan hub shall be of heavy welded steel construction with blades bolted to the hub fan blades and assembly shall be statically and dynamically balanced.

Shaft shall be of steel accurately ground and shall not pass through first critical speed through entire range of specified fan speed.

Motor shall be with minimum IE2 rating. Motor shall be standard permanent split capacitor of shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for a quiet operation with a maximum speed of 1000 RPM for fans 60 cm dia or larger and 1440 RPM for fans 45 cm dia and smaller. Motors for larger fans shall be suitable for $415 \pm 6\%$ volts, 50 cycle 3-phase power supply and for smaller fans shall be suitable for $220 \pm 6\%$ volts, 50 cycles single-phase power supply. Motors shall be suitable for horizontal or vertical service as indicated in drawings and schedule of quantities.

Propeller fans shall be provided with following accessories: - Wire guard and

bird-screen

Gravity louvers at outlet

Regulator for controlling fan speed for single-phase fan motor. Single-phase preventers for 3 phase fans.

Wiring between regulator and fan motor including termination at both ends.

3 pin plug top with power cable with earthing from fan motor to 3 pin socket shall be Included in installation cost of fan.

2.4 SMOKE SPILL TUBE AXIAL FLOW FANS (DIRECT DRIVE)

Fans shall be licensed to bear the AMCA Air and Sound Certified Ratings Seal. The test standard used shall be ANSI/AMCA 210-85, ANSI/ASHRAE Standard 51-1985 "Laboratory Method of Testing Fans for Rating" and AMCA 300 "Reverberant Room Method for Sound Testing of fans".

To achieve the minimum and equal clearance between the blade tips and casing, tube casing shall maintain its roundness by means of using one piece of sheet metal with 90 edge flanging up.

Fan motor base support shall be properly secured (locked and sealed) to the fan housing and be of adjustable type to have precise control of motor shaft central position as well as running clearance between blade tips and casing. Motor (KW/HP) shall be able to be changed or upgraded at site without changing fan housing or ducting construction.

Fans supplied shall be complete with factory fabricated mounting bracket (ceiling or foot mounted) and suction/discharge matching flanges as accessories.

All hubs shall be cast Aluminum alloy (Grade LM2) unless for Smoke Extractor Fans where high temperature (250C/2Hrs) air is expected then Aluminum alloy or

steel fan impeller blades are required. Otherwise impeller blade material with Polypropylene (PP), Glass-reinforced Polypropylene (PPG) and Glass-reinforced Polyamide (PAG), to provide self-balancing, anti-static, anti-sparking characteristic is preferable.

Running clearance between blade tips and casing shall not exceed 1% of the impeller diameter, and 2% for smoke spill high temperature fan where mechanical expansion coefficient is different from normal ambient temperature. Fan manufacturer shall provide the fan assembled with the same clearance between blade tips and casing of the tested prototype. Note that the air performance and pressure loss are greatly affected by this clearance.

Impellers shall be secured to the drive shaft by a key and keyway. Axial location shall be provided by a collar or shoulder on the drive shaft together with a retaining washer and screw fitted into a tapped hole at the end of the shaft and locked in position. Blades shall be secured in place to the angle setting by setscrews, locking nuts or setting pins.

Fan motor shall be totally enclosed and external terminal box of at

least IP56 shall be provided. Motor shall be with minimum IE2

rating.

Fans shall not exceed 1500 RPM.

All fans after assembly shall be dynamically trim-balanced to ISO1940 and AMCA 204/3 - G2.5 quality grade. A computer printout with vibration spectrum analysis shall be attached to the fans.

Fan should be of G.S.S. , the Steel sheet should be JFE Galva zinc (Base metal cold rolled), JIS G3302, SGCC with Z22 (minimum coating weight on both sides @ 220 g/m2) zinc coating & Zero Spangle, skin passed, chromate and dry.

2.5 TUBE AXIAL FLOW FANS (DIRECT DRIVE)

Fan shall be complete with motor, motor mount, direct driven and vibration isolation type, suspension arrangement as per approved for construction shop drawings. Fresh air fans shall be equipped with filters as specified in schedule of quantity.

Casing shall be constructed of heavy gauge sheet steel. Casing shall be provided with hinged door enabling easy replacement 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. An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Fan casing are with internal punched inlet and outlet flanges to prevent air leakage, for size up to 1600 mm dia. and shall be constructed of rolled steel with a continuous seam welded. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed (minimum 2 coats of rust-proof primer) and finish coated with enamel paint or powder coated after phosphating process.

Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be de-rusted, cleaned, primed and finish coated with enamel paint.

Rotor hub and blades shall be of cast aluminum, or cast steel construction. Blades shall be die-formed aero foil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blade mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control maybe manually re-adjustable at site, upon installation, for obtaining actual airflow values, as specified.

Motor shall be with minimum IE2 rating. Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be conform to IS: 1822 —Motor starters of voltage not exceeding 1000 volts|| and shall be air insulated and suitable for 415 volts, + 10%, 50 Hz., 3 phase AC supply. Enclosures shall have protection of IP 54.

Starter for the motor shall be direct on line (D.O.L) for motors up to and including 7.5 H.P. rating and automatic star-delta close transition type for motors of higher ratings unless otherwise specified in the tender specifications. Starters shall be rated for intermittent duty. Starting current should not exceed two times the full load current.

The starter shall be mounted on the main electrical control panel/ unit mounted/ self-mounted as specified.

Each starter shall be provided with the following protections: -

a) Thermal overload on all the three phases with adjustable settings,

- b) Under voltage protection, and
- c) Independent single phasing preventer. (current sensing type)

Adequate number of extra NO/ NC contacts for interlocks, indicating lamps etc. shall be provided on the starter/ contactor.

The noise level of the fan shall not be more than 80 dB measured from 3 M from the unit.

The speed of fan shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1450 RPM for fans with impeller diameter of 450 mm and less.

Vibration Isolation

Base shall be provided for each fan. Base for both fan and motor shall be built as an integral part and shall be mounted on a concrete foundation through cushy foot vibration isolators. The concrete foundations shall be at least 15 cm above the finished floor level and shall be further isolated from the structural floor through 5 cm. Thick layers of sand all around, topped with bitumen. In case ceiling hung fan within the ceiling shall be provided Vibration Isolation Suspension (VIS) shall be provided in each of string.

2.6 CENTRIFUGAL FANS

Centrifugal fans shall be of double-width, double-inlet construction, with bearing on both sides, complete with access door, squirrel-cage induction motor, V-belt drive, belt guard etc.

The Fan & motor assembly should be weatherproof, suitable for outdoor mounting and application. Fan to be UL 762 certified for kitchen & restaurant exhaust application all fans should be AMCA rated and UL listed

Housing shall be of heavy gauge sheet steel in welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans. However neoprene/ asbestos packing shall be provided throughout split joints to make it airtight. 1.2 mm galvanized wire mesh inlet guard, of 5 cms sleeves shall be provided on both inlets. Housing shall be provided with access door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

Fan wheel shall be of GSS and backward curved non-overloading type unless otherwise specified. Fan wheel and housing shall be statically and dynamically

balanced. Fan outlet velocity shall not exceed 610 meters per minute.

Shaft shall be constructed of steel, turned, ground and polished.

Bearings shall be of the sleeve/ball bearing type mounted directly on the fan housing. Bearing shall be self-aligned, oil grease packed, pillow block type.

Drive to fan shall be provided from 3 phase electric motor through belt with adjustable motor sheave and belt guard. Belt shall be of the oil resistant type. The number of belts shall be not less than two.

Motor shall be with minimum IE2 rating and TEFC type. Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be conform to IS: 1822 —Motor starters of voltage not exceeding 1000 volts|| and shall be air insulated and suitable for 415 volts, + 10%, 50 Hz., 3 phase AC supply. Enclosures shall have protection of IP 54.

Starter for the motor shall be direct on line (D.O.L) for motors up to and including 7.5 H.P. rating and automatic star-delta close transition type for motors of higher ratings unless otherwise specified in the tender specifications. Starters shall be rated for intermittent duty. Starting current should not exceed two times the full load current.

The starter shall be mounted on the main electrical control panel/ unit mounted/ self-mounted as specified.

Each starter shall be provided with the following protections: -

- a) Thermal overload on all the three phases with adjustable settings,
- b) Under voltage protection, and
- c) Independent single phasing preventer. (current sensing type)

Adequate number of extra NO/ NC contacts for interlocks, indicating lamps etc. shall be provided on the starter/ contactor.

2.7 CABINET FANS (BELT DRIVEN)

The impellers of the fan or fan shall be of GI sheets, double inlet backward curved centrifugal design, both statically and dynamically balanced. The fan housing shall be of sturdy construction made from double skinned GSS casing

Having 0.6mm pre-coated GI sheet outside and plain 0.6mm thick GI sheet inside with 25 mm thick puff insulation with smooth air inlets.

The fan shall be mounted on properly aligned shaft and mounted on self-aligning bearing blocks. The casing of the fan section shall be made of 16 G (1.6mm) GI sheets suitably reinforced to provide rigidity. The frame work shall either be folded G.I. sheets or of hot dipped galvanized iron.

Fresh air fans shall be equipped with filters as specified in schedule of quantity

The fan section shall be complete with V belt drive, belt guard and motor mounting base in case of Belt driven type. Drive to fan shall be provided from 3 phase electric motor through belt with adjustable motor sheave and belt guard. Belt shall be of the oil resistant type. The number of belts shall be not less than two.

Motor shall be with minimum IE2 rating. Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be conform to IS: 1822 —Motor starters of voltage not exceeding 1000 volts and shall be air insulated and suitable for 415 volts, + 10%, 50 Hz., 3 phase AC supply. Enclosures shall have protection of IP 54.

Starter for the motor shall be direct on line (D.O.L) for motors up to and including 7.5 H.P. rating and automatic star-delta close transition type for motors of higher ratings unless otherwise specified in the tender specifications. Starters shall be rated for intermittent duty. Starting current should not exceed two times the full load current.

The starter shall be mounted on the main electrical control panel/ unit mounted/ self-mounted as specified.

Each starter shall be provided with the following protections: -

- a) Thermal overload on all the three phases with adjustable settings,
- b) Under voltage protection, and
- c) Independent single phasing preventer. (current sensing type)

Adequate number of extra NO/ NC contacts for interlocks, indicating lamps etc. shall be provided on the starter/ contactor.

2.8 CABINET FANS (DIRECT DRIVEN)

Cabinet Inline/Cabinet backward curved type direct driven fans installed in ICU/HDU and other clinical areas. The impellers of the fan or fan shall be of GI sheets. The fan housing shall be of sturdy construction made from double skinned GSS casing having 0.6mm pre-coated GI sheet outside and plain 0.6mm thick GI sheet inside with 25 mm thick puff insulation with smooth air inlets. The fan shall be mounted on properly aligned shaft and

mounted on self-aligning bearing blocks. The casing of the cab section shall be made of 16 G (1.6mm) GI sheets suitably reinforced to provide rigidity. The frame work shall either be folded G.I. sheets or of hot dipped galvanized iron.

The fan section shall be complete with brushless EC motor mounting base.

Drive to fan shall be provided from 3 phase electric motor through direct drive type complete with Brushless EC motor.

Motor shall be with minimum IE2 rating. Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be conform to IS: 1822 —Motor starters of voltage not exceeding 1000 volts|| and shall be air insulated and suitable for 415 volts, + 10%, 50 Hz., 3 phase AC supply. Enclosures shall have protection of IP 54.

The Fan speed must be 100% adjustable with the potentiometer placed in the connection box. Fan should be send Analogue input with terminals in the terminal box to control the fan with 0-10V input signal. Models are suitable for mounting in any orientation and operation within ambient air temperatures between -20°C up to +40°C

Starter for the motor shall be direct on line (D.O.L) for motors up to and including 7.5 H.P. rating and automatic star-delta close transition type for motors of higher ratings unless otherwise specified in the tender specifications. Starters shall be rated for intermittent duty. Starting current should not exceed two times the full load current.

The starter shall be mounted on the main electrical control panel/ unit mounted/ self-mounted as specified.

Each starter shall be provided with the following protections: - Thermal overload on all the three phases with adjustable settings, Under voltage protection, and Independent single phasing preventer. (current sensing type)

Adequate number of extra NO/ NC contacts for interlocks, indicating lamps etc. shall be provided on the starter/ contactor.

3 **TWO-STAGE EVAPORATIVE COOLING UNIT**

3.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of two stage evaporative direct/indirect cooling unit for use in kitchen fresh/make-up air.

Evaporative coolers are cooling systems that use only water and a blower to circulate air.

In the system, warm, dry air is pulled through a water-soaked pad. As the water evaporates, a cooling effect on the surrounding air occurs. Evaporative coolers use only a fraction of the energy of traditional air conditioning systems. Unfortunately, except for in very dry climates, they may increase humidity to a level that makes occupants uncomfortable. Two-stage evaporative coolers do not produce humidity levels as high as that produced by traditional single-stage evaporative coolers.

Features

In the first stage of a two-stage cooler, warm air is pre-cooled indirectly without adding humidity (by passing inside a heat exchanger that is cooled by evaporation on the outside).

In the direct stage, the pre-cooled air passes through a water-soaked pad and picks up humidity as it cools. Because the air supply to the second stage evaporator is pre-cooled, less humidity is added to the air (because cooler air can't hold as much moisture as warmer air).

This results in a cool air with a relative humidity between 50 and 70 percent, depending on the climate, compared to a traditional system that produces about 80 percent relative humidity air.

An advanced two-stage evaporative cooler uses 100 percent outdoor air and a variable speed blower to circulate cool air.

Benefits

Two-stage evaporative coolers can reduce energy consumption by 60 to 75 percent

over conventional air conditioning systems.

This relative improvement depends on location and application. Evaporative coolers work best

in very dry climates.

3.2 TYPE

The evaporative units shall be double skin construction, draw-thru type comprising of various sections, filter section, direct/indirect cooling section, fan and motor section as per required application as mentioned in BOQ in suitable horizontal configuration. As shown on drawings and included in schedule of quantities.

3.3 CAPACITY

The air-moving capacity of unit shall be as shown on Drawings and in Schedule of Quantities

and as per kitchen consultants.

The evaporative unit capacity of the cooling and air quantity from the blower fan and static pressure of blower fan shall be as laid down in the tender documents. Where these parameters as calculated by the tenderer exceed the specified values, the blower fan shall satisfy these calculated values.

The designed face velocity of air not exceeding 155 m/min.

The requisite static pressure demanded by the air circuit shall be developed by the fan at the selected operating speed. The static pressure value shall not in any case be less than 65 mm water gauge in evaporative case, The fan motor HP shall be suitable to satisfy these requirements and the drive losses.

3.4 CASING:

Double skinned panels shall be 40+/-2 mm thick double Skin Panels with thermal break profile, shall be made of 0.63mm Pre-coated GI

on outside and 0.63mm GI inside with CFC – FREE polyurethane foam insulation of 40 (+/- 5%) kg/Cu M injected in between with an internal gasket between the skins to interrupt the thermal bridge of the panel.

The entire framework shall be mounted on an aluminum alloy/galvanized steel or heavy duty engineering composite material (depending on size) channel base as per manufacturer's recommendation. Panels shall be assembled together to form an enclosure that is capable of low air leakage potential, conforming to class A of EN 1886:2007. Handles shall be made of hard nylon and all access panels should be open-able with Allen key arrangement. Units supplied with various sections shall be suitable for on-site assembly with continuous foam gasket. All fixing and gaskets shall be concealed.

Units shall have hinged or removable type quick opening access door in the fan section and also in filter section where filters are not accessible from outside. Access doors shall be double skin type. All the section of air handling units should be accessible for easy maintenance.

Internal panels shall be fabricated so that there are no gaps between the panel and frame work. Fabrication clearances shall be closed with blank-off pieces or with sealant. Partitions shall be of sufficient thickness to prevent deflection and vibration during unit operation. Manufacturer shall provide suitable stiffening by means of box type members across the same.

Unit shall be with clean inside surfaces with beveled corners to the best possible extent without crevices as may allow growth of algae / fungus. In case on internal fittings such as dampers, the same shall be with beveled edges and without sharp corners to prevent operator injury. There shall be no screws projecting into unit or air stream. If the same is unavoidable, the tips shall be fitted with rubber caps to prevent operator injury.

Unit panels shall be factory fitted with pressure ports for DPT installation. The number and size of these shall be confirmed in the unit technical approval stage. In case opening is to be made in unit panel, the same shall be with C-channel all around to prevent entry

of PUF into air stream. The channels shall be cut at 45 degrees at the corners to avoid overlap. Material for the channel shall be same as that of internal skin of unit.

Rubber grommets shall be provided at all entry points into unit such as piping connection, cable entry etc. The same shall be double lip tight fitting to prevent air leakage.

All access doors shall be outward opening. For doors provided downstream of the fan, especially in high static units, additional clamps shall be provided along periphery of door to maintain constant pressure and ensure proper sealing.

3.5 DAMPER:

Dampers shall be opposed blade type. Blades shall be made of 16 G double skinned airfoil aluminum sections with integral gasket and assembled within a rigid extruded aluminum alloy frame. All linkages and supporting spindles shall be made of aluminum or nylon, turning in teflon bushes. Manual dampers shall be provided with a bakelite knob for locking the damper blades in position. Linkages shall be extended wherever specified for motorized operation. Damper frames shall be sectionalized to minimize blade warping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure. Damper construction shall be such a that there is no rattling noise, when damper is partially (close to 50%) closed & unit is ON.

3.6 MOTOR & DRIVE:

Fan motors shall be energy efficient (IE-3) and shall be $415 \pm 10\%$ volts, $50 \pm 5\%$ cycles, three phases, totally enclosed fan-cooled class F, with IP-55 protection. Motors shall be especially designed for quiet operation. Belt driven backward cured DIDW fans shall be used for SA. Provision for cable entry to the motor shall be made at the factory itself. Drilling of holes at site shall not be acceptable. Limit switch arrangement along with wiring shall be provided, so

that when access doors opens, fan stops. Motor shall be epoxy painted.

3.7 BACKWARD CURVED DIDW FAN:

Fans shall be belt drive backward curved DIDW fan with aerofoil design blades for kitchen exhaust areas of floor mounted units. **The entire fan with casing will be certified by a reputed 3rd party internationally acclaimed certifying body like Eurovent, or AHRI or AMCA,** and the entire Fan + Motor assembly will be balanced at supplier's works before dispatch . Fans drive shall be suitable for variable frequency drive shall be backward inclined irrespective of static pressure value. Fans shall be selected for minimum efficiency of 70%. MS epoxy coated in case of backward curved DIDW fans. For DIDW Fan shaft shall be grounded C40 carbon steel and supported in self-aligning Plummer block operating less than 75% of first critical speed, grease lubricated bearings. Fan wheels and pulleys shall be individually tested and precision balanced dynamically. Fan motor assembly shall be statically and dynamically balanced to G6.3 grade as per relevant ISO/AMCA standard. **Certified Computerized selection for unit shall be with fan selection and sound level spectrum. Complete unit sound level should be given in computerized selection sheet instead of sound level of bare fan.**

Motors shall be mounted inside the unit casing on rigid frame/ slide rails for alignment, and be totally enclosed, fan cooled, to be class 'F' insulation.

Heavy duty anti-vibration mounts shall be provided for isolating the unit casing. Fire retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan inlet/ discharge.

3.8 DRAIN PAN :

Condensate drain pan shall be fabricated from 1.25mm thick SS304 stainless steel sheet and a minimum of 25mm deep with all corners welded. It shall be isolated from bottom floor panel through 10

mm thick closed cell Polyethylene foam insulation or elastomeric nitrile rubber or puff with necessary dual slope to facilitate fast removal of condensate. Necessary supports will be provided to slide the coil in the drain pan.

3.9 FILTER:

The air used in a system must be filtered to maintain a clean atmosphere in the conditioned space. The concentration of contaminants in the air and the degree of cleanliness required in the conditioned space will determine the type of filter or filters that must be used.

PRE-FILTERS (MERV-8) :

Cleanable metallic viscous type filter made out of aluminium wire mesh or of dry cleanable synthetic type minimum 50mm thick, shall be provided on the suction side of AHU as standard equipment with the unit. These filters shall have the efficiency of 90% down to 10 micron particle size. When these filters become loaded or full of dirt, it is removed from service and replaced by another filter. The dirty filter can then be washed in a cleaning solution in a tank, dried and then given a bath of viscous oil. Face velocity across these filters shall not exceed 155 MPM.

3.10 COOLING PAD:

The cooling pads shall be of honey comb design to provide extended and sufficient wetted surface to give a water absorbing efficiency of at least 80% at an air velocity of 3.0 m/sec.

The cooling pads shall be made of either acetate paper or high impact PVC. The cross section and depth shall be sufficient for specified efficiency. The cooling pad section shall be of 16 G (1.6mm) G.I. sheet similar to fan section. It shall be complete with galvanized supports for mounting the pads and a water distribution through the uniform supply of water over the entire surface.

Sensible Heat Exchanger

The fresh air taken shall be cooled sensibly before mixing of water to the air stream. This is the first heat exchanger in an IDEC unit. The construction of it should be such that the air being sensibly cooled (i.e. without adding water/air to it) should not get in contact with scavenging air.

The heat exchanger shall have peak wet bulb efficiency of 80%. This heat exchanger module shall be made of engineering polymer with a cellulosic media thermally fused. The velocity within the heat exchanger should not exceed 450 FPM(2.3 m/s) at any given cross section on heat exchanger face area. These need to be stacked up modularly to required air capacity. These heat exchanger modules shall facilitate a secondary air passage without mixing with the primary air flow. The heat exchanger shall be UL type tested.

Adiabatic Heat Exchanger

This shall be of imported cellulose paper pads and of cross fluted configuration assembled in self-supporting pads in a light weight construction. The pads shall be able to redistribute the water and shall be impregnated with insoluble anti-rot salts, rigidifying saturates and wetting agents with built in eliminators. The velocity across the fill shall not exceed 450 fpm (2.3 m/s) and shall not allow carryover of water. Minimum thickness of fill shall be 200 mm and minimum efficiency of pads 90%.

3.11 WATER SUMP:

The water sump below the pad section shall be of minimum 1mm SS 304. The tank shall be complete with makeup, overflow and drain connections. A float valve shall be provided for makeup water line.

The pump set shall be of construction, with end suction and top discharge with flanged connections, bronze impeller and casing all mounted directly on a squirrel cage, drip proof induction motor of suitable capacity. Distribution pumps (1W+1S) shall be provided for both stages. Internal distribution piping of GI IS-1239 Class-C with nozzles shall be included for efficient water distribution. Necessary valves and strainer shall be provided for pumps.

Power for pumps, scavenger fan etc. shall be obtained from starter panel along with internal power cabling.

3.12 MISCELLANEOUS:

Necessary accessories shall be provided wherever necessarily required for proper operation and shall also include:

- 1) Necessary GI piping for water circulation
- 2) Vibration isolations pads for the blowers and pumps
- 3) Canvass connections at the outlet of each fan
- 4) Nuts, bolts, shims etc. as required for the grouting of the equipment
- 5) Float valves in the air washer tank, along with quick fill connection

3.13 VIBRATION ISOLATORS:

Vibration isolators shall be provided with all air handling units. Vibration isolators shall be cushyfoot mounting type.

3.14 NOISE LEVEL:

For Floor mounted unit: Not more than 75 dBA at 2 Mtr. Distance

3.15 ACCESSORIES:

Each air handling unit shall be complete with the following **as part of Unit price.**

Flexible connection between the fan outlet and duct.
Vibration isolators of 90% efficiency.

Opposed blade damper at supply air, return air & fresh air point in unit section.

3.16 PANITING:

Shop coats of low VOC 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 paint to match the finish over the adjoining shop painted surface.

3.17 INSTALLATION:

Unit installation shall be carried out as per manufacturer's recommendation and mounted on serrated rubber pads/neoprene pads/vibration isolating spring in case of floor mounted units and

GI hangers of suitable sizes shall be used for hanging ceiling suspend units.

3.18 PERFORMANCE DATA:

Unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing, commissioning of the installation.

Computerized selection for unit shall be provided through 3rd party certified software for all the FMUs.

3.19 TESTING:

Capacity of unit shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and at outlet.

Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury in glass thermometer. Computed result shall conform to the specified capacities and quoted ratings. Consumption shall be computed from measurements of incoming voltage and input current.

Witness test by MEP consultant and client shall be required at manufacturer place prior to dispatch of material on site.

4 DUCTING & PIR DUCTING (FACTORY FABRICATED & SITE FABRICATED) SHEET METAL WORKS AND ACCESSORIES – SPECIFICATIONS

4.1 GENERAL

The work under this part shall consist of furnishing labor materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, and exhaust system ready for operation as per drawings.

Except as otherwise specified all duct work and related items shall be in accordance with these specifications.

Ductwork shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers, Duct accessories like Flexible connections constructed of fire

resistance flexible double canvas sleeve ,splitters, turning vanes, supporting, flanges, nut bolts, rods ,hangers, bird screen etc. shall be included in the part.

Insulation thickness to be considered while designing duct size wherever ducts are to be insulated on internal surface to take care of friction loss.

Contractor will need to submit technical data sheet of each and every equipment and ancillaries to Engineer In-Charge & get approval prior to procurement

All Equipment & Ancillaries etc. shall be factory inspected by Engineer In-Charge and Client Representative prior to dispatch on site.

All necessary site housekeeping, civil work & MS structure required for successful installation etc., material security, site construction lighting etc. required for site work shall be inclusive in the scope of vendor.

4.2 DUCT MATERIALS

All ducts shall be fabricated either from Galvanized Sheet Steel (GSS) conforming to IS: 277 or aluminum 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.

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 galvanized steel sheets, in case of G.I. sheet ducting or 1.8 mm thick aluminum sheet, in case of aluminum sheet ducting and shall be stiffened with 25 mm x 25 mm x 3 mm angle iron braces.

Circular ducts, where provided shall be of thickness as specified in IS: 655 as amended up to date.

Aluminum ducting shall normally be used for OT's, Positive isolation rooms, MRI and critical areas wherever high cleanliness standards are functional requirements.

4.3 GOVERNING STANDARDS

Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards-Metal and Flexible-Second Edition- 1995" SMACNA)

4.4 RAW MATERIAL

Ducting

All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. raw material furnished with accompanying Mill test Certificates.

Galvanizing shall be of 120GSM. (Total coating on both sides).

In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

The G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross-section dimensions.

4.5 DUCT CONNECTORS AND ACCESSORIES

All transverse duct connectors (flanges/cleats) and accessories/related hardware are such as support system shall be zinc-coated (galvanized). Bird screen on duct outlet wherever required shall be provided.

4.6 FABRICATION STANDARDS

All ductwork including straight sections, tapers, elbows, branches, shoe pieces, collars, terminal boxes and other transformation pieces should be factory-fabricated will require fabrication by utilizing the following machines and processes to provide the requisite quality of ducts and speed of supply.

Coil lines to ensure location of longitudinal seams at corners/folded edges only to obtain the required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.

All ducts, transformation pieces and fittings to be made on CNC profile cutters for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.

All edges to be machine treated using lock formers, flanges and roller for turning up edges. In the case of ambiguity, SMACNA codes to be followed for duct fabrication and installation.

Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.

4.7 SELECTION OF G.I. GAUGE AND TRANSVERSE CONNECTORS

Duct Construction shall be in compliance with norms as per SMACNA.

All transverse connectors shall be the 4-bolt slip-on flange system imported makes of similar 4-bolt systems with built-in sealant if any to avoid any leakage additional sealant to be used.

Non-toxic, AC-applications grade P.E. or PVC cascading is required between all mating flanged joints. Gasket sizes should conform to flange manufacturer's specification.

4.8 DUCT CONSTRUCTION

Ducts so identified on the Drawings shall be acoustically lined and insulated as described in the section "Insulation". Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required .The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.

Dimensional Tolerances: All fabricated dimensions will be within ± 1.0 mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be ± 1.0 mm per meter.

Each and every duct pieces should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge.

Ducts shall be straight and smooth on the inside Longitudinal seams shall be airtight and at comers only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness.

Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

Plenums shall be shop/factory fabricated panel type and

assembled at site. Factory Fabricated ducts shall have

the thickness of the sheet shall be as follows Thickness

of sheet shall be as per the table given below:

Maximum Side (mm)	Thickness (mm)	
	Galvanized Steel Sheet	Aluminum Sheet
Up to 750 mm	0.63	0.80
751-1500	0.80	1.00
1501-2250	1.00	1.50
2250-2500	1.20	1.80
Plenums and Ducts above 2500	1.60	

The bracing shall be as per ISS 655-1964. Supports for ducts at 2.4m distance apart up to 2250/1.2m distance apart for larger ducts.

Ducts shall be rectangular in cross section and fabricated in accordance with the following table:

Maximum Side of Duct (mm)	Minimum Thickness of Sheet (mm/SWG)	Fastener Size	Transverse Joints	Reinforcement	Hang er Rod Dia (mm)
Up to 400	0.63 (24 SWG)		GI Flange joint	Cross Break	10
401 to 750	0.63 (24 SWG)	3/8"	GI Flange joint	25 X 25 X 4.2 Girth angle @ 1000 mm c/c	10
751 to 900	0.80(22SWG)	3/8"	38x38x4.2	25 X 25 X 4.2	10
			Companion Flanges	Girth angle @ 1000 mm c/c	
901 to 1500	0.80(22SWG)	5/8"	38x38x4.2	38x38x4.2	10
			Companion Flanges	Girth angle @ 760 mm c/c	
1501 to 2250	1.00(20SWG)	5/8"	38x38x4.2	38x38x4.2	10
			Companion Flanges	Girth angle @ 760 mm c/c	
2250 and above	1.25(18 SWG)	5/8"	50x50x4.2	50x50x4.2	12
			Companion Flanges	Girth angle @ 610 mm c/c	
Plenums	1.25(18 SWG)	5/8"	50x50x6.4	50x50x6.4	12
			Companion Flanges	Girth angle @ 610 mm c/c	

The gauges, joints and bracings for sheet metal duct work shall further conform to

the provisions as shown on the drawings. All nuts, bolts and washers shall be zinc plated steel. All rivets shall be galvanized or shall be made of magnesium - aluminum alloy. Self-tapping screws shall not be used.

Ducts larger than 600 MM shall be cross broken, duct sections up to 1200 MM length may be used with bracing angles omitted.

Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer-In-Charge.

All ducts shall be supported from the ceiling/slab by means of G.I .threaded Rods of 10 MM (3/8") DIA with G.I. slots at the bottom. The rods shall be anchored to R.C. Slab using metallic expansion fasteners.

Girth angles and companion flanges shall be mitered and welded at corners and riveted to duct sheets at 75mm centers. Flanged joints shall be made with 9.5-mm GI bolts spaced at 1.5cm centers and provided with 4.2mm rubber or 6.0mm. All joints and seams shall be rendered airtight. All duct seams and joints to be sealed with silicon sealant to stop supply air leakage. Duct panels are not to be cross broken if insulated. Longitudinal seams shall be inside groove of Pittsburgh type. All ducting supports, bracing and framework shall be painted with 2 coats of epoxy primer and 2 coats of epoxy paint min. (50 microns).

Self-adhesive food grade Neoprene rubber shall be used between duct flanges and between duct supports in all ducting installation.

All fire rated duct, smoke exhaust ducts shall be quoted with flame bar BWII or equivalent to achieve the required fire rating also all the related accessories gaskets shall be suitable for the required fire rating.

4.9 FLEXIBLE DUCTS

An uninsulated flexible duct shall be made of double lamination of metalized polyester film permanently bonded to a coated spring steel wire helix. Duct shall be in tear & puncture resistant construction.

For insulated flexible duct where specified, inner core for the same should be made of double lamination of metalized polyester film permanently bonded to a coated spring steel wire helix. Fiberglass insulation of minimum 14 kg/ cu.m density, 25 mm thickness shall be wrapped over the inner core & covered with strong outer jacket cum vapor barrier made of fiber glass reinforced metalized polyester film laminate.

4.10 INSTALLATIONS

All ducts shall be installed generally as per tender drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor:

During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer-In-Charge.

Great care shall be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.

All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.

The ducts shall be re-enforced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.

The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge. The contractor shall verify all measurements at site and shall notify the Engineer-In-Charge of any difficulty in carrying out his work before fabrication.

Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.

Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.

Joints requiring bolting or riveting may be fixed by Hexagon nuts and bolts,

stove bolts or buck bolts, rivets or closed center top rivets or spot welding. Self-tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.

Fire retarding flexible joints is to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-In-Charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.

The flexible joints are to be not less than 75 MM and not more than 250 MM between faces.

The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.

Duct passing through brick or masonry, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof. Proper fire sealant to be provided for all wall openings

4.11 DOCUMENTATION TO MEASUREMENTS

For each drawing, all supply of ductwork must be accompanied by computer-generated detailed bill of material indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable.

Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.

All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.

4.12 TESTING

After duct installation, a part of duct section (approximately 5% of total ductwork)

may be selected at random and smoke tested for leakage. The procedure for leak testing should be followed as per SMACNA- "HVAC Air Duct Leakage Test Manual: (First Edition).

QUALITY CHECKS ON DUCTING

SL	DESCRIPTION	YES OK - X	NO	REMARKS
1	Whether material adheres to Fabrication Standards as specified (Lock form Quality Sheets)			
2	Valid for construction (VFC) Drawings. At site.			
3	Cross breaking, bracings / reinforcements are as per standard.			
4	Air tightness of transverse / Longitudinal Joints ensured.			
5	Grease and heat resistant sealant for kitchen exhaust duct.			
6	Check following aspects of duct supporting system			
6.1	Hanger spacing			
6.2	Anchor bolts size and quality			
6.3	Primer painting of supports			
6.4	Check allowable load on trapeze angle for bigger ducts			
7	Check whether contractor has provided			
7.1	Vanes in elbows			
7.2	Starting collars and take Offs			
7.3	Splitters			
8	Check transitions & offsets slopes & fabrication.			
9	Whether the installed ducting is as per layout approved, check locations, headroom etc.			
10	Whether grilles / diffusers are as per approved shade by Architect & Interior.			
11	Check the method of installation for Grilles / Diffusers			
12	Repair / paint damaged surfaces.			
13	Check the coordination of following activities as per the given sequence:-			
13.1	Main Ducts Cut for taking collars			
13.2	Match / Fabricate collar taking false ceiling framework for diffuser into account			
13.3	Fix grilles / diffuser framework in false ceiling			
13.4	Install the collar			
13.5	Install diffuser			

14	All elbows / turning points and branches to be properly supported		
15	Access door is provided at serviceable position for fan and fire damper		
16	Air balancing for room is studied		
17	Air replacement is considered for air exhausted from room.		
18	PVC or stainless steel material is used for corrosive fume exhaust system.		
19	Anti-vermin netting installed for louvers removable and serviceable.		
20	Water or gas vent outlet is not installed near air intake louver.		
21	Kitchen exhaust is not short circuited to outdoor air intake louver.		
22	Kitchen room pressure is slightly below the surrounding area.		
23	Sound level of fan is studied.		
24	Face velocity for louvers / grills / diffusers is studied.		
25	Air distribution of the room is studied.		
26	Cross break all flat surfaces to prevent vibrations or buckling due to air flow.		
27	Sides of ducts having collar for grills should not be cross broken to facilitate alignment of grills.		
28	All bends and collars should have vanes.		
29	If duct passes through fire chamber increase sheet thickness.		
30	Kitchen exhaust ducts to be tapered at bottom for oil / grease collection.		
31	Avoid flanged joints in kitchen exhaust duct above false ceiling.		
32	When aluminum ducts are used with steel angles, steel to be painted with Zinc chromate paint		
33	Provide check nuts with duct hangers		
34	Ducts below 250 mm should not be more than 1 m long to facilitate proper joining.		
35	Plenums should have flanged and bolted ends for rigidity and easy maintenance.		
36	Avoid 'U' bends in ducts		
37	Provide long radius bends and offsets.		
38	No collars to be taken from top.		
39	Install duct spool pieces near equipment for easy removal.		

4. A PIR Ducting (Pre- Insulated Ducting)

PIR DUCTING WORKS AND ACCESSORIES – SPECIFICATIONS

4.13 General

The duct shall be fabricated out of sandwiched panels made up of Complete HCFC Free PolyIsocyanurate Rigid Foam between Aluminium Foils on both the sides as per the parameters

4.14 Material Specifications

The duct shall be fabricated out of sandwiched panels made up of Embossed Aluminium Foil of suitable thickness on both the sides and in between sandwiched with PIR foam. Aluminium foil to be coated with Anti-microbial, Anti- fungal coating with no mold growth for better hygiene and insulating foam material shall be Expanded Rigid Polyisocyanurate Foam having closed cell content, Complete CFC & HCFC free, Non-Toxic

4.15 Properties

- It should be certified for 'for Class 'O' according to BS 476
- No relevant modification of insulation, chemical or physical characteristics of the panels to be measurable, when conveying air up to 2000 Pascal for suitable thick panels
- Insulating material: Close cell rigid Polyisocyanurate foam, Complete HCFC free,
- Density should be not less than 45 Kg/m³
- Panel should be Anti-microbial, Anti-fungal, with no mold growth for better hygiene
- Thermal conductivity: 0.021 W/mK or lower
- Water absorption shall be less than 0.5% by 24 hours immersion test
- Product should not have perceptible odour
- Material should have Noise Reduction Co-efficient (NRC) of 0.3 as per National Physical Laboratory.
- No relevant reduction of insulation, chemical or physical characteristics of the panels to be measurable, when conveying air in the temperature range of -45°C to +150°C.

4.16 Duct Accessories

All the duct accessories should be of Polymer(PVDC) profile like duct Jointing profiles, Gasketed H Bayonet, Connecting profiles, adhesives, sealants, Reinforcement clips, Aluminium tape, corner covers of profiles are to be used from the original Duct Panel Manufacturers only to achieve accuracy and best efficiency

in construction of duct. Suitable Adhesive should be used for installation.

4.17 Duct Fabrication and Installation

The ducts shall be fabricated as per the drawing provided and should be supplied at site in Pre-Cut form and should be boxed at site complete with all suitable joint fittings & profiles, inserts, using proper adhesive and sealing arrangements etc.

Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer — In — Charge.

The joints between the ducts shall be using polymer invisible flanges and slide-in-channel (Gasketed) to be used and to be connected by special cover corners, having a holding pin, which goes inside the flange and the insulation, to avoid any field connection and to give the system more strength.

For Duct Sizes Below 450mm maybe Shiplap Joints with Special Tape to can be used for leak free joints based on site requirement.

All Branches, Collar, Dropper Connection to be done using male-female 45° Cut with tiger clips.

Ductwork shall be installed, using supports, as per recommendation and manufacturer's requirements.

Maximum distance between supports shall not exceed:

All duct work shall be of high quality approved PIR Sheets guaranteed not to crack or peel on bending or fabrication of ducts. Care should be taken at site so that the Aluminium foil covering the panel is maintained intact during Installation to ensure Vapour Barrier continuity.

All joints shall be air tight and shall be made in the direction of air flow. All duct joints shall be inserted with exact size cut inserts to suit the profiles and corners should be covered with Polymer corners.

Fixing of Pre-Insulated Ducts with various ducting items like Volume Control Dampers or Fire dampers etc. shall be done using suitable material F- Flanges of the desired type of manufacturer make only.

For External Ducting all Joints to be covered with special reinforced tape on joints along with Gasketed to withstand seasonal variation.

4.18 Reinforcements:

Appropriate number of internal stiffening of GI Threaded Bar, Nut and Bolt and load-distribution GI Discs for very large ducts are provided

For positive pressure (supply ducts) and for negative pressure (return ducts) load

distributing GI Discs are placed externally and internally for better strength. Reinforcements will be fixed perpendicular to the larger duct dimension. However, as per site requirement and constraints, certain duct pieces can be fabricated and made at site using the same above standards to suit pieces. Great care should be taken to ensure that the ducting work does not extend outside and beyond height limits as noted on the drawings. The ducting work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer – In – Charge. The contractor shall verify all measurements at site and shall notify the Engineer – In – Charge

5 INSULATION

5.1 SCOPE

The scope of this section comprises the supply and application of various type of insulation conforming to these specifications:

5.2 MATERIAL (XLPE Thermal Insulation) :

Closed cell Chemical cross linked polyethylene foam (XLPE) with reinforced Glass cloth facing with and without self- adhesive and anti-bacterial properties shall be used. The Product have temperature range of -80°C to 105° C. Thermal conductivity of the insulation material is 0.034 W/m° K at an average temperature of 23°C. The density of insulation is 25±3Kg/m³ or more than specified value. The material also UV and Ozone resistant. The joints sealed with self adhesive tapes of similar specifications like Glass cloth.

The insulation material is fire rated for Class O as per BS 476 Part 6 for Fire propagation test and for Class 1 as per BS 476 Part 7 for surface spread of flame test& ASTM E84 test. Resistance to bacteria and fungi is excellent on insulation surface accordance with ISO ASTM G21:2009 and ISO 22196:2007. Smoke toxicity level is passed as per IMO MSC 61(67): A.1, P.2 and Toxicity smoke R value is 0.77 as per BS 6853:1999. Fir & Smoke characteristic as per EN 45545-2 getting value is R1 HL3. Material having Environment friendly like Ozone resistance Excellent, Ozone Depletion potential zero and CFC& HCFC, dust, fiber free.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for thermal conductivity values, density, water vapour permeability and fire

properties. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for thermal conductivity and density at Contractor's cost. Adhesive used for sealing the insulation shall be not-flammable, vapour proof adhesive strictly as per manufacturer's recommendations.

5.3 METHOD OF APPLICATION:

All Duct surfaces should be free of dust, grease, oil. To clean the duct, first wipe with a clean cloth to remove dust particles. Then remove grease and oil by applying a methylated spirit or acetone or equivalent special glue cleaner and allow evaporating. Work within reasonable clean area to avoid too much dust prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut closed cell XLPE sheets to size with sufficient allowance in dimension. Cutting of XLPE sheets shall be done with adjustable blade to make 90° cut in thickness of XLPE sheet. Hacksaw or blades are not acceptable tools for cutting the insulation.

Material shall be fitted under compression and no stretching of material shall be permitted. A thin film of only OEM supplied food grade adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface. When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. All longitudinal and transverse joints shall be sealed by providing 6 mm thick 50 mm wide XLPE tape. The adhesive shall be strictly as recommended by the manufacturer. Apply 2 coats of lag coating over insulation.

5.4 MATERIAL (NITRILE RUBBER THERMAL INSULATION)

Insulation material for Duct insulation shall be **closed cell anti-fungus, anti-microbial Elastomeric Nitrile Rubber (CFC/HCFC FREE) on one side with factory laminated glass cloth.** Thermal conductivity of the insulation material shall not exceed 0.033 W/m²K at an average temperature of 0°C. Density of the nitrile rubber shall be 40- 60 Kg/m³. The product shall have temperature range of -40 °C to 105°C. The insulation material shall be fire rated for Class O as per BS 476 Part 6: 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapor permeability shall be not less than 0.024 per inch (1.74 x 10⁻¹⁴ Kg/m.s.Pa i.e. $\mu=10000$: Water vapor diffusion resistance).

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for thermal conductivity values, density, water vapor permeability and fire properties. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested

for thermal conductivity and density at Contractor's cost. Adhesive used for sealing the insulation shall be not-flammable, vapor proof adhesive (LOW VOC) strictly as per manufacturer's recommendations.

Ducting insulation thickness shall be as mentioned in .

5.5 METHOD OF APPLICATION:

All Duct surfaces should be free of dust, grease, oil. To clean the duct, first wipe with a clean cloth to remove dust particles. Then remove grease and oil by applying a methylated spirit or acetone or equivalent special glue cleaner and allow evaporating. Work within reasonable clean area to avoid too much dust prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut closed cell nitrile rubber sheets to size with sufficient allowance in dimension. Cutting of nitrile rubber sheets shall be done with adjustable blade to make 90° cut in thickness of nitrile rubber sheet. Hacksaw or blades are not acceptable tools for cutting the insulation.

Material shall be fitted under compression and no stretching of material shall be permitted. A thin film of only OEM supplied food grade adhesive (LOW VOC) shall be applied on the back of the insulating material sheet and then on to the metal surface. When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. All longitudinal and transverse joints shall be sealed by providing 6 mm thick 50 mm nitrile rubber tape. The adhesive shall be strictly as recommended by the manufacturer. Apply 2 coats of lag coating over insulation.

5.6 DUCT ACOUSTIC INSULATION (With Open Cell Nitrile Rubber)

Material for Duct Lining: 15 mm thick Class O open cell structured Nitrile rubber with 150 kg/m³ density (CFC/HCFC FREE).

Method of Application:

Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut closed cell Elastomeric rubber sheets to size with sufficient allowance in dimension insulating material sheet and then on to the metal surface. Apply OEM supplied food grade adhesive (LOW VOC) on duct surface and insulation sheet and when adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. All longitudinal and transverse joints shall be sealed by providing 6 mm thick 50 mm wide Nitrile rubber tape. The adhesive shall be strictly as recommended by the manufacturer and should be of low volatile organic compound. Acoustic insulation to be applied for both supply & return air

duct/PLENUM up to 5 mtr. in length from AHU.

Internal duct acoustic insulation shall not be applicable for OT & Positive isolation room of supply & return air duct. Internal duct acoustic insulation shall not be applicable for OT & Positive isolation room of supply & return air duct.

5.7 AHU ROOM ACOUSTIC INSULATION (With Open Cell Nitrile Rubber)

Material: 20 mm thick Class O open cell structured Nitrile rubber with 150kg/m³ density (CFC/CHFC FREE)

Two walls and ceiling of air conditioning plant room and air handling unit rooms shall be provided with acoustic lining. Material shall be processed from Nitrile rubber open cell foam.

The material should be fiber free. The density of the same shall be 150 Kg/m³. The material should have thermal conductivity not exceeding 0.05 W/Mk. The maximum surface temperature of material shall withstand is 105°C. And minimum temp shall be -20°C. Thickness shall be as specified. The material should confirm to class as per BS 476 Part 6: 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test.

Surface shall be cleaned and two coats of adhesive (LOW VOC) recommended by the manufacturer should be applied on the walls. The foam sheets should be cut to required size and a layer of adhesive (LOW VOC) should also be applied to it. When it is tack dry it is stuck to the walls / ceiling. Aluminum plate washers with aluminum screws to be screwed to wall through this nitrile rubber sheet at various intervals to avoid loosening of sheets and to provide proper clamping to wall.

All longitudinal and transfer joint shall be covered with 22 gauge 50 mm wide GI strip with screws.

Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU / fan rooms.

5.8 UNDERDECK INSULATION FOR RCC ROOF OF SERVICE FLOOR&TOP FLOOR

MATERIAL: 32 MM THICK, 25-30KG/M³ DENSITY OF CLOSED CELL XLPE THERMAL INSULATION METHOD OF APPLICATION:

The slab surface shall be thoroughly cleaned and rendered free of all dust. The insulation surface shall be coated uniformly with 2 coats of OEM recommended adhesive (LOW VOC) and then XLPE thermal insulation sheet shall be firmly stick to the slab surface with uniform pressure all over. Joints to be sealed with 6 mm thick nitrile rubber tape properly. Aluminum plate washers with aluminum screws to be screwed to slab through this XLPE thermal insulation sheet at various intervals to avoid loosening of sheets and to provide proper clamping to slab.

6 AIR TERMINALS

GRILLS / DIFFUSERS/DAMPERS

6.1 FRESH AIR INTAKE LOUVERS

Fresh air intake louvers 50 mm deep (minimum) wherever required as per shop drawing. Louvers shall be made of extruded aluminium construction duly anodized or powder coated. Bird/insect screen shall be provided with the intake louvers. The blades are inclined at 45⁰ on a 40 mm blade pitch to minimize water ingress. The lowest blade of the assembly shall extend out slightly to facilitate disposal of rainwater without falling in door/wall on which it is mounted.

The intake louvers shall be provided with factory fitted all aluminum construction volume control dampers in black anodized finish.

A flanged frame using RS sections shall be provided on front face to conceal the gap between the louvers and the adjoining wall face. Corners of frame shall be welded. The frame shall be made structurally rigid.

Louvers made from extruded aluminum section shall be in modular panel form for ease of handling. These shall be free from waves and buckles. Vertical blades shall be truly vertical and horizontal blades shall be truly horizontal. Butt joints in blades shall not be accepted.

Additional intermediate equally spaced supports and stiffeners shall be provided to prevent sagging/ vibrating of the louvers, at not more than 750mm centers where the louver's length is longer than 750mm.

Louvers shade shall be approved in consultation with an architect.

6.2 EXHAUST AIR LOUVERS

Exhaust louver shall be of light weight extruded aluminum material gravity louvers and without dampers.

6.3 GI MODULATING MOTORIZED FRESH AIR DAMPERS: (Electrically operated by Actuator)

All Fresh air ducts for AHU's shall be provided with approved make Motorized dampers. Motorized Dampers shall be furnished and installed at locations shown in Drawings and as described in .

Volume control device, made of extruded aluminium gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise. Dampers shall be rigid in construction to the passage of air.

The volume dampers shall be of an approved type, automatically operated and complete with suitable links & quadrants, locking devices, which will permit the dampers to be adjusted and locked in any position.

The dampers shall be of opposed blade or louver type. The damper blade shall not be less than 1.25 mm (16) gauge and shall not be over 225 mm wide. Automatic and motorized volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Damper frames shall be constructed of 16 gauge steel.

In normal position damper blade shall be held in open position with the help of a 24 V DC /AC operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

The damper shall be actuated through electric actuator. The actuator shall be energized with the help of a signal from carbon dioxide PPM level in R.A. path.

Damper actuator shall be electrically actuated so as to modulate the damper in the event of required air PPM level. The damper shall be installed in accordance with the installation method recommended by the manufacturer

6.4 DAMPERS

Aluminum dampers shall be used for all OT & MRI ducting. Other than these areas, GI dampers shall be used in each and every application.

PRESSURE RELIEF DAMPER/BACK DRAFT DAMPER:

Non-return / Gravity / Back draft dampers can either be operated by gravity (where pressure or velocity opens and closes the damper) or be motorized to open and close when required. These dampers are composed of a set of horizontally mounted blades, they are normally closed and are free to rotate about the horizontal axis. The blades are manufactured from lightweight aluminum sheets.

Frame is manufactured from high quality aluminum as well as from galvanized steel.

The casing frame must be fully sealed robust and rigid assembly formed out of best quality aluminum sheets / galvanized sheet steel of 1.2 mm thickness. With Fully sealed low leakage blades are formed out of high quality lightweight aluminum sheets of 1.0 mm thickness.

The bearings must be made of PVC/Nylon to give smooth and rattle free operation. The blades are fitted with galvanized steel connecting spindle to main casing / frame for rigid and strong construction for rattle free and smooth operation due to variable air pressure.

A galvanized / aluminum angle is fitted internally to main frame to avoid over movement of blades

6.5 JET NOZZLE

Eye ball type jet nozzle with ring to fix on duct. Ring should have butterfly type damper, air tight connection. Nozzle to be powder coated. Nozzle to be painted as per architect & interior instruction. Nozzle can be turned through ± 30 degree from its center line axis and rotated 360 degree.

6.6 PAINTING

All grilles, and diffusers shall be powder coated in colour as approved by Architect/Consultant before installation. All ducts immediately behind the grilles/diffusers etc. Are to be given two coats of black paint in Matt finish for vision barrier.

6.7 SLOT DIFFUSER

Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to three slots as required. Slot width shall be 20 mm. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminum sheet.

Slot Diffuser shall be extruded aluminum construction multi slot type with air pattern controller provided in each slot. Supply air diffusers shall be provided with Hit & Miss volume control dampers in each slot of the supply air diffusers. Diffusers for different spaces shall be selected in consultation with the Architect and provided as per requirement of the schedule of Quantities.

6.8 GUIDELINES FOR INSTALLATION OF GRILLES

Installation of the grilles shall be done by the air conditioning contractor irrespective of the type/model of false ceiling systems. The diffusers will have to be individually suspended from the duct and aligned to match the ceiling line level. In case of gypsum or any other false ceiling system, all wooden frames, rectangular or circular for supply/return/exhaust air diffusers will be provided by the Air conditioning contractor.

All air outlets/return air inlets in the same room shall be of the same size unless otherwise specified. Grilles samples must be submitted to the consultants for prior approval before procurement and installation.

7 ELECTRICAL WORKS FOR HVAC SYSTEM SECTION I: CONTROLS &

ELECTRICAL WORK

7.1 GENERAL

The various controls listed below shall be electrically operated and generally comply with the specifications listed below:

In case of low voltage controls, necessary step-down transformers shall be provided with each control as required. Approval from fire & other required statutory approval required. Works (Cost to be included).

Contractor will need to submit technical data sheet of each and every equipment and ancillaries to Engineer In-Charge & get approval prior to procurement.

Electrical Panel shall be factory tested by Engineer In-Charge and client representative prior to dispatch on site.

7.2 MOTOR STARTERS

7.2.1 CONTRACTOR

Motor starter contactors shall be of the electromagnetic type rated for uninterrupted duty as defined in applicable standards.

Main contacts of motor starter contactors shall be of silver-plated copper.

Each motor starter contactor shall be provided with two NO and two NC auxiliary contacts. Insulation class of operating coils shall be class B or better.

Operating coils of contactors shall be suitable for operation from the specified control supply system. Contactors shall be of the double break, non-gravity type. One number spare auxiliary contactor with 4 No./4NC contact along with its coil completely wired up-to the terminal should be provided.

7.2.2 **DIRECT ON LINE STARTERS**

Direct on line starters shall be suitable for Class AC 3 utilization category.

7.2.3 **REVERSING STARTERS**

Reversing starters shall comprise forward and reverse contactors, electrically interlocked with each other. Reversing starters shall be suitable for Class AC 4 duty.

7.2.4 **THERMAL OVERLOAD RELAYS**

Starters shall be complete with three elements, positive acting, ambient temperature compensated, time lagged thermal overload relay with adjustable settings. The settings range shall be properly selected in accordance with the rating of the motor.

Thermal overload relays shall be hand reset type.

'Stop' push button of the starter and hand reset device shall be separate from each other. Overload relay hand reset push button shall be brought out on the front of the compartment door. Overload relay shall be provided with at least one 'NO' and one 'NC' or one change over contact.

7.2.5 **CURRENT TRANSFORMERS**

Current transformers shall be of the dry type.

Current transformer shall have a short time withstand rating equal to the short time withstand rating of the associated switchgear for one second.

Unless otherwise specified, the minimum performance requirement of current transformers is as follows:

- a) Measuring CTs 7.5VA, accuracy class 1.0 and an instrument safety factor of 5.
- b) Protective CTs 7.5 VA, accuracy class 5P and an accuracy limit factor of 10.
- c) Notwithstanding the above it shall be the VENDOR'S responsibility to coordinate the current transformer burden with the requirements of relays, instruments and leads associated with that particular current transformer.

- d) Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests.
- e) All current transformers shall be earthed through a separate earth link on the terminal block to permit easy measurement of the current transformer insulation resistance. (CTs built in with the thermal relays of the contactors are excluded).

7.2.6 **VOLTAGE TRANSFORMERS**

Voltage transformers shall be of dry type.

Unless otherwise specified, the minimum performance requirements of voltage transformers are as follows:

- a) Measuring VTs 15 VA per phase and accuracy class 1.0.
- b) Protective VTs 15 VA per phase and accuracy class 1.0.
- c) Dual purpose VTs 100 VA and dual accuracy class 1.0/3.0 for metering and protection respectively. VA is per phase.
- d) All secondary windings of voltage transformers including open delta windings shall be rated for 110/ 3 V per phase.
- e) Voltage transformers shall have a continuous overvoltage factor of 1.2 and short time overvoltage factor as follows:
 1. 1.5 for 30 seconds in case of effectively earthed. 1.9 for 8 hours in case of non-effectively earthed system.
 2. Voltage transformers shall be complete with suitable rated primary, secondary and tertiary fuses. Primary fuses shall have a rupturing capacity equal to the rupturing capacity rating of the associated switchgear. Fuses shall be provided on each sub circuit.
 3. It shall be possible to replace voltage transformers without having to de energize the main bus bars.
 4. The terminals of V.T. secondary and tertiary windings which are required to be connected to earth shall be earthed by an isolating link without a fuse.
 5. Single phasing preventers relay shall be provided when required to protect motor against single phasing. The relay shall not operate for supply voltage unbalance of + 5% but shall positively operate for supply voltage unbalance of more than + 5%. The relay shall operate in the event of a single phase fuse blowing even though the motor c.m.f. in the concerned phase is of the order of 85%.

6. After sensing single phasing the relay shall operate with a time delay of 2 to 3 sec. The relay shall not operate for a 3 phase power supply failure. The relay shall be of the hand reset type with a hand reset push button. Resetting shall be instantaneous and independent of the adjusted time delay in the tripping of the unit. Visual indication for the operation of the relay shall be provided.
7. The relay shall be suitable for application to protect reversible and non-reversible motors. The relay operation shall be independent of the motor KW rating, the loading conditions prior to the occurrence of the single phasing and rpm of the motor. The relay shall be of the failsafe type and shall operate to trip the motor when the relay internal wiring is accidentally open circuited.

7.2.7 RELAYS

The following clauses shall apply to the protective relays.

Relay shall be

- a) Enclosed in dust proof flush mounting draw out type cases.
- b) Accessible for setting and resetting from the front.
- c) Provided with positive acting hand reset flag indicators visible from the front.
- d) Access to setting devices shall be possible only after the front covers are removed. Access to resetting devices shall be external to the case.
- e) Auxiliary relays shall be rated to operate satisfactorily between 70% and 110% rated voltage.
- f) Each relay shall be provided with at least two separate voltage from contacts.
- g) Make and type of relays shall be subject to the EIC approval.

7.2.8 INDICATING INSTRUMENTS & METERS

Electrical indicating instruments shall be of minimum 96mm x96mm square size, suitable for flush mounting. Indicating instruments shall have provision for zero adjustment outside the cover.

Instrument dials shall be parallax free with black numerals on a white dial.

Ammeters provided on motor circuits shall be provided with a suppressed extended

scale to indicate motor starting current.

Watt-hour meters shall be of the direct reading electro dynamometer type complete with cyclometer type dials and reverse running stops.

7.2.9 INDICATING LAMPS

Indicating lamps shall be:

- a) Of the filament type and of low watt consumption
- b) Provided with services resistors
- c) Provided with translucent lamp covers of colors 'Red', 'Green' and 'Amber' as required in the control wiring diagrams.
- d) Bulbs and lenses shall be easily replaceable from the front.

7.2.10 CONTROL & SELECTOR SWITCHES

Control and selector switches shall be:

- a) Of the rotary type
- b) Adequately rated for the purpose intended (Minimum acceptable rating is 10A continuous at 240V AC and 1A inductive break) 220V DC.
- c) Provided with escutcheon plates clearly marked to show the positions.
- d) Control switches for circuit breakers shall be provided with pistol grip type handles.
- e) Control switches for circuit breaker control shall be provided with Contact development and sequencing device.

Selector switches shall be:

- a) Of the maintained contact stay put type. Switches in ammeter circuits shall have make before break type contact.
- b) Provided with oval handles.

7.3 PUSH BUTTONS

Push button shall be:

- a) Of the momentary contact, push to actuate type rated to carry 10A at 240V AC and 1A (inductive breaking) at 220V DC.
- b) Fitted with self-reset, 2 NO and 2 NC contacts.
- c) Provided with integral escutcheon plates marked with its function.

- d) 'Start', 'Open', 'Close' push buttons shall be green in colour.
- e) 'Stop' push buttons shall be red in colour.
- f) All other push buttons shall be black in colour.
- g) Emergency Stop' push buttons shall be of the lockable in the pushed position type and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button.

7.4 CABLE TERMINATORS

Suitable compression type heavy duty brass cable glands with nuts, rubber sealing ring and brass washers mounted on a removable and control cables entering the switchgear shall incorporate built in facilities for earthing the wire armor of cables. Cable glands shall be plated to avoid corrosion.

Power cable glands and crimping type lugs shall be supplied to suit the cable sizes given in clause 3. If during course of detailed engineering of the switchgear it is found necessary to provide more glands or glands of higher size than those envisaged the vendor shall provide and accommodate the same.

Wire Sizes:

The vendor shall select the power cable glands and lugs based on the following cable sizes.

Type of cable:

1100 V grade stranded copper conductor PVC insulated PVC sheathed armored and outer sheathed FRLSceated cable conforming to IS: 1554 Part I.

KW Rating Service	No. of cores x conductor size (mm2)	approximate overall diameter/mm
Up-to 3	3 x 4	18
3.1- 7.5	3 x 6	19.5
7.6 -15	3 x 16	24
16 - 25	3 x 35	30
26 - 40	3 x 70	34
41 - 55	3 x 120	40
56 - 70	3 x 185	49
71 - 85	3 x 240	55.5
86 – 110	3 x 400	60
111- 175	3 x 1C x 500	
Space Heating	2 x 6	19

For supporting & clamping cable cores at regular intervals inside the cable alleys, suitable shuttered angles, up to the respective terminal blocks shall be provided. Necessary crimping type of tinned copper cable lugs for connecting the individual cores to the respective terminals shall be provided.

The cabling of various equipment shall be carried using PVC Insulated and armored cables.

The PVC armoured power cable for use on 415 volts system shall be 3 or 3.5 Core with aluminum/copper conductors and be of 660/1100 volts grade, as per IS 1554 (Part I) 1964. The cross section of the cable shall be to suit the load and rating of the equipment. The cables shall be of aluminum conductor, PVC insulated, strip armoured with overall PVC sheathing.

The cables shall be laid as per IS-1255/1967, Indian standard code of practice.

The cables shall be laid, as per drawings in the ducts/pipes/trays etc. along a short and convenient route between switch board and the equipment, (either in trenches, on wall or on hangers, supported from the slab). Cable routing shall be checked at the site of work to avoid interference with structure, equipment etc. Where more than one cable are running close to each other, proper spacing should be provided between them.

The radius of bends of the cable should not be less than 12 times the overall dia. Of cable in order to prevent undue stress and damage at the bends, the cables should be supported with wooden cleats on M.S. Supports, when laid in trenches, or wall/ceiling suspended hangers. When laid underground the cables should be covered with fine soft earth and protected with 2nd Class bricks. Suitable G.I. Pipe shall be used wherever cables are laid under the roads etc.

Wooden bushes shall be provided at the ends of pipes through which cables are connected through.

INTERNAL WIRING

Control wiring shall be of the rating of 650V and power wiring shall be of the rating of 1100V.

Wiring inside the switchgear shall be carried out with 1100/650 V grade, PVC insulated, stranded conductor wires. Minimum size of conductor for power circuits is 4 sq.mm copper or equivalent size aluminum conductor. Control circuits shall be wired with copper conductor of at least 2.5 sq.mm for CT circuits and 1.5 sq.mm for other circuits, the number and size of strands shall be 7 of 0.67 mm and 0.5mm diameter respectively.

Engraved identification ferrules, marked to correspond with the wiring diagrams shall be fitted to each wire. Ferrules shall be of yellow colour with black lettering.

Wires forming part of a tripping circuit of circuit breaker shall be provided with an additional red ferrule marked 'T'. Spare auxiliary contacts of all equipment forming part of the switchgear shall be wired up to the terminal blocks. Spare and unassigned modules shall be complete with internal wiring.

Wiring shall be terminated on preferably stud type terminal blocks such that the wires are connected by cable lugs with nuts and washers/lock nuts.

Not more than two connections shall be made on any one terminal.

SURFACE WIRING

The surface wiring shall be cased in PVC conduits which shall be of 1100 volts grade and conform to IS 9587-1987 (revised to date)

The conduits used shall be of high quality & all joints shall be made with sockets. The bends and elbows shall have inspection covers fixed with grease free screws. The joints shall be water tight. Approved metal saddles shall be used to secure the exposed conduits at a space of 1 meter or less. The connection of the conduits to switches etc., shall be secured by check nuts and ebonite bushes provided at the ends of conduits.

The PVC conduits shall be heavy duty and rigid type-ISI marked/conforming to IS specifications. The wall thickness shall not be less than 2 mm. For conduits above 32 mm dia. Metallic conduits of 19 mm dia. and below shall not be used. Conduit accessories (Boxes etc.) shall conform to IS-5133-1968 and IS-2667-64 (amended-revised to date). Conduit pipes shall be jointed, wherever necessary by means of screwed couples and screwed accessories only. In Long distance straight, run of conduits inspection type couplers at suitable intervals shall be provided. Threads on conduit pipes shall be between 13 mm to 19 mm long.

The wiring shall be carried-out as per IS 732-1989 (Amended and revised to date).

Flush inspection covers shall be provided in case of Concealed, recessed conduits. The staples for the conduits shall not be spaced more than 0.60 meters apart. Before filling up the chase with concrete the conduits should be given a coat of rust proof paint.

The wires shall be drawn only after all the conduits have been properly fixed in position. Fish wires (steel wire: 16 SWG) shall be laid in conduits for drawing of wires subsequently.

CONTROL CABLING /WIRING

- a) Control cables shall be 1100 volts grade, as per IS 1554, made from copper conductor of 1.5 Sq. mm PVC insulated single Core, strip armored with an overall PVC sheathing.
- b) The cables and conduits wiring shall be carried out as per details given under 21.5.1 and 25.2 above.

7.5 MISCELLANEOUS

- a) The final connections to the equipment shall be through Flexible connections in case of conduit wiring and also where the equipment is likely to be moved back and forth, such as on slide rails.
- b) An isolator switch shall be provided at any motor which is separated from the main switch panel by a wall or partition or other barrier or is more than 15 meters away from the main panel.
- c) Two separate and distinct earthing conductors shall be connected from the equipment up to the main switch board panel.
- d) The branch lines from the main panel to each equipment shall be separated and should not cross other lines.
- e) The entire installation shall be tested as per Electricity rules and I.S.S. 732-1973 with amendments 1,2&3 prior to the commissioning of the plant and a suitable test report furnished by a competent and authorized person. The test report will be obtained by contractor himself at his own expenses.
- f) All exposed switch board panels, conduits, hangers etc. shall be given 2 coats of suitable paint of approved color, when all work has been completed.

TERMINAL BLOCKS

Terminal blocks (both for power and control circuit) shall be of reputed make especially for CT and VT circuit. It shall comprise of finely threaded pairs of brass studs of at least 6mm diameter, links between each pair of studs, washers, nuts and locknuts. The studs shall be securely locked within the mounting base to

prevent their turning. Insulated barriers shall be provided between adjacent terminals.

Terminals for circuits with voltage exceeding 125 V shall be shrouded. Terminal blocks shall be grouped depending on circuit voltage. Different voltage groups of terminal blocks shall be segregated.

Terminal blocks shall be adequately rated to carry the current of the associated circuit. Minimum rating of the terminal block is 10A.

Terminals shall be numbered for identification. Engraved white on black labels shall be provided on the terminal blocks, describing the function of the circuit. Where duplication of a terminal block is necessary it shall be achieved by solid bonding links.

Terminal blocks for CT secondary lead wires shall be provided with shorting and disconnecting/ earthing facilities. Terminal blocks shall be arranged with at least 100mm clearance between two sets of terminal blocks.

Control terminals for external connections shall be suitable for terminating at least two conductors each of 2.5 sq.mm size.

LABELS

All labels shall comprise white letters on a black background.

Labels shall be made of non-rusting metal or 3 ply lacmoid, or engraved PVC. Labels shall be properly fixed, with provision to prevent distortion due to expansion. Size of lettering shall be 6mm.

7.6 EARTHINGS

Each MCC and LCC shall be provided with an earth busbar running along the entire length of the board. Material and size of the earth busbar shall be as specified in data sheets. At either end of the earth bus, one (1) clamp type terminal with nuts, bolts and washers shall be provided for bolting the main earthing conductor of size and material indicated in data sheets. In case the earth bus is provided near top of the switchgear, one down comer at either end shall be provided for connection to

the main earthing conductor.

Earth busbars shall be supported at suitable intervals.

Positive connection between all the frames of equipment mounted in the switchboard and earth busbar shall be provided by using insulated copper wires/bare busbars of cross section equal to that of the busbar, or equal to half the size of circuit load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to the earth busbar using 1100/650 V grade, 2.5 sq.mm stranded, copper, earthing conductor.

LOCAL PUSH BUTTON

Constructional Features

The constructional features of the local push button stations shall be as follows:

- a) Metal enclosed weather proof suitable for mounting on wall or steel structures. The enclosure shall be die cast aluminum or sheet metal of 2mm thickness.
- b) Dust and vermin proof.
- c) Provide a degree of protection of not less than IP:54.
- d) Metal parts shall be given tropical zing treatment as per standards and painted with one coat of epoxy primer and two coats of light grey epoxy paint.
- e) Provided with inscription plates of rear engraved Perspex with white letters on black background. The letter size shall be 6mm.
- f) Provided with two earthing terminals suitable for 8 SWG G.I. wire.
- g) Provided with removable undrilled gland plate and adequate members of cable glands for PVC insulated, armoured cable. The cable entry shall be from the bottom.
- h) All local push button stations shall have locking facility. The lock switch shall have two positions "locked" and "unlocked". When in unlocked position the switch shall allow individual starting of the equipment. Start/stop push buttons provided for local operation of the equipment shall be provided on the same enclosure and stop rush buttons shall be lockable in stop position. The lock switch shall be key-operated.

PUSH BUTTONS

- a) The Open/Close/Start push buttons shall be of the momentary contact push to actuate type.
- b) The stop push buttons shall be stay put type with mushroom knob.
- c) All push buttons shall be :
 - d) Fitted with two (2) normally open and two (2) normally closed contacts rated to carry and break 6 Amps at 415 Volts. (10A at 240 AC).
 - e) Provided with integral escutcheon plates marked with its function.
 - f) 'Open/Close/Start' push buttons shall be green colour.
 - g) 'Stop' push button shall be red in colour.
 - h) **Wiring**

The push button stations shall be as follows : Push button station Type A Each P.B., station shall comprise three push buttons viz. 'OPEN' 'CLOSE' and 'STOP' for control of reversible motors.
 - i) Push button station type B Each P.B. station shall comprise two push buttons viz. 'START' and 'STOP' for control of non-reversible motors.
 - j) Push button station type C Each P.B. station shall comprise only one push button i.e. 'STOP' for emergency stop function.
 - k) Power Electricity at specified voltage (415/220V).

DRAWINGS AND DATA

As part of proposal BIDDER shall furnish the following drawings and data:

- a) For each switchgear, overall dimension drawing showing front view, plan, elevation and cross section.

- b) All drawings and data sheets shall be annotated in English

CIRCUIT BREAKERS

The panel and the bus bars plus outgoing of all devices shall be protected by different types of circuit breakers as described below and conforming to specification as given later on:

Sl. No.	Type	Up to 40 Amp	Up to 63 Amp	80 – 200 Amp	200 – 400 Amp	Above 630 Amp
1	Incoming	MCB	MCCB	MCCB	MCCB	ACB
2	Outgoing	MCB	MCB	MCCB	MCCB	ACB

Moulded Case Circuit Breakers (MCCB)

The MCCB shall have TP + NL and be suitable for simultaneous manual opening and closing with rotary operating handle.

The ON/OFF/TRIP positions shall be clearly marked and easily visible to an operator and confirm to latest IS: 13947-1993.

There shall be fixed/adjustable tripping devices with inverse time characteristics for overload and short circuit protection.

Suitable Interlocking mechanism shall be provided, where required. Miniature Circuit

Breakers (MCB)

The MCB shall have quick make/break contacts with a heat resistant housing, having high Impact strength and confirm to IS 8828-1996.

The contacts shall be of silver nickel alloy.

The MCB shall permit over load for short duration, as required for Inductive loads and the breaking capacity shall not be less than 10 KV at 415 Volt A.C.

It shall be equipped with overload and short circuit protection devices and shall be suitable for DIN mounting. Isolator Switches

Isolator switches are to be provided for equipment located outdoors or for those located in separate enclosure, other than those Nos. having the Electric Panel.

The Isolator Switch should be of Rotary Load Break type with a weather proof sheet steel enclosure. Its rating shall be same as the outgoing device in the Electric Panel.

7.7 CONTACTORS

All non-inductive loads shall be provided with suitable sized magnetic contactors.

The contactors shall have 3/4 poles plus a minimum 2 'NO' and 2 'NC' contacts. All contacts shall be of solid silver.

The No volt coil shall generally be suitable for 220 Volts + 10%, - 15% (wide band type) A.C. supply except when specified or required otherwise.

STATERS

The type of starters to be provided for the

motors shall be as follows: Squirrel Cage

motors up to 5.0 HP (3.7 KW) Direct on Line

Type

Squirrel Cage motors Above 5.0 HP (3.7 KW) Automatic Star Delta Type

Compressor motor Above 300 HP (225 KW) Automatic Auto Transformers (where specified)

All starters shall have auxiliary contacts for interlocking different machines, connecting indicating lights, controls, alarms, etc.

All starters shall be provided with separate single phasing preventers.

DIRECT ON-LINE STARTERS

These starters shall have heavy duty air break contactors of suitable rating.

These starters shall be complete with adjustable overload relays on all three phases, single phase preventing device and under voltage release. The starters should be "hand reset" type.

The "No Volt Coil " of these starters shall be 220 Volts + 10% - 15% (wide band type) whenever any controls on safety devices are connected in the starters circuits, otherwise standard 415 volts coils may be used. There shall be ON-OFF push button for each starter unless remote operation of the starter is required. Digital type Ammeter and voltmeter and energy meter to be fixed to the enclosure along with the necessary wiring.

AUTOMATIC STAR DELTA STARTES

These starters shall have heavy duty air break contactors of suitable ratings along with an adjustable timer to automatically switch the motor connections from star to delta connections.

Each starter shall be complete with adjustable overload relays on all three phases and under voltage release. The starters should be "hand reset" type.

The "No Volt Coil" shall be of 220 Volts + 10% - 15% (wide band type) rating wherever any controls of safety device are connected in the starter circuit, otherwise standing 415 volts coils may be used. There shall be ON-OFF push button for each starter unless remote operation of the starter is required. Digital type Ammeter and voltmeter and energy meter to be fixed to the enclosure along with the necessary wiring

AUTOMATIC AUTO-TRANSFORMER STARTER

These starters will be oil immersed, each one fixed on a

separate panel. Necessary devices shall be provided for

the automatic tap setting of the starter.

The starter should have "No Volt Coil" wide band type circuit of 220 volts to be connected to control circuits.

The Motor starter shall be in accordance with IS 1882. The starter shall be totally enclosed metal clad, dust and vermin proof construction. The starter shall be of continuous rating.

Contactors shall have the number of poles as required for appropriate duty. The making capacity of the starters shall be suitable for AC 3 duty.

PANEL ACCESSORIES

All Voltmeters and Ammeters as specified shall be square of 96 mm x 96 mm, flush mounting type.

The Indicating Lamps shall be of LED type with Low Watt Power. The Lamps shall have translucent covers of following colors.

- Red/Yellow/Blue for phase light.
- Green/Amber for ON/OFF indication.
- Concealed door lock.

7.8 SUBSIDIARY PANELS (With Single Switch)

Subsidiary panels shall be provided for equipment located away from the plant room, such as air handling units, blower etc.

The construction of these panels should be similar to the main panel and shall have all related accessories, except when specified.

The sub panel shall be wall hung type and as

compact as possible. Panel fabrication drawings

shall be got approved before fabrication.

ENCLOSURES FOR CONTROLLERS AND ELECTRICAL PANELS

The entire Panel shall be housed in Lockable Vandal proof boxes which shall either be floor mounted or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.

The panel shall be metal enclosed 14 SWG CRCA sheet steel cubicle with gaskets between all adjacent units and beneath all covers to render the joints dust proof. All doors and covers shall be hinged and latched and shall be folded and braced as necessary to provide a rigid support. Joints of any kind in sheet metal shall be

seam welded with welding slag grounded off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with nuts. Self-threading screws shall not be used in the construction of control panels. Knockout holes of approved size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. Clamps shall be provided to support the weight of the cables. The dimension of the boxes shall depend on the requirement with the color decided in consultation with the Architect/Consultant.

Note: All panel enclosures shall be suitable for Indoor application (IP 41protections) and for outdoor application (IP 56) UL listed.

The system shall have capability to interface with the Fire Alarm System& BMS system.

VARIABLE FREQUENCY DRIVE

- a) The variable frequency drive shall be PWM type (Pulse width modulation) microprocessor based of dedicated HVAC application design.
- b) The drive shall include a diode bridge, fixed voltage D.C. link section with both inductors and capacitors to form a filter, inverting bridge comprising I.G.B.T's, 32 bit microprocessor and I.C's. The Power factor shall remain above 0.95 regardless of speed or load. Any VFD using PF correction capacitor is not acceptable.
- c) The drive shall have a keypad control, a LCD display module, and manual ON/OFF switch and bypass switch.
- d) The drive shall have the following features:
- e) The voltage to frequency ratio shall be suitable for pump and fan control.

- f) The drive shall be suitable to work either in a "Stand Alone" mode or through a serial communication loop to CONTROLLER via an in-built RS485 port. All parameters shall be programmable from CONTROLLER and all data shall get displayed on CONTROLLER.
- g) The drive shall contain within its enclosure D.C. link filters to minimize harmonics and current distortion and 2 Zone, 2 set point P.I.D. controller to provide closed loop control from up to 2 signal transmitters.
- h) Speed reference signal shall be customer selectable for 0-10 VDC or 4-20 MA.
- i) The VFD shall be capable of displaying the following information in plain English via a 40 character alphanumeric display:
 - Frequency :
 - Voltage :
 - Current :
 - Kilowatts per hour :
 - Fault identification :
 - Percent torque :
 - Percent power :
 - RPM :
 - Setting of O L protection :
- j) The VFD controller shall be suitable for elevation up to 1000 meters above sea level.
- k) The VFD shall be of the type suitable for operation on a 3 phase, 415 V, 50 HZ

Input power supply at the following conditions:

Input supply voltage variations : + 10 %
 Input supply frequency variations : 48 – 62 Hz + 1%
 Ambient temperature : 0 - 45 deg C,
 without derating. Maximum relative humidity :
 95% non-condensing
 Vibration : 0.7 g
 RMS in 3 directions Minimum efficiency at full load :
 96%

- l) The VFDs will be mounted in the open near the AHUs Cooling towers in the AHU room / Plant room. Hence the VFDs shall have integrated, factory built metallic enclosures of IP 54 rating, without any de-rating. VFDs of IP00 / IP 20 / IP 21/ IP 42 rating enclosures with additional sheet metal enclosures to achieve IP 54 ratings are not permitted.
- m) VFDs shall conform to the recognized international standards like IEC and manufactured according to ISO 9001, BS 5750 part 1 & 2 and shall be UL listed. It shall carry the CE mark on EMC compliance.
- n) The VFD shall be capable of providing a starting torque of 160% for 0.5 sec and an overload torque of 110% torque for 1 minute.
- o) The VFD shall maintain full output voltage during main's variations of + 10% to prevent loss of torque and speed variations occurring during motor operation.
- p) The VFD shall comply with Electro Magnetic Compatibility (EMC) product standard EN61800-3, First Environment, Unrestricted distribution with minimum 50 meters of output cabling. The supplier of drives shall include additional filters needed, if any, to meet this compliance.
- q) The VFDs shall allow connecting shielded / screened 3 core plus earth motor cable for all power sizes, without any restriction.
- r) The VFDs shall have internal harmonic filters on both limbs of the DC bus to reduce current harmonics. AC line chokes on the input side are not allowed for harmonic current control as it will cause voltage drop to the VFD and motor.
- s) For easier maintenance and to reduce inventory, the VFD shall allow connection of motors one frame size larger and 4 sizes smaller than its nominal rating.

- t) The VFD shall have the following protective functions: Electronic motor overload, Protection to motor and VFD against input transients, phase loss, short circuit, under voltage, over voltage, phase imbalance, motor over temp., phase to phase short circuit or earth fault at motor terminals.
- u) The U peak of the VFD shall be below 1000 Volts (when measured with a cable length of 50 meters) to prevent damage to motor insulation. Manufacturer of the VFD shall submit data sheet to verify this requirement in order to permit the usage of standard motors for the applications specified.
- v) The VFD shall be capable of having an output motor cable length of at least 150 meters (armoured cabling) without any need of additional equipment like output chokes. This is essential for applications like pumps and cooling towers where the motors are located far away from the control center.
- w) The VFDs shall incorporate a surge protection circuit as standard to protect the VFD from transients and spikes in the incoming power supply.
- x) The VFD shall be fully protected from switching a contactor / isolator at the output without causing tripping e.g.: for switching on/off the isolators of the AHU / ventilation fans / pumps near the motor and switching back ON with VFD in on mode.
- y) The VFD shall monitor the belt (AHU etc.) or coupling etc.), and it shall display a warning signal if it detects a broken coupling / belt. There shall be provision to export this warning signal to the CONTROLLER system through RS 485, without any need of I/Os.
- z) The display of the VFD shall be Alpha numeric type. Display of all messages and faults shall be in English text format. Codes are not acceptable The display shall show the following operating parameters:
 - Power consumed by motor in kW

- Run time of motor in Hours
 - Current drawn by motor in Amps.
 - Output frequency in Hz.
 - Motor speed in RPM
 - Set point in process units
 - Feedback in process units
- aa) It shall be possible to see at least 4 of the above operating parameters in the VFD display, simultaneously.
- bb) A parameter lock shall be available in the VFD local display panel to prevent unauthorized resetting of parameters.
- cc) The VFDs shall have internal galvanic isolation (PELV) to avoid damage to CONTROLLER/ PLC / DDC system when interconnected. If PELV is not available, the VFD vendor should offer up to-isolators for all the inputs and outputs in the VFD.
- dd) The VFD shall automatically adjust the switching frequency based on motor current demand rather than motor speed so that the best possible switching frequency is provided, to match both performance and to maintain silent operation all speeds. The switching frequency range shall be from 4-14 kHz for VFDs to be installed on AHUs.
- ee) The VFD shall monitor the relationship between voltage and current in the motor and adjust the output voltage to minimize current and maximize motor and drive efficiency. VFDs offering fixed settings of V/f ratios are not permitted.
- ff) The VFD shall have Auto / OFF / Manual switch on the key pad itself. It shall be possible to manually change the speed of the AHUs from the key pad of the VFD, if required, without the need of an external potentiometer. In manual mode the speed reference signal shall be from keypad of VFD and in auto mode, the reference shall be from the remote – either CONTROLLER or transmitter.

- gg) The VFD shall have self-adjustable ramp times to prevent tripping / VFD damage in case inappropriate ramp times are set with respect to application requirement.
- hh) The VFDs shall have the provision to program a minimum and maximum speed of operations, through the VFD programming itself.
- ii) In case of a power failure, the VFD shall be capable of automatically restarting after a programmable time delay, without the need of an operator having switch on the unit.
- jj) To prevent damage to the VFDs due to pre-rotating fans, the VFD shall have the capability to detect such spinning fans and adjust its frequency to its spinning speed before it starts controlling the fan. If the fan is running in the opposite direction, the VFD should brake the fan by sending a DC current, before starting the fan in the right direction.
- kk) If a temperature / pressure / flow feedback signal is given to the VFD, it shall use its PID controller to modulate the speed in such a way that the set point of temperature or pressure is accurately maintained.
- ll) The VFD shall be capable of accepting two such feedback signals simultaneously and be able to do a speed control based on average / sum / difference / minimum / maximum / 2 zone control of the above 2 signals.
- mm) The feedback signal shall be monitored by the VFD and should provide a warning signal if the feedback goes above or below the programmed high and low limits. It shall be possible to transfer this signal to the CONTROLLER system as well.
- nn) If the VFD loses the feedback signal or reference signal in auto mode, the VFD shall be capable of maintaining the speed at which it is running or to go to maximum speed or to trip.
- oo) The VFD shall have the provision to automatically stop the motor when the feedback signal remains at the low level for a predetermined time.

- pp) The PID controller shall be capable of programming the set points and incoming signals in any of the flowing units RPM, l/s, l/m, l/h, m³/h, m³/s, bar, Pa, kPa, GPM, lb. /s, lb. /h, CFM, in³/h, in.wg, ft.wg, PSI, kW, HP, oC, of, as required by the application, and be able to display the same while in operation.
- qq) The VFD shall enable the motor to step over speeds that cause mechanical vibration / resonance in duct work / pipe lines which can potentially damage the mechanical components in the system.
- rr) The VFD shall have an auto de-rating facility by operating at a lower capacity in case of a phase loss or higher ambient temperature so that minimum air conditioning can be maintained. VFDs that trip on a phase loss or high ambient temperature are not suitable for this application and hence not permitted.
- ss) The VFDs shall have the provision of 4 parameter set ups, which can be activated by the CONTROLLER or by digital inputs.
- tt) The VFD shall have the provision to generate a warning signal, if the operating frequency is above or below programmed the high and low limits, to stage on /off other devices.
- uu) The variable frequency drives (VFD) shall have the provision to integrate into a CONTROLLER system, utilizing a serial communication through Modbus RTU protocol that enables a full "read & write" seamless interface between the VFD &CONTROLLER. The VFD manufacturer shall be responsible for technical support to the CONTROLLER Vendor in the implementation of a serial interface to the CONTROLLER System. The CONTROLLER Vendor shall be responsible for the complete "integration and interoperability" of the VFD through the CONTROLLER via the serial interface.

- vv) The VFD shall provide to CONTROLLER, via serial communication (by RS-485, 2 wire), access to the following VFD parameters as a minimum
- Motor Current
 - Motor kW
 - AHU KWh
 - AHU Running hours
 - Auto / Off / Manual status feedback
 - PID controller programming
 - Set point programming
 - Alarms
 - Run & Trip status
 - Air flow status / alarm
 - Dirty filter status / alarm
 - Fault log history
- ww) The VFD shall also be able to provide the following selectable & programmable physical I/Os to the CONTROLLER system
- 5 Digital inputs (for start, stop, interlock, auto, manual, setup selection etc.)
 - 1 Relay outputs (for reading Auto / Manual status & VFD On / off indication)
 - 1 Analog input, 4 – 20 mA (for single feedback signal to VFD)
 - 2 Analog inputs 0-10V (for feedbacks, if two feedbacks are taken)
 - 2 Analog Outputs, 4-20 mA (for speed & kW feedback to CONTROLLER)
- xx) It shall be possible to read the digital / analog inputs and control the analog and relay outputs of the VFD from the CONTROLLER system through the serial communications, thereby enabling the drive's inputs / outputs to be used as extended I/Os for the CONTROLLER system, to achieve maximum operational and cost efficiency.
- yy) To extend the life of a motor in a damp environment (like cooling towers), the VFD should trickle a small amount of current to the motor, while stopped, to protect it from condensation and the effects of a cold start.
- zz) Upon receiving a start command, the VFD should be able to export another signal, which can be used to start a damper / valve motor actuator. On receiving the signal from damper / valve that it is open, the VFD should start its operation. If the valve / damper is closed, the VFD should not start.
- aaa) The VFD should have a start delay feature, where in it gives time to

prepare for the operation, open dampers or VAV boxes before starting to accelerate the motor.

- bbb) The VFD should have a fireman's override feature, where in the drive can override its standard settings to provide for a life safety application such as building pressurization or smoke purge operation.
- ccc) The VFDs shall have a Real Time Clock (RTC) by which the start / stop of the system can be programmed on a real time basis along with scheduling. The RTC should also allow the speed of the VFD to be changed on the basis of actual time and also log the faults with a date and time stamp. VFD should be compatible able to receive signals from sensors and controller and modulate motor accordingly to maintain desired parameters.

8 ADJUSTMENT AND BALANCING TESTS AT SITE

8.1 GENERAL

The Contractor shall perform all inspection and tests of the air conditioning and ventilation systems as a whole and of components individually as required, under the supervision of the Engineer, in accordance with the provisions of the applicable 'ASHRAE' standards or approved equal, and as per Site requirements.

8.2 PIPING& VALVES SYSTEM

- a) In general, pressure tests shall be applied to piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subjected to pressures exceeding their test ratings.
- b) Tests shall be completed and approved before any insulation is applied.
- c) After tests have been completed, the system shall be drained and cleaned of all dust and foreign material. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.
- d) It should be checked that the same is as per makes specified in contract.
- e) Dimensions including weight shall be checked for pipes against the requirements of contract.
- f) Manufacturer's test certificates for valves for testing of pressure withstand.

8.3 DUCT WORK

- a) All branches and outlets shall be tested for air quantity, and the total of the air quantities shall be within plus three percent (5%) of fan capacity. Duct shall be pressure tested as per SMACNA for all main ducting and all main branches with permissible leakage testing. No smoke or light duct testing is allowed.
- b) Volume dampers and splitter dampers shall be tested for proper operation.
- c) The sheet used for ducting shall be checked for physical test at site. The physical test should include the sheet thickness and bend test as per relevant IS specifications.
- d) Zinc coating of GSS sheet as mentioned in the tender documents may be got tested from a laboratory to verify that same meets the contract requirements.

8.4 BALANCING AND ADJUSTMENT

All air handling ventilation equipment, duct work and outlets shall be adjusted and balanced to deliver the specified air quantities indicated, at each inlet and outlet, on the drawings. If these air quantities cannot be delivered without exceeding the speed range of the sheaves or the available horse power, the Engineer shall be notified before proceeding with the necessary rectification and balancing of air distribution system.

8.5 ELECTRICAL EQUIPMENT

- a) All electrical equipment shall be cleaned and adjusted on Site before application of power.
- b) The following tests shall be carried out:
 - 1) Wire and Cable continuity tests.
 - 2) Insulation resistance tests, phase to phase, phase to earth, and Phase to neutral on all circuits and equipment, using a 500 Volt mega.
 - 3) The earth resistance between conduit system and earth must not exceed half (0.5) OHM.
 - 4) The phase rotation tests.
 - 5) Operating tests on all protective relays to prove their correct operation before energizing the main equipment.

- 6) Operating tests on all starters, circuit breakers, etc.

8.6 PERFORMANCE TESTS

- a) The installation as a whole shall be balanced and tested upon completion, and all relevant information, including the following shall be submitted to the Engineer in charge/consultant.
 - i) Computed capacity of each air-conditioning unit.
 - ii) Air volume passing through each unit, ducts, grille, etc.
 - iii) Differential pressure readings across each filter, fan and coil, and through each condenser.
 - iv) Electrical current readings, in amperes of full and average load running, and starting, together with name plate current of each electrical motor.
 - v) Daily records shall be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream 'ON-COIL' of each cooling coil. Also, suction temperatures and pressures for each refrigerating unit and the current and voltage drawn by each machine.
 - vi) Any other reading shall be taken which may subsequently be specified by the Engineer/consultants.

8.7 MISCELLANEOUS

- a) The above tests are mentioned herein to provide amplification but not by way of limitation, to the provisions of Conditions of Contract and Specification. Duration of the tests shall be not less than 120 continuous hours. These tests shall be carried out, in summer as well as in monsoon and winter period, during the defects liability period.
- b) The date for commencement of all tests listed above shall be subject to the approval of the Engineer and in accordance with the requirements of this Specification.
- c) The Contractor shall provide the skilled staff and all necessary instruments, and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system, if the Engineer requests such a test for determining specified or guaranteed data, as given in the Specifications or on the Drawings.
- d) Any damage resulting from the tests shall be repaired and/or damaged material replaced, all to the satisfaction of the Engineer.
- e) In the event of any repair or any adjustment having to be made, other than normal running adjustments, the tests shall be void and shall be recommenced after the adjustment or repairs have been completed.

- f) The Contractor shall inform the Engineer when such tests are to be made, giving sufficient notice, to enable the Engineer to be present.
- g) Complete records of all tests shall be kept by the contractor, and 3 copies of these and all location drawings shall be furnished to the Engineer/consultants.
- h) The Contractor may be required to repeat the test as required, should the ambient conditions at the time, in the opinion of the Engineer, not give sufficient and suitable indication of the effect and performance of the installation as a whole, or of any part, as required
- i) Contractor shall entirely be responsible for end design parameters expected for HVAC system

9 SYSTEM TESTING ADJUSTMENT AND BALANCING

9.1 SCOPE

- a) Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.
- b) Testing, adjusting and balancing of HVAC system at site.
- c) Testing, adjusting and balancing of exhaust system at site.

Comply with current editions of all applicable practices, codes, methods of standards prepared by technical societies and associations including:

ASHRAE: 170-2010 HVAC Application

SMACNA: Manual for the Balancing and Adjustment for air distribution System

9.2 PERFORMANCE

- a) Verify design conformity.
- b) Establish fluid flow rates, volumes and operating pressures.
- c) Take electrical power readings for each motor.
- d) Establish operating sound and vibration levels.
- e) Adjust and balance to design parameters
- f) Record and report results as per formats specified.

9.3 DEFINITIONS

Test: To determine quantitative performance of equipment.

Adjust: To regulate for specified fluid flow rates and air patterns at terminal equipment (e.g. reduce fan speed, throttling etc.)

Balance: To proportion within distribution system (sub mains, branches and Terminals) in accordance with design quantities.

9.4 TESTING, ADJUSTING AND BALANCING (TAB) PRECEDURES

The following procedures shall be directly following in TAB of the total system.

Before commencement of each one of the TAB procedure explained hereunder, the contractor shall intimate the Project Manager about his ready to conduct the TAB procedures in the format given in these specifications.

9.5 DESCRIPTION OF SYSTEM AND REQUIREMENT

Adjust and balance the following system to provide most energy efficient operation compatible with selected operating conditions.

All supply, return and outside air systems. All exhaust air systems

All refrigerant systems. Emergency purge systems

9.6 AIR SYSTEMS

a) *Air Handlers Performance*

The TAB procedure shall establish the right selection and performance of the AHUs with the following results. Inlet air Dry and Wet bulb temperatures. Outlet air Dry and Wet bulb temperatures. Air leaving dew point temperature Sensible heat Pickup Latent heat Pickup Sensible heat factor.

b) *Air distribution*

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts utilizing telescoping probes of Electronic Rotating Vane Anemometers and Air balancing for grilles and diffusers.

c) *The Preparatory work*

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals.

All outside air intake return air and exhaust air dampers are in proper position. All system volume dampers and fire dampers are in full open position.

All access doors are installed & are airtight.

Grilles are installed & dampers are fully open.

Provision and accessibility of usage of TAB instruments for transverse measurements are available. All windows, doors are in position.

Duct system is of proper construction and is equipped with turning vanes and joints are sealed.

9.7 READINESS FOR COMMENCEMENT OF TAB

Prior to commencement of any test, the readiness to do so should be recorded as per the prescribed checklist.

9.7.1 TAB INSTRUMENTS

Air measuring Instruments

- a) For measuring DB and WB temperature, RH and dew point, microprocessor based TSI USA make Veloci- Calc plus Meter, Model 8386, or equivalent shall be used. This instrument shall be capable of calculating the sensible, latent total heat flows, sensible heat factor and give printouts at site and have data logging/downloading facility.
- b) For measuring Air velocity, DB temperature and Air volume, TSI USA make Veloci-Calc meter model 8345 or equivalent shall be used. It shall be able to provide instant print out of recorded Air Volume readings.
- c) Pivot tube.
- d) Electronic Rotary Vane Anemometer TSI make or equivalent.

- e) Air balancing Flow Measuring Hood TSI make or equivalent.

[All above instruments shall have NIST certification (US Institute of Science and Technology) Calibration Certificate]

2. Rotation
Measuring
Instrument
Electronic
Digital
Tachometer

3. Temperature & RH Measuring Instrument

TSI Veloci-Calc model 8386 and Veloci-Calc model 8345 or equivalent.

4. Electrical
Measuring
Devices
Clamp on
Volt
ammeters
Continuity
Meter

5. Vibration and Noise Levels

Vibration and alignment field measurements shall be taken for each circulating water pump, water chilling unit, air handling unit and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipment vibration, bearing housing vibration, and other test as directed by the Project Manager.

Sound level readings shall be taken at ten (10) locations in the building as selected by the Project Manager. The readings shall be taken on an Octave Band Analyzer in a manner acceptable to him. The contractor shall submit test equipment data and reporting forms for review. In order to reduce the ambient noise level the readings shall be taken at night. All tests shall be performed in the presence of Consultant / Project Manager.

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 Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage system, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."**

[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 Building for 11KV Substation /Transformer yard, MGPS Plant, Bio-Medical Waste, Organic Waste Composter, Public Toilet in parking area, Main Gate & Security Cabin, water supply & Sanitary Installations, external sewerage system, storm water drainage, STP & ETP plant, Roads, Pathway, Parking including Electrical, ELV, Firefighting and Mechanical Ventilation (HVAC) for Gangwal School of Medical Science & Technology at IIT Kanpur."**

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

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 gauges 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.

PART- G- Link of all GFC Drawings (Civil, Electrical & HVAC)

<https://drive.google.com/drive/folders/1HH9uKzcDDGkh4Dvsm3JngbMrgo9RCH5A?usp=sharing>

केन्द्रीय लोक निर्माण विभाग

कार्यालय झापन

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. सिंह) 22/10/2021

अधीक्षण अभियंता (सी.एंड.एम.)

e-file 9116587

Issued from file No. CSQ/CM/16(1)/2021

प्रतिनिधि: सभी केलोनिवि तथा लोनिवि दिल्ली के अधिकारियों को आवश्यक सूचना एवं कार्यवाही हेतु (केलोनिवि वेबसाईट के माध्यम से).