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**Name of Work:**           **Construction of vertical extension (i.e. 5th to 8th floor) of National Aerosol Test Facility Building at IIT Kanpur (SH: Air-conditioning Work)**

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**NIT amounting to 1, 10, 43,429/-- is approved.**

**[Certified that this N.I.T. contains 166 pages (One Hundred Sixty Six Only).]**

**Executive Engineer**  
**I.W.D. Elect. & AC Divn.**  
**I.I.T., Kanpur**

**Superintending Engineer**  
**Central Office, I.W.D.**  
**I.I.T., Kanpur**

# ***PART-A***

**INDIAN INSTITUTE OF TECHNOLOGY KANPUR**  
**INSTITUTE WORKS DEPARTMENT**  
**Electrical & Air-conditioning Division**  
**E-TENDER NOTICE**

**NIT No. 18/AC/2020/1268**

**dated: 23.12.2020**

The Superintending Engineer, IWD, I.I.T., Kanpur on behalf of Board of Governors of IIT Kanpur invites online item rate tenders for the following works from eligible Original Equipment Manufacturers of VRF ac units or their eligible authorized dealers:-

Sl. No	Name of work and location	Estimated cost put to tender (In Rs.)	Earnest Money (In Rs.)	Period of Completion (in Month)	Last date & time of submission of tender	Period during which EMD, Cost of Tender Document, e-Tender Processing Fee and other Documents shall be submitted	Time & date of opening of tender
1	<b>Construction of vertical extension (i.e. 5th to 8th floor) of National Aerosol Test Facility Building at IIT Kanpur (SH: Air-conditioning Work)</b>	1,10,43,429/-	2,20,869/-	3	Upto 3:30 PM on 07.01.2021	After last date and time of sub-mission of tender and upto 3:30 PM on 11.01.2021	At 3:30 PM on 12.01.2021

The E-tender documents is available on <http://eprocure.gov.in/eprocure/app>

Superintending Engineer

Copy to :

1. Institute website: [www.iitk.ac.in/iwd/tenderhall.htm](http://www.iitk.ac.in/iwd/tenderhall.htm)
2. Notice Board

## **Information of e-Tendering for Contractors**

1. *The intending tenderer must read the terms and conditions of FORM-6 for e-Tendering carefully. He should only submit his tender if he considers himself eligible and he is in possession of all the documents required.*
2. *Information and Instructions for tenderer posted on website shall form part of tender document.*
3. *The tender document consisting of plans, specifications, the schedule of quantities of various types of items to be executed and the set of terms and conditions of the contract to be complied with and other necessary documents can be seen and downloaded from website <https://eprocure.gov.in/eprocure/app> or [www.iitk.ac.in](http://www.iitk.ac.in) free of cost.*
4. *But the tender can only be submitted after uploading the mandatory scanned documents as per list given below.*
5. *Those contractors not registered on the website mentioned above, are required to get registered beforehand. If needed they can be imparted training on online bidding process as per details available on the website.*

## BID DOCUMENT

Online bids (Technical & Financial) from eligible bidders which are valid for a period of 90 days from the date of Technical/financial Bid opening (i.e.11.01.2021) are invited for and on behalf of the Board of Governors, IIT, Kanpur for “**Construction of vertical extension (i.e. 5th to 8th floor) of National Aerosol Test Facility Building at IIT Kanpur (SH: Air conditioning Works).**”

Notice Inviting Tender No.	18/AC/2020/1268 dated 23.12.2020
Name of Work	<b>Construction of vertical extension (i.e. 5th to 8th floor) of National Aerosol Test Facility Building at IIT Kanpur (SH: Air-conditioning Work)</b>
Estimated Cost	Rs.1,10,43,429/-
Earnest Money	Rs.2,20,869/-
<b>Date of Publishing</b>	<b>24.12.2020 (15:30 hrs)</b>
Clarification Start Date and Time	<b>24.12.2020 ( working days only)</b>
Clarification End Date and Time	<b>04.01.2021 ( working days only)</b>
Queries (if any)	No queries will be entertained after clarification end date and time
<b>Bid Submission Start Date</b>	<b>24.12.2020 (18:00 hrs)</b>
Last Date and time of uploading of Bids	<b>07.01.2021 (15.30 hrs)</b>
Last Date and time of <b>submitting</b> , EMD and other documents at IWD, IIT Kanpur	<b>11.01.2021 (15:30 hrs)</b>
Date and time of opening of Technical Bids	<b>11.01.2021 (16.00 hrs)</b>
Date and time of opening of Financial Bids	<b>12.01.2021 (15.30 hrs)</b>

Interested parties may view and download the tender document containing the detailed terms & conditions from the website <http://eprocure.gov.in/eprocure/app>

**(The bids have to be submitted online in electronic form on [www.eprocure.gov.in](http://www.eprocure.gov.in) only. No physical financial bids will be accepted.)**

## INSTRUCTION FOR ONLINE BID SUBMISSION

The bidders are required to submit soft copies of their bids electronically on the Central Public Procurement (CPP) Portal ie <http://eprocure.gov.in/eprocure/app> , using valid Digital Signature Certificates. The instructions given below are meant to assist the bidders in registering on the CPP Portal, prepare their bids in accordance with the requirements and submitting their bids online on the CPP Portal.

### **REGISTRATION**

- (i)** Bidders are required to enroll on the e-Procurement module of the Central Public Procurement Portal (URL:<https://eprocure.gov.in/eprocure/app>) by clicking on the link “Online Bidder Enrollment” option available on the home page. **Enrolment on the CPP Portal is free of charge.**
- (ii)** During enrolment/ registration, the bidders should provide the correct/ true information including valid email-id & mobile no. All the correspondence shall be made directly with the contractors/ bidders through email-id provided.
- (iii)** As part of the enrolment process, the bidders will be required to choose a unique username and assign a password for their accounts.
- (iv)** For e-tendering possession of valid Digital Signature Certificate (Class II or Class III Certificates with signing key usage) is mandatory which can be obtained from SIFY /nCode/eMudra or any Certifying Authority recognized by CCA India on eToken/ SmartCard.
- (v)** Upon enrolment on CPP Portal for e-tendering, the bidders shall register their valid Digital Signature Certificate with their profile.
- (vi)** Only one valid DSC should be registered by a bidder. Bidders are responsible to ensure that they do not lend their DSCs to others which may lead to misuse and should ensure safety of the same.
- (vii)** Bidders can than log into the site through the secured login by entering their userID/ password and the password of the DSC/ eToken.

### **SEARCHING FOR TENDER DOCUMENTS**

- 1) There are various search options built in the CPP Portal to facilitate bidders to search active tenders by several parameters. These parameters could include Tender ID, organization name, location, date, value, etc. There is also an option of advanced search for tenders, wherein the bidders may combine a number of search parameters such as organization name, form of contract, location, date, other keywords, etc., to search for a tender published on the CPP Portal.

- 2) Once the bidders have selected the tenders they are interested in, they may download the required documents / tender schedules. These tenders can be moved to the respective 'My Tenders' folder. This would enable the CPP Portal to intimate the bidders through SMS / e-mail in case there is any corrigendum issued to the tender document.
- 3) The bidder should make a note of the unique Tender ID assigned to each tender, in case they want to obtain any clarification / help from the Helpdesk.

#### **PREPARATION OF BIDS:**

- (i) For preparation of bid Bidders shall search the tender from published tender list available on site and download the complete tender document and should take into account corrigendum if any published before submitting their bids.

After selecting the tender document same shall be moved to the 'My favourite' folder of bidders account from where bidder can view all the details of the tender document.

- (ii) Bidder shall go through the tender document carefully to understand the documents required to be submitted as part of the bid. Bidders shall note the number of covers in which the bid documents have to be submitted, the number of documents - including the names and content of each of the document that need to be submitted. Any deviations from these may lead to rejection of the bid.
- (iii) Any pre-bid clarifications if required, then same may be obtained online through the tender site, or through the contact details given in the tender document.
- (iv) Bidders should get ready in advance the bid documents in the required format (PDF/xls/rar/jpg formats) to be submitted as indicated in the tender document/schedule. **Bid documents may be scanned with 100 dpi with black and white option which helps in reducing size of the scanned document.**
- (v) Bidders can update well in advance, the documents such as experience certificates, annual report, PAN, EPF & other details etc., under "My Space/ Other Important Document" option, which can be submitted as per tender requirements. This will facilitate the bid submission process faster by reducing upload time of bids.

#### **SUBMISSION OF BIDS:**

- (i) Bidder should log into the site well in advance for bid submission so that he/ she upload the bid in time i.e. on or before the bid submission time. Bidder will be responsible for any delay.
- (ii) Bidder should prepare the EMD as per the instructions specified in the NIT/ tender document. The details of the DD/BC/BG/ others physically sent, should tally with

the details available in the scanned copy and the data entered during bid submission time. Otherwise the uploaded bid will be rejected.

- (iii) While submitting the bids online, the bidder shall read the terms & conditions (of CPP portal) and accepts the same in order to proceed further to submit their bid.
- (iv) Bidders shall select the payment option as offline to pay the EMD and enter details of the DD/BC/BG/others. The intending tenderer has to fill all the details such as Banker's name, Demand Draft/Fixed Deposit Receipt /Pay Order/ Banker's Cheque/Bank Guarantee number, amount and date.
- (v) The amount of EMD can be paid by multiple Demand Draft / Pay Order / Banker's Cheque / Deposit at call receipt / Fixed Deposit Receipts along with multiple Bank Guarantee of any Scheduled Bank.
- (vi) Bidder shall digitally sign and upload the required bid documents one by one as indicated in the tender document.
- (vii) Bidders shall note that the very act of using DSC for downloading the tender document and uploading their offers is deemed to be a confirmation that they have read all sections and pages of the tender document without any exception and have understood the complete tender document and are clear about the requirements of the tender document.
- (viii) Bid documents may be scanned with 100 dpi with black and white option which helps in reducing size of the scanned document. For the file size of less than 1 MB, the transaction uploading time will be very fast.
- (ix) **If price quotes are required in XLS format, utmost care shall be taken for uploading Schedule of quantities & Prices and any change/ modification of the price schedule shall render it unfit for bidding.**

**Bidders shall download the Schedule of Quantities & Prices i.e. Schedule-A, in XLS format and save it without changing the name of the file. Bidder shall quote their rate in figures in the appropriate cells, thereafter save and upload the file in financial bid cover (Price bid) only.**

**If the template of Schedule of Quantities & Prices file is found to be modified/corrupted in the eventuality by the bidder, the bid will be rejected and further dealt as per provision of clause no 23.0 of ITB including forfeiture of EMD.**

**The bidders are cautioned that uploading of financial bid elsewhere i.e. other than in cover 2 will result in rejection of the tender.**

- (x) Bidders shall submit their bids through online e-tendering system to the Tender



Inviting Authority (TIA) well before the bid submission end date & time (as per Server System Clock). **The TIA will not be held responsible for any sort of delay or the difficulties faced during the submission of bids online by the bidders at the eleventh hour.**

- (xi) After the bid submission (i.e. after Clicking “Freeze Bid Submission” in the portal), the bidders shall **take print out of system generated acknowledgement number** and keep it as a record of evidence for online submission of bid, which will also act as an entry pass to participate in the bid opening.
- (xii) Bidders should follow the server time being displayed on bidder’s dashboard at the top of the tender site, which shall be considered valid for all actions of requesting, bid submission, bid opening etc., in the e-tender system.
- (xiii) All the documents being submitted by the bidders would be encrypted using PKI (Public Key Infrastructure) encryption techniques to ensure the secrecy of the data. The data entered cannot be viewed by unauthorized persons until the time of bid opening. The confidentiality of the bids is maintained using the secured Socket Layer 128 bit encryption technology.

**ASSISTANCE TO BIDDERS:**

- (i) Any queries relating to the tender document and the terms and conditions contained therein should be addressed to the Tender Inviting Authority for a tender or the relevant contract person indicated in the tender. The contact number for the helpdesk is 0512-2597416 between 10:30 hrs to 17:00 hrs.
- (ii) Any queries relating to the process of online bid submission or queries relating to CPP Portal in general may be directed to the 24X7 CPP Portal Helpdesk. The 24 x 7 Help Desk Number 0120-4200462, 0120-4001002 and 0120-4001005. The helpdesk email id is [support-eproc@nic.in](mailto:support-eproc@nic.in)

## INSTRUCTION FOR e-PROCUREMENT

### 1. PREPARATION AND SUBMISSION OF BIDS :

- a. The detailed tender documents may be downloaded from <http://eprocure.gov.in/eprocure/app> till the last date of submission of tender. The Tender may be submitted online through CPP Portal <http://eprocure.gov.in/eprocure/app>
- b. The bidder should submit the bid online in two parts viz. Technical Bid and Financial Bid. Technical Bid should be upload online in cover- 1 and Financial Bid in “.Xls” should be upload online in cover-2

### 2. SUBMISSION OF THE BID : All interested eligible bidders are requested to submit their bids online on CPP Portal: <http://eprocure.gov.in/eprocure/app> as per the criteria given in this document:

- a. Technical Bid should be upload online in cover-1.
- b. Financial Bid should be upload online in cover-2

Both Technical and Financial Bid covers should be placed online on the CPP Portal (<http://eprocure.gov.in/eprocure/app>).

### 3. TECHNICAL BID: Signed and Scanned copies of the Technical bid documents as under must be submitted online on CPP Portal: <http://eprocure.gov.in/eprocure/app>

#### **List of Documents to be scanned and uploaded (Under Cover-1) within the period of bid submission:-**

- Copy of proof of Original Equipment Manufacturer of VRF (Variable Refrigerant Flow) ac units from approved makes or certificate of Authorized Dealership from Original Equipment Manufacturer from approved makes.
- Required experience / completion certificates of similar nature of works. The works certificates submitted by the bidder clearly indicate that:
  1. The completion certificate cost of the executed variable refrigerant flow (VRF) type air-conditioning works of capacity at least 140 hp.
  2. Actual date of completion of the above air-conditioning work.
- Copy of EPF & ESI No.
- Copy of GST Registration No.
- Details of turn over during the last three years.
- Copy of bank solvency certificate
- Scan copy of E.M.D. as to be submitted in hard copy.
- The tenderer shall have to furnish an affidavit on non-judicial stamp paper of Rs. 10.00 as under: “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 light, then I/We shall be debarred for tendering in IIT Kanpur contracts in future forever. Also, if such a violation comes to light before date start of work, the Superintending Engineer shall be free to forfeit the entire amount of Earnest Money Deposit / Performance Guarantee

The hardcopy of above documents alongwith earnest money deposit receipt shall be submitted in the office of Executive Engineer (AC), Central Office, IWD within last date and time of submission as specified in the above bid document.

Please note that no indication of the rates/amounts be made in any of the documents submitted with the TC-BID.

#### 4. Financial Bid

- a. The currency of all quoted rates shall be Indian Rupees. All payment shall be made in Indian Rupees.
- b. In preparing the financial bids, bidders are expected to take into account the requirements and conditions laid down in this Tender document. The financial bids should be uploaded online as per the specified “.Xls” format i.e. Price Bid in Excel sheet attached as ‘.Xls’ with the tender and based on the scope of work, service conditions and other terms of the Tender document. It should include all costs associated with the Terms of Reference/Scope of Work of the assignment.
- c. Being an individual work contract no other tax is payable other than GST. The GST shall be paid extra as applicable.

#### 5. Last Date for Submission of Tender:

- a. Online bids complete in all respects, must be submitted on or before the last date and time specified in the schedule of events.
- b. The IIT, Kanpur may, at its own discretion, alter/extend the last date for submission of tenders.

#### 6. Bid Validity

- a. All the Bids must be valid for a period of 90 days from the last date of submission of the tender for execution of Contract. However, the quoted rates should be valid for the initial/ extended period of the Contract from the effective date of the Contract. No request will be considered for price revision during the original Contract period.
- b. A bid valid for a shorter period shall be declared as non-responsive.
- c. In exceptional circumstances, prior to expiry of the original time limit, the IIT may request the bidders to extend the period of validity for a specified additional period beyond the original validity of 90 days. The request and the bidders' responses shall be made in writing. The bidders, not agreeing for such extensions will be allowed to withdraw their bids without forfeiture of their Bid Security.

#### 7. Modification / Substitution/ Withdrawal of bids:

- a. No Bid shall be modified, substituted or withdrawn by the Bidder after

the Bid 's due Date.

- b. Any alteration/ modification in the Bid or additional information supplied subsequent to the Bid's due Date, unless the same has been expressly sought for by the Authority, shall be disregarded.

8. **Rejection of the Bid:** The bid submitted shall become invalid if:-

- a) The tenderer is found ineligible.
- b) The tenderer does not upload all the documents as stipulated in the tender document.
- c) If any discrepancy is noticed between the documents as uploaded at the time of submission of tender and hard copies as submitted physically in the office of tender opening authority.

- **NOTICE INVITING TENDER ( FORM -6 FOR E-Tendering)**

The Superintending Engineer, IWD, I.I.T., Kanpur on behalf of Board of Governors of IIT Kanpur invites online item rate tenders from eligible Original Equipment Manufacturers of VRF type ac units or their eligible authorized dealers for the following work(s): **Construction of vertical extension (i.e. 5th to 8th floor) of National Aerosol Test Facility Building at IIT Kanpur (SH: Air conditioning Work).**

1.1 The work is estimated to cost Rs. **1,10,43,429/-**. This estimate, however, is given merely as a rough guide.

## 2 **Criteria of eligibility**

1. The original equipment manufacturer or the authorized dealers of VRF type ac units of approved make.
  2. Having satisfactorily completed 3 (three) similar works each of value **40%** of the estimated cost or two similar works each of value **60%** of the estimated cost or one similar work of value **80%** of estimated cost during last seven years. Out of the above at least one work must be in the Central Govt. /Central autonomous bodies/central PSU/State PSU/State Govt.
  3. Similar nature of work means: Supply, installation, testing & commissioning of VRF type ac system of capacity at least **140 hp**, installations including associated AHU, CSU, and FCU, ducting, piping, and its controls etc.
  4. Having GST, ESI & EPF registration No. of government authorities.
  5. Details of average annual financial turnover of air-conditioning works should be at least 100% of the estimated cost during the last 3 consecutive financial years.
  6. Having a bank solvency certificate of not less of 40% of estimated cost.
3. Agreement shall be drawn with the successful tenderers on prescribed Form No. CPWD 7 (or other Standard Form as mentioned) which is available as a Govt. of India Publication and also available on website [www.iitk.ac.in](http://www.iitk.ac.in) Tenderers shall quote his rates as per various terms and conditions of the said form which will form part of the agreement.
4. The time allowed for carrying out the work will be **3 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 tender documents.
5. The site for the work is available.\*
6. The tender document consisting of plans, specifications, the schedule of quantities of various types of 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 Form can be seen on website [www.tenderwizard.com/IIT](http://www.tenderwizard.com/IIT), <https://eprocure.gov.in/cppp/latestactivetenders> or [www.iitk.ac.in](http://www.iitk.ac.in) other necessary documents also can be seen in the office of the EE, Electrical and Air conditioning Division, IWD, IIT, Kanpur between hours of 3.00 PM to 3:00 PM from **24.12.2020 to 07.01.2021** free of cost.
7. After submission of the tender the contractor can re-submit revised tender any number of times but before last time and date of submission of tender as notified.

8. *While submitting the revised tender, 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 tender as notified.*
9. *When tenders are invited in three stage system and if it is desired to submit revised financial tender then it shall be mandatory to submit revised financial tender. If not submitted then the tender submitted earlier shall become invalid.*
10. *Earnest Money can be paid 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 **Director, IIT, Kanpur** along with Bank Guarantee of any Scheduled Bank wherever applicable.*

*A part of earnest money is acceptable in the form of bank guarantee also. In such case, 50% of earnest money or Rs. 20 lac, whichever is less, will have to be deposited in shape prescribed above, and balance in shape of Bank Guarantee of any scheduled bank.*

*Treasury Challan or Demand Draft or Pay Order or Banker's Cheque or Deposit at Call Receipt or FDR or Bank Guarantee against EMD, Cost of Tender Document and Cost of Tender Processing Fee shall be placed in single sealed envelope superscripted as "Earnest Money, Cost of Tender Document and Cost of Tender Processing Fee" with name of work and due date of opening of the tender also mentioned thereon.*

*Copy of Enlistment Order and certificate of work experience wherever applicable and other documents if required and specified in this bid document shall be scanned and uploaded to the e-Tendering website within the period of tender submission and certified copy of each shall be deposited in a separate envelop marked as "Other Documents".*

*Both the envelopes shall be placed in another envelope with due mention of Name of work, date & time of opening of tenders and to be submitted in the office of Superintending Engineer after last date & time of submission of tender and up to 03:30 PM on **11.01.2021**. The documents submitted shall be opened at 04:00 PM on **11.01.2021**.*

*Online tender documents submitted by intending tenderers shall be opened only of those tenderers, whose Earnest Money Deposit, Cost of Tender Document and e- Tender Processing Fee and other documents placed in the envelope are found in order.*

*The tender submitted shall be opened at 03:30 PM on **12.01.2021**.*

11. *The tender submitted shall become invalid and cost of tender & e-Tender processing fee shall not be refunded if:*
  - (i) *The tenderers is found ineligible.*
  - (ii) *The tenderers does not upload all the documents as stipulated in the tender document.*
  - (iii) *If any discrepancy is noticed between the documents as uploaded at the time of submission of tender and hard copies as submitted physically in the office of tender opening authority.*
12. *The contractor whose tender is accepted will be required to furnish performance guarantee of 5% (Five Percent) of the tendered amount within the period specified in Schedule F. This guarantee shall be in the form of cash (in case guarantee amount is less than 10000/-) or Deposit at Call receipt of any scheduled bank/Banker's cheque of any scheduled bank/Demand Draft of any scheduled bank/Pay order of any Scheduled Bank of any scheduled bank (in case guarantee amount is less than ` 1,00,000/-) or Government Securities or Fixed Deposit Receipts or Guarantee Bonds of any Scheduled Bank or the State Bank of India 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.*

13. *Intending Tenderers are advised to inspect and examine the site and its surroundings and satisfy themselves before submitting their tenders as to the nature of the ground and sub-soil (so far as is practicable), the form and nature of the site, the means of access to the site, the accommodation they may require and in general shall themselves obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect their tender. A tenderers shall be deemed to have full knowledge of the site whether he inspects it or not and no extra charge consequent on any misunderstanding or otherwise shall be allowed. The tenderers shall be responsible for arranging and maintaining at his 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 tender by a tenderer implies that he has read this notice and all other contract documents and has made himself aware of the scope and specifications of the work and local conditions and other factors having a bearing on the execution of the work.*
14. *The competent authority on behalf of the Board of Governors, IIT, Kanpur does not bind itself to accept the lowest or any other tender and reserves to itself the authority to reject any or all the tenders received without the assignment of any reason. All tenders in which any of the prescribed condition is not fulfilled or any condition including that of conditional rebate is put forth by the tenderers shall be summarily rejected.*
15. *Canvassing whether directly or indirectly, in connection with tenderers is strictly prohibited and the tenders 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 tender and the tenderers shall be bound to perform the same at the rate quoted.*
17. *The contractor shall not be permitted to tender for works in the IIT Kanpur responsible for award and execution of contracts, in which his near relative is posted a Divisional Accountant or as an officer in any capacity between the grades of Superintending Engineer and Junior Engineer (both inclusive). He shall also intimate the names of persons who are working with him in any capacity or are subsequently employed by him and who are near relatives to any gazetted officer in the IIT Kanpur. Any breach of this condition by the contractor would render him liable to be removed from the approved list of contractors of this Department.*
18. *No Engineer of Gazetted Rank or other Gazetted Officer employed in Engineering or Administrative duties in an Engineering Department of the Government of India is allowed to work as a contractor for a period of one year after his retirement from Government service, without the prior permission of the Government of India in writing. This contract is liable to be cancelled if either the contractor or any of his employees is found any time to be such a person who had not obtained the permission of the Government of India as aforesaid before submission of the tender or engagement in the contractor's service.*
19. *The tender for the works shall remain open for acceptance for a period of **ninety (90) days** from the date of opening of tenders if any tenderer withdraws his tender before the said period or issue of letter of acceptance, whichever is earlier, or makes any modifications in the terms and conditions of the tender which are not acceptable to the*

department, then the Government shall, without prejudice to any other right or remedy, be at liberty to forfeit 50% of the said earnest money as aforesaid. Further the tenderers shall not be allowed to participate in the retendering process of the work.

20. This Notice Inviting Tender shall form a part of the contract document. The successful tenderers/contractor, on acceptance of his tender 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 Tender, all the documents including additional conditions, specifications and drawings, if any, forming part of the tender as uploaded at the time of invitation of tender and the rates quoted online at the time of submission of tender and acceptance thereof together with any correspondence leading thereto.

b) Standard C.P.W.D. Form 7 or other Standard C.P.W.D. Form as applicable.

20.1.1 The tender document will include following three components:

**Part A:-** CPWD-6, CPWD-7 including schedule A to F for the major component of the work, Standard General Conditions of Contract for CPWD 2014 as amended/modified up to **07.01.2021**.

**Part B:-** General/specific conditions, specifications and schedule of quantities applicable to major component of the work.

**Part C:-** Schedule A to F for minor component of the work. (SE/EE in charge of major component shall also be competent authority under clause 2 and clause 5 as mentioned in schedule A to F for major components), General/specific conditions, specifications and schedule of quantities applicable to minor component(s) of the work.

20.1.2 The tenderers must associate himself, with agencies of the appropriate class eligible to tender for each of the minor component individually.

20.1.3 The eligible tenderers shall quote rates for all items of major component as well as for all items of minor components of work.

20.1.4 Entire work under the scope of composite tender including major and all minor components shall be executed under one agreement.

20.1.5 Security Deposit will be worked out separately for each component corresponding to the estimated cost of the respective component of works. The Earnest Money will become part of the security deposit of the major components of work.

21. The EPF & ESI contribution deposited against the contract workers shall be reimbursed on actual basis.

22. **Entire work under the scope of tender including major (high side or equipment's) and all minor (low side) components shall be executed under one agreement. Whereas a supplementary agreement with the same rate, terms & conditions as specified in the original bid have to executed with IIT Kanpur for the**



***Comprehensive Annual Maintenance Contract part of the tender after successful commissioning of the project as per para 5.20 of CPWD Works Manual 2019 , updated upto 07.01.2021. The form of supplementary agreement is at [Appendix-XI](#)***

***Superintending Engineer  
For & on behalf of the Board of Governors, IIT, Kanpur***

**ITEM RATE TENDER AND CONTRACT FOR WORK**

- (A) **Tender for the work of:** **Construction of vertical extension (i.e. 5th to 8th floor) of National Aerosol Test Facility Building at IIT Kanpur (SH: Air-conditioning Work)**

**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 Governors, IIT, Kanpur within the time specified in Schedule 'F', viz., schedule of quantities and in accordance in all respects with the specifications, designs, drawings 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 respects in accordance with, such conditions so far as applicable.*

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

*A sum of Rs. **2,20,869.00** 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 scheduled bank as earnest money. If I/we, fail to furnish the prescribed performance guarantee or fail to commence the work within prescribed period I/we agree that the said Board of Governors, IIT, Kanpur 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 of commence work as specified, I/we agree that Board of Governors, IIT, Kanpur or his 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 therein and to carry out such deviations as may be ordered, up to maximum of the percentage mentioned in Schedule 'F' and 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 or both 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 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 there from 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 \_\_\_\_\_ \*\* \_\_\_\_\_*

*Witness: \*\**  
*Address: \*\**  
*Occupation: \*\**

*\*\**  
*Signature of contractor*  
*Postal Address \*\**

# ACCEPTANCE

The above tender (as modified by you as provided in the letters mentioned hereunder) is accepted by me for and 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 the Board of Governors, IIT,  
Kanpur*

*Dated* \_\_\_\_\_

*Signature* \_\_\_\_\_  
*Designation* \_\_\_\_\_

**Operative schedules shall be supplied separately to each intending tenderer**

**SCHEDULE ‘A’**

**Schedule of Quantities:**

**SCHEDULE ‘B’**

*Schedule of materials to be issued to the contractor:*

<i>S. No.</i>	<i>Description of item</i>	<i>Quantity</i>	<i>Rates in figures &amp; words at which the material will be charged to the contractor</i>	<i>Place of issue</i>
1	2	3	4	5
-----NIL -----				

**SCHEDULE ‘C’**

*Schedule of Tools and Plants to be hired to the contractor*

<i>S. No.</i>	<i>Description</i>	<i>Hire charges per day</i>	<i>Place of issue</i>
1	2	3	4
-----NIL -----			

**SCHEDULE ‘D’**

*Extra schedule for specific requirements/document for As attached in tender form. the work, if any:*

**SCHEDULE ‘E’**

Schedule of component of other Materials, Labour, POL etc. for price escalation: **N.A.**

**SCHEDULE ‘F’**

Reference to General Conditions of contract.

<b>Name of Work:</b>	<b>Construction of vertical extension (i.e. 5th to 8th floor) of National Aerosol Test Facility Building at IIT Kanpur (SH: Air-conditioning Work)</b>		
<b>Estimated cost of the work:</b>	Air-conditioning Items of Work	<b>Rs.1,10,43,429/-</b>	
<b>Earnest money</b>	<b>Rs.2,20,869/-</b>		
<b>Performance Guarantee</b>	5% of the tendered value of the work		
<b>Security Deposit</b>	2.5% of the tendered value of the work		

**General rules and direction:**

**Definitions:**

2(v)	<b>Engineer-in-Charge</b>	
	For Air-conditioning & Executive Engineer, Refrigeration/Electrical items of work	<b>Institute Works Department IIT, Kanpur</b>
2(vi)	Accepting Authority	<b>Superintending Engineer, Institute Works Department IIT, Kanpur</b>
2(vii)	Percentage on cost of materials and labour to cover all overheads and profits	15%
2(viii)	<b>Standard Schedule of Rates:</b>	
	Electrical Items of Work:	D.S.R. 2018 with up to date correction slips
2(ix)	Department:	Central Public Works Department
2(x)	Standard CPWD contract Form:	GCC 2020, CPWD <b>form-7</b> as modified & corrected up to <b>07.01.2021</b> (Whether correction vide latest circulars are incorporated or not in this document).
<b>Clause 1</b>	i) Time allowed for submission of Performance Guarantee from the date of issue of letter of acceptance	15 Days
	ii) Maximum allowable extension beyond the period as provided in i) above	7 Days
<b>Clause 2</b>	Authority for fixing Compensation under Clause 2	<b>Superintending Engineer, Institute Works Department IIT, Kanpur. Or successor thereof</b>
<b>Clause 2 A</b>	Whether Clause 2A shall be applicable	No
<b>Clause 5</b>	i) Number of days from the date of issue of letter of acceptance for reckoning date of start	<b>22 Days</b>
	ii) Time allowed for execution of work	<b>3 (Three) Months</b>

**Authority to decide      Extension of time      Superintending Engineer,  
Institute Works Department  
IIT, Kanpur**

**Clause 6/ 6A**

**Only clause 6  
applicable.**

**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*

**Not applicable**

**Clause 10A**      *Material to be provided by the contractor.*

**Applicable**

**Clause 10B (ii), (iii)**      *Whether clause 10-B (ii) and 10-B (iii) shall be applicable.*

**Not Applicable**

**Clause 10 C**      *Component of labour expressed as percentage of value of work*

**Not applicable**

**Clause 10 CA**      *Materials covered under this clause.*      **Nearest material (other than cement, reinforcement bars and structural steel) for which All India Whole sale price Index is to be followed.**      **Base price of all the materials covered under clause 10 CA**

- 1. Cement (PPC)      **Nil**
- 2. Steel      **Nil**

**NIL  
NIL**

**Clause 10 CC**      *Increase/Decrease in Price of materials/wages*

**Not Applicable**

**Clause 11      Specification to be followed for execution of work:**

**For electrical works**      **CPWD specifications 2013 internal and 2013 external electrical works**

**For Air conditioning & Refrigeration item of works**      **CPWD Specifications 2017 HVAC for Air-conditioning & refrigeration works with up to date correction slips.(Hereinafter called CPWD specifications also)**

**Clause 12**

**12.2 & 12.3**      *Deviation limit beyond which clause 12.2 & 12.3 shall apply for building work*      ---

**Clause 16      Competent Authority for Deciding reduced rates:**

*For electrical/civil/Air-conditioning & refrigeration items of work*      **Superintending Engineer,  
Institute Works Department  
IIT, Kanpur**

**Clause 18**                      *List of mandatory machinery, tools & plants to be deployed by the contractor at site.*                      **Ladders, Multi-meter, drill machine, crimping tools, spanner set, blower, Gas Charging line with equipment, welding torch etc**

**Clause 36 (i)**                      **Requirement of technical Representative(s)**

**Requirement of technical Representative(s)**

**Requirement of Technical Representative (S) and recovery Rate**

Sl. No.	Minimum Qualification of Technical Representative	Discipline	Designation (Principal Technical / Technical representative)	Minimum Experience	Number	Rate at which recovery shall be made from the contractor in the event of not fulfilling provision of clause 36(i)	
						Figures	Words
1.	B.E./B.Tech	Electrical / mechanical	Graduate Engineer	5	1	Rs.21,000/- p.m	Twenty One Thousand per month

*For supervision of air-conditioning as well as electrical items of work, technical representatives of the respective disciplines will be required to be deployed.*



# SALIENT/MANDATORY REQUIREMENTS FOR THE TENDER

**Name of Work:** **Construction of vertical extension (i.e. 5th to 8th floor) of National Aerosol Test Facility Building at IIT Kanpur (SH: Air-conditioning Work).**

- 1 *The tenderer is advised to read and examine the tender documents for the work and the set of drawings available with Engineer-in-charge. He should inspect and examine the site and its surroundings by himself before submitting his tender.*
- 2 *Separate schedule of quantity is included in this tender for air conditioning & refrigeration items of work. If the tenderer wants to offer any unconditional rebates on their rates, the same should also be offered in the respective components of schedule separately. The contractor shall quote the item rates in figures and words accurately so that there is no discrepancy in rates written in figures and words.*
- 3 *Time allowed for the execution of work is 3 **(Three) months**.*
- 4 *The contractor(s) shall submit a detailed program of execution in accordance with the master programme/milestone within ten days from the date of issue of award letter.*
- 5 *Contractor has to arrange and install field laboratory during the currency of work and nothing extra will be paid on this account.*
- 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 *Contractor has to deploy required Plant and machinery on the project. In case the contractor fails to deploy the plant and machinery whenever required and as per the direction of the Engineer-in-charge, he (Engineer-in-charge) shall be at a liberty to get the same deployed at the risk and cost of the contractor.*
- 8 *The contractor shall comply with the provisions of the Apprentices Act 1961, and the rules and orders issued there under from time to time. If he fails to do so, his failure will be a breach of the contract and the Superintending Engineer/Executive Engineer may in his discretion, without prejudice to any other right or remedy available in law, cancel the contract. The contractor shall also be liable for any pecuniary liability arising on account of any violation by him of the provisions of the said Act.*
- 9 *Electricity and water services will be provided by the institute free of cost on the request of the contractor.*

# ***PART-B***

## GENERAL TERMS AND CONDITIONS

- 1 *Unless otherwise provided in the Schedule of Quantities/Specifications, the rates tendered by the contractor shall be 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. Extra payment for centering/shuttering, if required to be done for heights greater than 3.5 m shall however be admissible at the rates arrived at in accordance with clause 12 of the agreement, if not already specified.*
- 2 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.
- 3 Some restrictions may be imposed by the security staff etc. on the working and for movement of labour, materials etc. The contractor shall be bound to follow all such restrictions/instructions and nothing extra shall be payable on account of the same.
- 5.1 *The contractor shall fully comply with all legal orders and directions of the Public or local authorities or municipality and abide 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.*
- 5.2 *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.*
- 6 If as per local Municipal regulations, huts for labour 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.
- 7 The structural and architectural drawings shall at all times be properly co-related before executing any work. However, in case of any discrepancy in the item given in the schedule of quantities appended with the tender and Architectural drawings relating to the relevant item, the former shall prevail unless otherwise given in writing by the Engineer-in-charge.
- 8.1 For the purpose of recording measurements and preparing running account bills, the abbreviated nomenclature indicated in the publications Abbreviated Nomenclature of Items of DSR 2014 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.
- 8.2 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.
- 8.3 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.
- 9 *The contractor shall take instructions from the Engineer-in-charge for stacking of materials. No excavated earth or building materials etc. shall be stacked/collected in areas where other buildings, roads, services, compound walls etc. are to be constructed.*
- 10 *Any trenching and digging for laying sewer lines/water lines/cables etc. shall be commenced by the contractor only when all men, machinery's and materials have been arranged and closing of the trench(s) thereafter shall be ensured within the least possible time.*

- 11 *It shall be ensured by the contractor that no electric live wire is left exposed or unattended to avoid any accidents in this regard.*
- 12 *In case the supply of timber/steel frames/shutters for doors, windows etc. is made by some other agency, the contractor shall make necessary arrangements for their safe custody on the direction of the Engineer-in-charge till the same are fixed in position by him & nothing extra shall be paid on this account.*
- 13 *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.*
- 14 *The entire royalty at the prevalent rates shall have to be paid by the contractor on all the boulders, metals, shingle sand 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.*
- 15.1 *The contractor shall bear all incidental charges for cartage, storage and safe custody of materials issued by the departments and shall construct suitable godowns, yards at the site of work for storing all materials as to be safe against damage by sun, rain, dampness, fire, theft etc. at his own cost and also employ necessary watch and ward establishment for the purpose, at his own cost. Materials to be charged directly to work and stipulated for issue free of cost shall also be issued to the contractor as soon as those are received at site or at the stipulated place of issue. The provision of this para shall apply equally and fully to those as well.*
- 15.2 *All materials obtained from the Institute Works Department store or otherwise on receipt shall be got checked by the Engineer-in-charge of the work or his representations before use.*
- 15.3 *Registers for the materials to be issued by the department shall be maintained as required by the Engineer-in-charge and these shall be signed by the contractor or his authorized agent and representative of Engineer-in-charge on each day of transactions.*

## SPECIAL TERMS & CONDITIONS

1. *In the Contract (as hereinafter defined) the following definitions words and expressions shall have the meaning hereby assigned to them except where the context otherwise required.*

- i) Institute shall mean the Indian Institute of Technology (IIT), Kanpur
- ii) The President shall mean the Board of Governor, IIT Kanpur.
- iii) The Engineers In-charge, who shall administer the work, shall mean the Executive Engineer (Electrical& AC) for electrical and Air-conditioning works.
- iv) Government or Govt. of India shall mean the Indian Institute of Technology represented by its Director.
- v) The term Director General of Works shall mean the Chairman, Building & Works Committee of the Institute.
- vi) Accepting authority shall mean the Director, IIT Kanpur or his authorized representative.
- vii) Superintending Engineer shall mean the Superintending Engineer of the Institute, who as overall In-charge and head of the Institute Works Department shall direct the contract.
- viii) Site Engineers shall mean the Assistant Engineer & Jr. Engineer (AC/Electrical) for Electrical & Air-conditioning works, appointed by the Institute Works Department.

### 2. **Duties & Powers :**

i) Site Engineers:

The duties of the Site Engineer(s) are to watch and supervise the works and the workmanship employed in connection with the works, and to test and examine any materials to be used. He shall have no authority to relieve the contractor of any of his duties or obligations under the contract nor, except as expressly provided here under, to order any work involving delay or any extra payment by the Institute, nor to make any variation in the works.

The Engineer-in-charge, from time to time in writing, delegate to the Site Engineer (s) any of the powers and authorities vested in them. Any written instruction or written approval given by the Site Engineer (s) to the contractor within the terms of such delegation (but not otherwise) shall bind the contractor and the Institute as though it had been given by the Engineer-in-charge / Architect provided always as follows :

- a) Failure of the Site Engineer (s) to disapprove any work or materials shall not prejudice the power of the Engineer In-charge / Architect to subsequently disapprove such work or materials and to order the pulling down, removal or breaking up thereof.

- b) If the contractor is dissatisfied by reason of any decision of the Site Engineer (s), he shall be entitled to refer the matter to the Engineer-in-charge / Architect, who shall thereupon confirm reverse or vary such decision.
3. The scope of contract comprises the construction, completion and maintenance of the works for (12) months after the completion and the provision of all labour, materials, construction of plant equipment and transpiration, temporary works and everything, whether of temporary or permanent nature required in and for such construction, completion and maintenance so far as the necessity for providing the same is specified in or reasonably be inferred from the contract. The contractors shall make his own arrangements for the store storage of materials, accommodation for his staff etc. and no claim for the temporary accommodation from the contractor shall be entertained.

The contractor shall carry out and complete the said work in every respect in accordance with this contract and as per the directions and to the satisfaction of the Engineer-in-charge/Architect. Issue of further drawings and /or written instructions, detailed directions and explanations which are hereinafter collectively referred to as instructions of the engineer-in-charge/ Architect's in regards to:-

- a. The variation or modification of the design, quality, or quantity of works or the addition or omission or substitution of any work.
- b. Any discrepancy in the drawings or between the schedule of quantities and /or drawings and/or specifications.
- c. The removal from the site of any materials brought thereon by the contractor and the substitution of any other material thereof.
- d. The dismissal from the works of any persons employed thereupon.
- e. The opening up for inspection of any work covered up.
- f. The amending /making good of any defects.

The contractor shall forthwith comply with and duly execute any instructions of work comprised in such engineers-in-charge instructions, provided always that the verbal instructions and explanations given to the contractor or his representative upon the works shall, if involving a variation , be confirmed in writing by the contractor within seven days and is not dissented in writing within a further seven days by the Engineer-In-Charge/Architect, such shall be deemed to be instructions of the Engineer-In-charge/Architect within the scope of the contract.

#### 4. **Contract Document:**

- 4.1 The several documents, forming the contract, are to be taken as mutually explanatory of one another and in case of ambiguities or discrepancies the same shall be explained and adjusted by the Engineer-In-Charge who shall thereupon issue to the contractor its interpretation directing in what manner the work is to be carried out. In case the contractor feels aggrieved by the interpretation of the Institute then the matter shall be referred to the Superintending Engineer and his decision shall be final, conclusive and bind on both parties.
- 4.2 The drawings etc. shall remain in the custody of the Institute. Two complete sets of drawings, specification and bill of quantities shall be furnished by the Engineer-In-Charge to the contractor in such time which must not delay the progress of the construction and the Institute shall furnish copies of any additional drawings, which in their opinion may be necessary for the execution of any part of the work. One complete set shall be kept on the work site and the Engineer-In-Charge and his representatives shall be, at all reasonable

times, have access to the same. The contractor shall study the drawings thoroughly before the commencement of work. In case of any discrepancy, the contractor shall seek clarification before proceeding with the works. Figured dimensions are in all case to be accepted in preference to the scaled sizes. Large scale details shall take preference over small scale one.

The contractor shall give adequate notice in writing to the Engineer-in-charge of any further drawings or specification that may be required for the execution of the works or otherwise under the contract.

The Engineer-in-charge shall have full powers and authority to supply the contractor from time to time during the progress of the work such drawings and instructions as shall be necessary for proper execution and the contractor shall carry out and be bound by the same.

- 4.3 The successful tenderer shall be required to enter into an agreement with the Institute. The Bill of Quantities & rates filled by the successful tenderer in, the General Condition of the Contract for CPWD works 2014, CPWD specifications for Civil, Electrical & Air-conditioning works, the special conditions, additional specifications, negotiation letter and the award letter etc. shall form part of the agreement to be signed by the successful tenderer. The cost of stamp paper and stamp duty, required for the agreement, shall be borne by the contractor.

#### 5. **Contract Agreement:**

The contractor shall, when called upon to do so, enter into and execute a contract agreement in the form annexed as annexure 'A' with such modifications as may be necessary. The contract agreement, inclusive of its enclosures, shall remain in the custody of the Superintending Engineer, Institute Works Department, IIT Kanpur and the made available him as and when required contractor shall however be supplied, an attested copy there free of cost.

6. All tenders are required to deposit earnest money in the form of FDR/CDR in the only duly endorsed in favour of **Director, IIT Kanpur. Earnest money should be enclosed in a separate sealed envelope and tender documents should be enclosed in a another envelope superscribed "Earnest Money- Name of work "Item Rate-Tender-Name of Work"** on the top of envelope. At the time of opening of tender earnest money envelope will be opened first and in case earnest money is not found in the requisite from or amount envelope containing item rate tender of the party concerned shall be opened and will be summarily rejected and documents submitted will be confiscated by the Institute.
8. Canvassing in connection with tenders is prohibited and the tenders, submitted by the tenderers who resort to canvassing, are liable for rejection.
9. Tenderers shall have to sign the attached declaration (Appendix B) and if the declaration is not found to represent a true statement of facts the contract is liable to be cancelled, earnest money forfeited and the contractor shall have no claim on the Institute.
10. Tenderes are not allow to make additions and alterations in the tender document. Any additions and alternations, if incorporated in the tender, shall be at the tender's risk since the modified tender is liable for rejection.

Conditional tenders violative of the sprit and the scope or the terms & conditions of the tender, are liable to be rejected without assigning any reasons. Tenders with any form of rebate shall be rejected summarily.

11. Water and electricity required for electrical & air-conditioning works shall be supplied free of charge.
12. Stamps duty on the security money shall also be the born by contractor as per prevailing notification of U.P Govt.
13. Income tax shall be deducted as per prevalent law.
14. Conditions for Electrical and Air-conditioning Works:-
  - 14.1 All chase cuttings in the wall, for recessed conduits & boxes and drilling the holes shall be done with power operated machines only. No chase shall be allowed to be cut manually with the use of hammer & chisel.
  - 14.2 All cuttings in cement plaster and brick shall be made good by using cement mortar 1:3 (1 part cement, 3 part coarse sand)
  - 14.3 The cut surfaces shall be repaired by an experienced mason only so as to match the repaired plaster with the original.
  - 14.4 All such repaired surfaces shall be cured for 3 to 4 days to keep the surfaces wet, using water spray machine (hand/motor operated) and avoid unnecessary flooding of the area.
15. Payment shall be regulated as under
  - a.) 75% of the tendered rate on receipt of materials at site.
  - b.) 15% of the tendered rate on installation and connection.
  - c.) 10% of the tendered rate on testing and commissioning.
  - d.) During comprehensive annual maintenance contract period of the installed VRF AC system for 5 years after DLP, 50% of the deducted security deposit (i.e. 2.5% of the total project cost) shall be retained as Security Deposit. The same shall be returned year wise proportionately. This security deposit may be released against the bank guarantee of the same amount.
16. Drawings/Data required prior to commencement of electrical/air-conditioning works:-
  - a) Shop floor drawings of refrigerant piping and equipments.
- 17.1 The following drawings shall be provided by the Engineer-In-Charge of the work:-
  1. Outdoor Units & indoor units layout drawing..
  2. Cable routing drawings showing details of size, type and no. of cables and mode of installation.
  3. Ducting /refrigerant pipe/drain pipe/unit positioning etc., drawing showing details of size, type, and mode of installation of indoor and outdoor equipments.
- 17.2 Following drawings shall be furnished by the contractor for the approval of the Engineer-In-charge.
  - a. G.A and schematic drawings of Outdoor/Indoor unit,refrigerant piping layout.
  - b. Ducting /refrigerant pipe /drain pipe etc., drawing showing details of size, type, and mode of installation.
18. Completion drawings:

On completion of works and before issuance of completion certificate, the contractor submit completion drawings in the form of four complete set of originals (reproducible)



- i) As built GA and schematic drawings of Indoor & outdoor ac units installations.
  - ii) Technical literature, test certificates, and operation and maintenance manuals for indoor/outdoor VRF ac units, compressors,& controllers required.
19. Works Inspection and Testing of Equipment:
- a.) Prior to dispatch of equipment the Institute reserves the right to inspect the same at the manufacturer's works and the contractor shall provide and secure every reasonable access and facility at the manufacturers works for inspection, for witness of all acceptance and routine tests as per relevant Indian Standards. Contractor shall give a reasonable notice of about 15 days for the purpose of test, and witness of all major equipments.
  - b.) Pre-commissioning test: All routine tests shall be carried out on the electrical & air-conditioning equipment. Protective & measuring devices should be checked for calibration of window/split/tower ac units should be checked for air quantities and temperature. All grills/diffusers should be checked for balanced air quantities.
20. **Rates:** The work shall be treated as on works contract basis and the rates tendered shall be for complete item of work and all charges for items contingent to the work, such as packing, forwarding, insurance, freight and delivery at site for the materials to be supplied by the contractor, watch and ward of all materials at the site, labour related expenses as per relevant labour laws, testing of materials/ samples etc. excluding Goods & Service tax (GST). **The rate shall be inclusive of the testing charges of COP confirmation of a sample machine in factory.**
21. **Taxes & Duties:**
- 21.1 Being an indivisible works contract, no other tax is payable other than GST. The GST shall be as applicable to IIT Kanpur as per Government rules.
22. The earnest money of the unsuccessful tenderers shall be refunded on written request, within 1(one) month of the award of work. The earnest money of the successful tenderer shall however be adjusted towards the security deposit.
23. The tender document & drawings in respect of the work can be seen in the o/o Executive Engineer
24. The tender document contains 166 pages. No page of the tender document shall be removed, mutilated, detached, or cancelled.
25. Rates for finished works shall be given for each items separately, both in words & figures. In the event of non compliance the tender shall be deemed incomplete and liable for rejection.
26. All entries by the tenderer should be made in one ink and one hand writing only. Tenders should be filled in legible hand writing and should not contain erasures, corrections and overwriting as far as possible. However if it becomes necessary, each correction etc. should be properly attested under dated signature.
27. The work shall be executed on the basis of the following CPWD specifications:
- i) Electrical & HVAC Works :
    - General specifications for Electrical Works Part-1 (Internal) 2013 with up to date corrections.

- General specifications for electrical works (external) 2013 with upto date corrections.
  - General specifications for electrical works Part-VII (DG set) 2013 with upto date corrections.
  - General specifications for electrical works Part-IV Sub-station- 2013 with upto date corrections.
  - General specifications of HVAC works 2017 with upto date corrections.
28. For the purpose of clause 12 of the General conditions of contract the following schedule of rates shall be applicable.
- i) Electrical Works: Electrical Works , air-conditioning & refrigeration works  
:Based upon prevailing market rates
29. The special conditions listed above shall take precedence over all above provisions of the contract. The General Condition of contract for CPWD works shall be generally followed including the clause 21 i.e. work shall not be sublet.
30. The contractor shall have to execute the work in such place and condition where other agencies will also be engaged for other works such as site grading, filling and leveling, interiors, landscape, and electrical and mechanical engineering works, etc. No claim shall be entertained due to work being executed in the above circumstances.
31. No contractor, to whom the provisions of the BOCW Act apply, shall be allowed to commence work on the campus unless he has produced the 'Registration Certificate' issued by the office of Dy. CLC (Central)
32. The contractor shall engage only such workers who are registered as beneficiaries with U.P. BOCW Welfare Board and in case of engagement of new workers; he shall ensure the submission of applications for registration of such workmen within appropriate time.
33. A certificate for administrative convenience shall be obtained from the contractor covered under BOCW Act whether he has engaged 10 or more workmen while working in the Institute and only thereafter, Cess @1% from the bills raised by him shall be deducted at source for all running works. Cess, so deducted shall be deposited with the BOCW Welfare Board.
34. As per clause 36 (I) of GCC : It should be noted that license wire man shall only be allowed for the wiring work.

## SPECIAL CONDITIONS OF CONTRACT

1.0 The specifications given hereunder relate to the HVAC System and shall be read in conjunction with the appropriate Indian and International Standard Specifications.

2.0 **Site**

*The air-conditioning system using Variable Refrigerant Flow System is being considered for IIT KANPUR to provide summer & monsoon cooling and winter heating.*

3.0 **Scope of Work**

*The general character and the scope of work to be carried out under this contract are illustrated in Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete 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 Architects/ Consulting Engineers and Owners. The Contractor shall furnish all labor, materials and equipment (except those to be supplied by the Owners, if any) as listed under Schedule of Quantities & specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of complete HVAC system as described in the specifications and as shown on the drawings. This also includes all materials, equipment, appliances and incidental work not specifically mentioned herein or noted on the drawings or documents as being furnished or installed, but which are necessary and customary to make a complete installation. Following shall be the scope of work in brief to be carried out under this Contract:*

- a. Supply, Installation, Testing & Commissioning of VRF systems.
- b. Supply, Installation, Testing & Commissioning of Ductable/cassette type indoor units.
- c. Supply, Installation and Testing of copper refrigerant piping sandwiched between slotted angle cable trays complete with fittings and insulation.
- d. Supply & Installation of condensate drain piping complete with insulation.
- e. Supply & Installation of electrical work associated with HVAC system comprising of panels complete with cabling, wiring & earthing.

- f. Supply & Installation of vibration isolators for HVAC equipment.
- g. Balancing, Testing and commissioning of the entire installation under scope.
- h. Supply and installation of false ceiling as per specification.
- i. Supply & installation of underdeck insulation.
- j. Foundations for various equipment including VRF Outdoor Unit, etc. being installed on Terrace.
- k. Providing PCC/RCC Blocks as foundations for air conditioning equipment including AHUs, etc. as required
- l. Providing cutouts in slabs/walls for passage of ducts, refrigerant pipes.
- m. Finishing & making good of the above openings/cutouts. Openings provided in slab on terrace to be provided with rainwater protection arrangement.

#### **4.0 Exclusions:**

*The following works associated with the HVAC installation do not fall in the scope of HVAC package:*

#### **Associated Works: Electrical**

- i) 415 $\pm$  10% V, 3 Phase AC power supply along with earthing to be terminated at the following locations :
  - a) In VRF outdoor unit located on terrace.
  - b) In AHU panel as shown in drawings.
- ii. 220  $\pm$  10% Volts, Single Phase power point to be provided near each cassette unit as shown in drawings.
- iii. 220  $\pm$  10% Volts, Single Phase power point to be provided near each inline fan for exhausts shown in drawings.

#### **Associated Works: Plumbing**

- i) Providing drainage facility near Air Handling Units.
- ii) Providing drain point in each AHU room.

#### **5.0 Equipment**

*Testing and Commissioning shall include furnishing all labour, materials, instruments etc. and incidentals necessary for complete testing of each component as per the specifications and manufacturer's recommendations.*

Maintenance services for the complete HVAC installation under scope shall be provided during the defects liability period.

## 6.0 Basis of Design

### 6.1 AIRCONDITIONING SYSTEM

The various parameters influencing the air conditioning system design have been furnished below.

#### a. Orientation

The building orientation is as envisaged in the architectural plans.

#### b. Outside design conditions

The outside design conditions for IIT Kanpur have been given here under:

Seasons	Dry Bulb Temperature	Wet Bulb Temperature
Summer	110 F (43.3 C) DB	75 F (23.9 C) WB
Monsoon	95 F (35 C) DB	83 F (28.3 C) WB
Winter	45 F ( 7.2 C) DB	41 F ( 5 C) WB

#### c. Inside design conditions

##### Summer & Monsoon :

Temperature :  $73 \pm 2F (22.7 \pm 1 C) db$   
Relative Humidity : Not to exceed 65% during monsoon

##### Lobbies & Corridors:

Temperature :  $76 \pm 2F (24.4 \pm 1 C) db$   
Relative Humidity : Not to exceed 65% during monsoon

##### Winter

Temperature :  $68 \pm 2F (20 \pm 1 C) db$   
Relative Humidity : Not to fall below 30%

#### d. Fresh air requirement: Generally in line with ASHRAE 62.1-2010 recommendations.

**Assumptions :**

*The heat loads mentioned above have been worked out based on the following assumptions:*

- a. Double glazing have been considered having U Value = 0.56 BTUs/hr/Sft. Deg F & Solar Heat Gain Coefficient =0.56.
- b. External Wall has been considered with U value= 0.32 BTUs/ hr/Sft. Deg F.
- c. Over deck thermal insulation shall be provided for exposed roof using at least 40mm thick extruded polystyrene insulation material (by other agencies).
- d. Internal venetian blinds/sun films to be provided on the glazing as required.

## 10.0 **System Design**

*In a such application the load and usage pattern fluctuates considerably between day and night, different seasons etc. The spaces to be air-conditioned take into account mostly sensible and some latent heat load.*

*The various systems of heating & air-conditioning being considered are described here under:*

### **Summer Air-conditioning & Winter Heating:**

*The proposed VRF system shall serve dual purpose of heating and cooling both. During winter, the VRF system shall provide heating by default.*

*The constant speed/ inverter compressor/s and the condenser shall be part of the outdoor unit/s (ODU). The electronic expansion valve and the evaporator would be part of the indoor units (IDU). Liquid refrigerant from ODU to IDU, and gas from IDU to ODU shall travel through insulated copper refrigerant pipes, thereby completing the Reverse Carnot Cycle.*

*Anti-corrosion treatment shall be carried out for all ODUs, preferably from factory. All refrigerant piping shall be insulated, and then wrapped in glass cloth, followed by application of specific chemicals towards UV protection, mechanical strengthening, and anti-corrosion. Refrigerant pipes shall run in shafts/ cutouts and above false ceiling spaces.*

*The IDUs have been selected for specific zones as elaborated above. Centralized Treated fresh air unit & associated Outdoor unit shall be placed on terrace.*

*Condensate drain piping associated with IDUs/TFAs shall be carefully carried out to ensure leak proof disposal of condensate water.*

## 11.0 **Noise Level**

*Noise level in conditioned spaces due to all refrigeration and air conditioning equipment shall not exceed 42 dB at 125 Hz (without operation of any other equipment) when measured at any point in occupied spaces less than 150 cm above floor level and not closer than 150 cm from any supply air register or 60 cm from any return air register.*

## 12.0 **Design Parameters**

*Performance rating of various equipment shall be based on the following design parameters :*

**12.1 Design Parameters for selection of air handling units and its components :**

Maximum face velocity across filters	500 FPM (152 MPM)
Maximum face velocity across coils	500 FPM (152 MPM)
Maximum fan outlet velocity	2000 FPM ( 610 MPM)
Maximum fan motor speed	1440 RPM

**12.3 Design parameters for duct designing shall be :**

Maximum flow velocity	1500 ( 457 MPM)
Maximum friction	0.09inch WG per100ft.run (7.5mm WG per100 M run.)
Maximum velocity at supply air outlet	500 FPM (152 MPM)
Maximum flow velocity in exhaust air duct.	1800 FPM (550 MPM)

**13.0 Technical Submittals**

*The successful tenderer after award of work shall furnish technical submittals for various items incorporating complete technical details prior to procurement of equipment/materials, for the approval of the Engineer-in-charge . The submittals for items mentioned in the tender document but not restricted to the following :*

a.	Variable Refrigerant Flow System.
b.	Ductable/ Cassette type indoor units
c.	Copper Piping
d.	Treated fresh Air Unit
e.	Air Distribution System
f.	Thermal/ Acoustic/ underdeck Insulation
g.	Control Wiring
h.	Fresh Air Louver

*Test certificates for various items shall also be submitted by the contractor*

**14.0 Performance Guarantee**

*The Contractor shall guarantee uninterrupted service and stipulated quality of performance of the installed HVAC plant. The guarantee shall be furnished in the proforma indicated in the Appendix-*

l. It is to be clearly understood that the specifications indicated represent minimum performance requirements for the tenderers guidance.



## **15.0 Taxes & Duties:**

- i. The work shall be treated as on works contract basis and the rates tendered shall be for complete item of work and all charges for items contingent to the work, such as packing, forwarding, insurance, freight and delivery at site for the materials to be supplied by the contractor, watch and ward of all materials at the site, labour related expenses as per relevant labour laws, testing of materials/ samples etc. excluding Goods & Service tax (GST)
- ii. Being an indivisible works contract, no other tax is payable other than GST. The GST shall be as applicable to IIT Kanpur as per Government rules.
- iii. Transit insurance shall be borne by the Contractor.
- iv. All the price indicated shall be F O R destination.

## **16.0 Fees and Permits**

*The Contractor shall obtain all permits /licenses and pay for any and all fees required for the installation, inspection and commissioning of the work.*

## **17.0 Liability to Govt. Regulations :**

- a. The Contractor shall be responsible and shall abide by all the Government rules and regulations pertaining to erection, testing and commissioning of complete HVAC system at site.
- b. Any compensation towards damage/loss of property/material/ equipment or to any person working at site shall be borne by the Contractor as per standard terms of Contract.
- c. No escalation/ change of prices would be admissible under any circumstances.

## **18.0 Insurance**

### **18.1 Insurance Policies:**

*Before commencing the execution of works, the Contractor, without limiting his obligations and responsibilities under this contract, shall insure against his liability for any material or physical damage, loss or injury which may occur to any property, including that of the Engineer-in-charge or a member of the general public, by or arising out of the execution of the works or in carrying out of the contract. Unless otherwise stipulated elsewhere in this contract, it shall be obligatory for the Contractor to obtain the insurance cover under the following policies :*

- a) Contractor's All Risk Insurance Policy to cover the following :
  - i. Entire contract value including cost of materials supplied by the Engineer-in-charge, if any for the period of completion including defects liability period.

- ii. Third party insurance to cover for any damages to third party. This shall be upto the period of completion of work only.
  - iii. Policy should cover Civil commotion, riots and other similar disturbances.
- b) Policy to cover Contractor's liability under workmen's Compensation Act, 1923, Minimum Wages Act 1948, Contract Labour (Regulation and Abolition) Act 1970 and other relevant Acts listed elsewhere. This shall be for the period of completion of work.
  - c) Insurance cover against damage, theft or any other loss of all materials and equipment brought to site for which advance payment is claimed -limit of liability not less than the value of such materials at any stage of the contract.

*The Contractor shall insure against all such liabilities and shall continue such insurance during the whole of the time when any persons employed by him are on the works.*

*The Contractor shall produce certificates of Insurance to the Architect. These certificates shall be fully executed and shall state that the policies can not be cancelled until ten (10) days after written notice of such cancellation has been given to the Engineer-in-charge.*

*The Contractor shall obtain written certificates of similar certificates from all sub- contractors and thereby assume responsibility for any claims or losses to the Engineer-in- charge resulting from failure of any of the sub-contractors to obtain adequate insurance protection in connection with their work.*

#### 18.2 Failure to Insure:

*If the Contractor fails to comply with the terms of this condition, the Engineer-in-charge may effect the Insurance and deduct the expenses from any moneys that may be or become payable to the Contractor or may, at his option, refuse payment of any certificate to the Contractor until the Contractor complies with this condition.*

#### 18.3 No Limit to Liability:

*In addition to the liability imposed by law upon the Contractor for injury (including death) to persons or damage to property by reason of the negligence of the Contractor or his agents, which liability is not impaired or otherwise affected hereby, the Contractor hereby assumes liability for and agrees to save the Engineer-in-charge harmless and indemnifies him from every expense, liability or payment by reason of any injury (including death) to persons or damage, to property suffered through any act of omission of the Contractor, or any of his sub-Contractors, or any person directly or indirectly employed by any of them or from the conditions of the premises or any part of the premises which is in the control of the Contractor or any of his sub-contractors, or*

*any one directly or indirectly employed by either of them, or arising in any way from the work called for by this contract.*

**19.0 Partial Ordering:**

*Engineer-in-charge reserve the right to order equipment & material from any and all the alternates and/or to order high side and/ low side equipment and materials or parts thereof from one or more tenderers.*

**20.0 Engineering Responsibility of the system**

- a. The responsibility of system design, manufacturing, erection, working and safety will solely be responsibility of the Contractor for the parameters as mentioned in the tender documents prepared by the Engineer-in-charge.
- b. The system after commissioning shall be handed over to the Engineer-in-charges and thereafter they will monitor the performance for standard designed (without operation of any other equipment) parameters for 30 days continuously. In case during this period the performance is not found satisfactory and rectification/ replacement, design improvement or any other change as felt necessary, will be made by the Contractor at no extra cost. Though these improvements can only be done after getting the approval from the Engineer-in-charges.

**21.0 Schedule and Manner of Operations**

*Time being the essence of this Contract, the Contractor will be expected to furnish all labour and materials in sufficient quantities and at appropriate times, expedite and schedule the work as required and so manage the operation that the work will be completed within the time stated in the Contract. In addition to providing a detailed time and progress schedule, the Contractor shall submit an outlined and graphic schedule of proposed procedures to the Engineer-in-charge within two days of issue of work order.*

## 22.0 Bye Laws & Regulations

*The installation shall be in conformity with the bye-laws, regulations and standards of the concerned local authorities so far as these become applicable to the installation. However, if these specifications call for a higher standard of materials and /or workmanship than those required by the regulations and standards then these specifications shall take precedence over the said regulations and standards then these specifications shall take precedence over the said regulations and standards. If the specifications call for requirements which violate the bye-laws and regulations, the bye-laws and regulations shall govern the requirements of this installations.*

## 23.0 Erection and Supervision :

- a. The Contractor shall depute engineers from time to time of commencement of assembly and installation work to inspect all relevant civil construction/ fabrication and other necessary facilities to make improved action if felt necessary. **However, a site engineer preferably a graduate in mechanical or electrical discipline** shall be deputed at site permanently till completion of the work and shall be identified to the Client at the time of appointment at site.
- b. All the ducting installation work shall be carried out in conformity with approved reflected ceiling plans well in advance to ensure uninterrupted working of other agencies.

## 24.0 Power for Construction

*The Engineer-in-charge has made arrangements to provide single/ three phase power connection for construction purposes as per site conditions. The Contractor shall make his own arrangements to take metered connection from the above point. He shall at his own cost provide and install the meter and all temporary service lines as required for his use on the work and remove the same on the completion of the work.*

## 25.0 Electrical Power and Soft Water Requirement

*The tenderer shall submit with their quotation the break up of electrical power requirement for all the HVAC equipment & soft water requirement.*

## 26.0 Sub-Contractors

*As soon as practicable and before awarding any sub-contract the Contractor shall notify in writing the names of the Sub-Contractor to the Engineer-in-charge proposed for the principle parts of the work. The Contractor shall not employ any Sub-Contractor whom the Engineer In Charge finds incompetent.*

## 27.0 Design Drawings

*The drawings prepared by the Engineer-in-charge as listed under Appendix-II are indicative only of the general arrangement of the entire installation. The Contractor shall follow these drawings*

*and specifications in preparation of his shop drawings and subsequent installation. He shall check the drawings of other trades to verify space for his installation. The Contractor shall thoroughly examine all relevant architectural, structural, plumbing, electrical and other services layout drawings before preparing the shop drawings for this installation and report to the Engineer-in-charge any discrepancy and obtain clarifications. Any changes found necessary for coordination and installation of this work with other services and trades shall be made with prior approval of the Engineer In Charge/Architect and Engineer-in-charge without any additional cost to the Engineer-in-charge.*

## **28.0 Technical Data**

*The tenderer shall submit a comprehensive schedule of technical data and complete manufacturer's specifications for all items of equipment and material including the manufacturer's name. The technical data shall be furnished in the proforma indicated in Appendix V.*

## **29.0 Shop Drawings**

- a. Within three days after the award of the Contract, the contractor shall furnish for the approval of the Architect/Engineer In Charge, three sets of detailed shop drawings of all equipment and materials including plant room, ducting, piping, ventilation system electrical work associated with the HVAC system required to complete the project as per Specifications and as required by the Architect/Engineer In Charge. These drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, as also the details of all related items of work by other Contractors. Each item of equipment proposed shall be a standard catalogue product of an established manufacturer as per specifications.

*If the Engineer-in-charge makes any amendments in the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated, along with the drawings on which corrections were made. After final approval has been obtained from the Engineer In Charge, the Contractor shall submit a further six sets of shop drawings for the exclusive use of and retention by the Engineer-in-charge. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawings for the particular material or equipment.*

- b. The shop drawings shall be submitted for approval sufficiently in advance of planned delivery and installation of any material to allow Engineer-in-charge ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved CPM charts.
- c. Samples, drawings, specifications, catalogues, pamphlets and other documents submitted for approval shall be in quadruplicate, each item in each set shall be properly labeled, indicating the specific service for which material or equipment is to be used, giving reference to the governing section and clause number of Specifications clearly identifying in ink the items and the operating characteristics data of a general nature shall not be accepted.

- d. Approval rendered on shop drawings shall not be considered as a guarantee of measurements of building conditions. Where drawings are approved said approval does not mean that drawings have been checked in detail nor does it way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the contract.
- e. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required thereof, shall be prepared by the Contractor at his own cost and approved by the Architect/Engineer In Charge.
- f. Where the work of the Contractor has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make satisfactory adjustments. If so directed by the Architect/ Engineer In Charge, the Contractor shall prepare composite working drawings and sections at a suitable scale not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the Engineer-in-charge.

### 30.0 Co-operation /Co-ordination with other agencies

*During the currency of the Contract, a number of Contractors will be at site to execute works under their respective contracts viz. structure, finishing works, electrical, lifts and other services. All these agencies will be at site at the same time. The Contractor shall offer full co-operation to, all these agencies with regard to use of materials etc. and co-ordinate the work in such a manner that the time schedules of all agencies are not adversely affected. The work shall be executed as per program approved by the Architect/Engineer In Charge. If part of site is not available, for any reason, or if there is some unavoidable delay in supply of materials stipulated by the Engineer-in-charge, the program of construction shall be modified accordingly and the Contractor shall have no claim for any extras or compensation on this account.*

*No claim shall be entertained from the Contractor on the plea that the work has been executed in the above circumstances or under difficult conditions. It shall be the responsibility of the Contractor to enforce necessary discipline among his workers and staff to ensure smooth working at the site in spirit of co-operation and amity with all other agencies.*

### 31.0 Construction Program & Schedule Of Operations :

*A tentative construction program indicating the scheduling of various activities forms an annexure to this document. The Contractor should examine this program with respect to construction logic, scheduling and duration of various activities etc. in relation to the resources available at his disposal, and suitably modify the program without extending the total duration of the job as also the completion targets for major milestones of the job and submit a modified construction program along with a firm commitment to adhere to the dates of completion of various activities. This construction program shall after scrutiny and approval of the Architect/*

*Engineer In Charge form part of the agreement and shall be treated as a baseline schedule to monitor, determine delays in individual activities, work milestones or the overall duration of the work.*

*In the event of the Contractor, not submitting any modified construction program, the tentative construction program shall remain binding on the Contractor.*

*The Contractor shall mobilize equipment, tools, plant, scaffolding, shuttering, material, labour etc. in sufficient quantities so as to complete the work to meet the above agreed construction program. In the event of delays in the construction activities, the Contractor shall mobilize additional resources to complete the job in the specified time period and at no extra cost to the Engineer-in-charge.*

*The Architect/Engineer-in-charge may suggest an alternative scheduling of operations, should they find it necessary to accomplish the targets and the Contractor shall accordingly mobilize additional resources at no extra cost to the Engineer-in-charge.*

### **32.0 Electrical Installation and Cabling**

*The electrical works related to the HVAC system shall be carried out in full knowledge and with complete co-ordination of the Contractor. It is to be clearly understood that the final responsibility for sufficiency, adequacy, and conformity to the performance of the HVAC system shall be with the Contractor.*

### **33.0 Testing and Commissioning**

*On completion, the installation shall be tested for conformity with the stipulated performance specifications. Any defect, shortcoming detected in the system/material/workmanship shall be rectified by the Contractor to the entire satisfaction of the Engineer In Charges without any extra cost to the Engineer-in-charge. The installation shall be tested again after the removal of the defects and shall be commissioned only after approval by competent inspecting authority or the Engineer In Charges and the Engineer-in-charge. All tests shall be carried out in the presence of the Engineer In Charges and Engineer-in-charge's representative.*

### **34.0 Completion Certificate**

*On successful completion of the installation, a certificate in the approved format shall be furnished by the Contractor. The Contractor shall be responsible for getting the entire installation duly approved by the Electrical Inspector or concerned authority, if any, and shall bear the all expenses in connection with the same.*

### **35.0 Completion Documents**

- a. 5 copies of operation manuals/catalogues of all standard equipment to be furnished by the contractor immediately after commissioning of plant.
- b. 5 copies of write up on preventive maintenance, trouble shooting and operating instructions of the system alongwith as-built drawings to be supplied by the Contractor at time of commissioning.
- c. 5 sets of catalogues of all accessories such as dampers, valves, strainers, gauges, electrical components etc.

#### 36.0 **Completion Drawings**

*On completion of the work in all respects, the Contractor shall supply five port folios (300 x 450mm) each containing a complete set of drawings at approved scale clearly indicating complete plant room layouts, ducting and piping layouts, location wiring and sequencing of automatic controls, location of all concealed piping, valves, controls, dampers, wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The Contractor shall frame under glass, in the air conditioning plant room, one set of these consolidated control diagrams.*

#### 37.0 **Training of Engineer-in-charge's representative**

*Upon completion of work and conclusion of all tests, the Contractor shall furnish necessary skilled labour and helpers for operating the entire installation for a period of thirty working days of eight hours each, to enable the Engineer-in-charge's representative to get acquainted with the operation of the system. During this period, the Contractor shall train the Engineer-in-charge's representatives in the operation, adjustments and maintenance of all equipment installed.*

#### 38.0 **Correction of Work before Final Payment**

*The Engineer-in-charge shall conduct a final inspection just before the virtual completion of the work and prepare a final list of materials, equipment and item of work which fail to conform to the contract specifications. The Contractor shall promptly replace or re-execute such items in accordance with the contract and shall bear all expenses of making good all work and the cost of all work of the other Contractor, destroyed or damaged by such replacement or removal.*

*If the Contractor fails to remove and replace above rejected materials, equipment/ or workmanship within a reasonable time, fixed by written notice, the Engineer-in-charge may employ and pay other persons to amend and make good such defects at the expense of the Contractor. All expenses incurred by the Engineer-in-charge in rectifying the defects including all damages, loss and expense consequent on the defects shall be recoverable from any amount due or which may become due to the Contractor.*

#### 39.0 **Virtual Completion**



*The work shall be considered virtually complete only upon fulfillment of the procedure laid down in the preceding clause and when the Engineer In Charges and the Engineer-in-charge has certified in writing that the work has been virtually completed. The defect liability period shall commence from the date of such certificate.*

#### **40.0 Maintenance of Liability Period**

*Defects liability period shall commence from the date of virtual completion upon fulfillment of the procedure laid down in clause No.38. Contractor shall include incidental expenses towards necessary maintenance during defects liability period by deputing a skilled technician once in every week. The scope of such maintenance shall be for complete HVAC system but not restricted to the following:*

- a. Wet Cleaning of unit filters and fresh air intake filters.
- b. Wet Cleaning of Paper fills and filters of Air washer.
- c. Total water in the airwasher sump to be drained, dried and filtered with fresh water.
- d. Degreasing of kitchen exhaust duct including extract fan section by using appropriate method (once in every six months).
- e. Checking of fan belts, pulleys etc.
- f. Dry Cleaning of electrical components using air blower.

#### **41.0 Force majeure**

*The right of the contractor to proceed with the work shall not be terminated because of any delay in the completion of the work due to unforeseeable causes beyond the control and without the fault or negligence of the Contractor, including but not limited to acts of God, or of public enemy, restraints of a sovereign state, floods, unusually severe weather.*

#### **42.0 Termination of the Contract by the Engineer-in-charge**

*If the Contractor shall be adjudged bankrupt or if he should make a general assignment for the benefit of his creditors, or if a receiver shall be appointed on account of his insolvency, or if he should persistently or repeatedly refuse to carry on the work diligently or shall fail except in cases for which extension of time is provided, to supply enough properly skilled workmen or proper materials or equipment for the progress of the work, or if he should fail to make prompt payments to sub-contractors or for materials or equipment or labour or persistently disregard laws, ordinance, or instructions of the Architect, or otherwise be guilty of a violation of any provision of the contract, or has abandoned the contract, or has failed to commence the works, or has suspended the work, then the Engineer-in-charge upon the certificate of the Architect that sufficient cause exists to justify such action, may without prejudice to any other right or remedy and after giving the Contractor seven days notice in writing, terminate the employment of the Contractor and take possession of the premises and if all materials, equipment, tools and appliances there on and use these as Engineer-in-charges property for the completion of the work. In such case the Contractor shall not be entitled to receive any further payment until the work is finished. If the amount due to the Contractor for the work carried out*

*by him as per the Contract terms shall exceed the expenses of finishing the work including compensation for additional management and administrative services, such excess shall be paid to the Contractor. If such expense shall exceed such unpaid balance, the Contractor, shall pay the difference to the Engineer- in-charge. The expense incurred by the Engineer-in-charge and the damage incurred through the Contractor's fault, shall be certified by the Engineer-in-charge and his decision on this matter shall be final and binding on the Contractor.*

**43.0 Delay and extension of time**

*In the opinion of the Engineer-in-charge the works be delayed :*

- a. By forcemajeure.
- b. By reasons of civil commotion, or strike or lockout affecting any of the building trade.
- c. In consequence of the contractor for not having received in due time necessary instructions from the Engineer In Charge for which he shall have specifically applied in writing.
- d. By reasons of or Engineer In Charge's instructions, the Engineer-in-charge shall make a fair and reasonable extension of time for completion of the contract works.
- e. In case of such strike or lock-out, the Contractor shall as soon as possible give a written notice thereof to the Engineer In Charges, but the Contractor shall nevertheless constantly use his endeavors to prevent delay and shall do all that may reasonably be required to the satisfaction of the Engineer-in-charge to proceed with the work.

**44.0 Settlement of Disputes & Arbitration**

*All disputes and differences of any kind whatever arising out of or in connection with the contract or the carrying out of the works (whether during the progresses of the works or after their completion, and whether before or after the determination, abandonment or breach of the contract) shall be referred to and settled by the Architects after hearing the disputing parties. The Architects shall state his decisions with reasons therefore. Such decisions may be in the form of a final certificate or otherwise. The decisions of the Architects with respect to any or all of the following matters shall be final and without appeal :*

- a) The variation or modifications of the design.
- b) The quality or quantity of works or the addition or omission or substitution of any work.
- c) Any discrepancy in the drawings and/or specifications and schedule of quantities.

- d) The removal and/or re-execution of any works executed by the Contractor.
- e) The dismissal from the works of any persons re-employed thereupon.

- f) The opening up for inspection of any work covered up.
- g) The amending and making good of any defects under defects liability period.
- h) Acceptability of materials, equipment and workmanship.
- i) Materials, labour, tools, equipment and workmanship necessary for the proper execution of work.
- j) Assignment and sub-letting.
- k) Delay and extension of work.
- l) Termination of contract by the Engineer-in-charge.

*But if either the Engineer-in-charge or the Contractor be dissatisfied with the decision of the Architects on any matter, question or dispute of any kind except the matters listed, then and in any such case, either party (the Engineer-in-charge or the Contractor) may within twenty eight days after receiving notice to such decision, give a written notice to the other party through the Architects requiring that such matters which are in dispute or difference of which such written notice has been given and no other shall be and is hereby referred to the arbitration and final decision of a single Arbitrator being a fellow of the Indian Institute of Architects or Institution of Engineers (India), to be agreed upon and appointed by both the parties or in the case of disagreement as to the appointment of a single Arbitrator to the arbitration of two Architects or Institution of engineers (India), one to be appointed by each party, which Arbitrators shall before taking upon themselves the burden or reference appoint an Umpire, who must also be a fellow of one of the above referred institutions.*

*The Arbitrator, the Arbitrators or the Umpire shall have the power to open up, review and revise any certificate, opinion, decision, requisition or notice pertaining to the matters referred to them, and to determine the same by his/their award. Upon every or any such references the cost of and incidental to the reference and award respectively shall be at the discretion of the Arbitrator or Arbitrators or Umpire who may determine the amount thereof, or direct the same to be taxes as between Attorney and Client or as between party and party, and shall direct by who and to whom and in what manner the same shall be borne and paid. The award of the Arbitrator or Arbitrators or the Umpire shall be final and binding on the parties.*

#### **45.0 Use and Care of Site**

*Contractor will be permitted to use without charge, the site and the areas shown in the contracts drawing for execution of work and for related activities. The contractor shall not commence any operation on such and except with the approval of the Engineer-in-charge.*

*All rubbish shall be burnt or removed from the site as it accumulates. All surface and soil drains shall be kept in a clean sound and workman-like state. All the areas of contractor's operation shall be cleared before returning them to the Engineer-in-charge. The contractor shall make good any damages or alternations made to areas, properly or land handed over to him before these are returned.*

46.0 **Safety Provisions**

*The contractor shall take full responsibility for the adequate stability and safety of all site operations and methods of construction, subject to provisions of excepted risks and special risks.*

*The contractor shall at his own expense arrange for the safety in his operations as required. Safety provisions shall be as per the latest safety manuals published by Indian Standard Institution, Statuary Rules, Regulations and Provisions of contract conditions.*

47.0 **Clearance of Site**

*The Contractor shall have to remove all malba and other unwanted materials from site of work, before handing over HVAC installation to the Engineer-in-charge. The work shall not be treated as complete in all respects unless these requirements are fulfilled by him. In the event of the Contractor failing to do so, the Engineer-in-charge shall have the right to get the site cleared at his expenses.*

48.0 **After Sales Services :**

*The HVAC Contractor shall ensure adequate and prompt after sales service in the form of maintenance personnel and spares as and when required with a view to minimizing the breakdown period. Particular attention shall be given to ensure that all spares are easily available during the normal life of the installation.*

# TECHNICAL SPECIFICATIONS

## 1.0 EQUIPMENT

### DOUBLE SKIN AIR HANDLING UNITS (Dx TYPE COMPATIBLE WITH VRF ODUs)

#### Scope

*The scope of this section comprises of supply, erection, testing and commissioning of double skin construction air handling units, conforming to these specifications and in accordance with requirements of drawings and schedule of quantities.*

#### Type

*The air handling units shall be double skin construction, draw-thru type comprising of various sections such as filter section, coil section and fan section factory assembled as elaborated in drawings and schedule of quantities.*

#### Capacity

*The air handling capacities, maximum motor rating, and static pressure shall be as shown on drawings, appendices and schedule of quantities.*

#### Housing/Casing

*The housing/casing of the air-handling unit shall be of double skin construction. The housing shall be so constructed that it can be delivered at site in total/semi knock down conditions depending upon the location.*

*The framework shall be extruded aluminium hollow sections filled with preformed insulation section. Frames shall be assembled using mechanical joints to make a sturdy and strong framework for various sections.*

*Double skin panels (each not exceeding 750mm wide) shall be made out of 24 gauge pre painted galvanized steel sheet on outside and 24 gauge plain galvanized sheet inside with 50 mm thick injected PU foam insulation in between. These panels shall be bolted from inside on to the work frame with soft rubber gaskets in between to make the joints air tight.*

*Frame work for each section shall be provided with thermal break profiles and bolted together with soft rubber gasket in between to make the joints air tight. Suitable doors with pressure die cast aluminium hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on steel channel frame work.*

*Marine light, view window and proximity switch to be provided in the casing of each Air handling unit.*

*Drain pan shall be constructed out of 18 gauge stainless steel with necessary slope to facilitate rapid removal of condensate water. Drain pan shall be insulated with closed cell elastomeric insulation material as required. Necessary supports will be provided to slide the coil in the drain pan. Outlet shall be provided from the drain pan in a manner that access panel can be opened without disconnecting the drain pipe connection.*

### **Motor and Drive**

*Fan motors shall be **high efficiency IE-02** suitable for operation on  $415 \pm 10\%$  volts, 50 cycles, 3 phase, squirrel cage, totally enclosed fan cooled with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type. Minimum efficiency of motors shall be 85%.*

*The fan shall be **forward/backward curved DIDW** type. The wheel and housing shall be fabricated in galvanized steel construction as per manufacturer standard. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearings. The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 1800 FPM (9.2 MPS). Fan housing with motor shall be mounted on a common steel base mounted inside the air handling housing on anti-vibration spring mounts or rubber turret mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass. Fan shall be selected for high efficiency.*

### **Cooling /Heating Coils**

*Direct Expansion coils shall have appropriate tube dia. and wall thickness as specified by the VRF System OEM with aluminum fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 500 FPM. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21Kg/Sqcm air pressure under water. Tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 fins per inch (4 to 5 fins per cm). The VRF System OEM shall provide the necessary Dx Expansion Valve kits as per system design.*

### **Filters**

*Each unit shall be provided with factory assembled filter section containing pre –filters having cleanable type synthetic air filters, having anodized aluminum frame. Wherever MERV 13 filters are required to be installed, unit shall be provided with factory fabricated plenum chamber in double skin construction as described above for casing specifications. The media shall be supported with HDPE mesh on one side and aluminum mesh on other side.*

*Filter face velocity shall not exceed 500 FPM (2.54 MPS). Filters shall fit so as to prevent bypass. Holding frames of aluminum shall be provided for installing a number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels.*

### **Accessories**

*The following accessories may be required at air handling units, the detailed specifications are given in individual sections, and quantities separately described in the schedule of quantities.*

- a. Thermostatic expansion valves for each 3 row coil set.
- b. Cooling/heating thermostats as per section "Automatic Controls and Instruments" shall be located in return air stream.
- c. Condensate drain piping up to sump or floor drain in air handling unit rooms as described in section "Piping".
- d. Vibration isolation pads for mounting of Air Handling Units on PCC blocks (225 x 225 x 225 PCC blocks shall be provided by other agencies)

### **Performance Data**

*Air handling units shall be selected for the lowest operating noise level. Technical submittal of air handling units shall be prepared for Engineer In Charge's approval prior to procurement as mentioned under relevant clause of Special Conditions. Fan performance rating and power consumption characteristics shall be submitted and verified at the time of testing and commissioning of the entire installation.*

### **Testing**

*Cooling/heating capacity of various air handling unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Air flow measurements shall be carried out by an anemometer and temperature measurements by accurately calibrated thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.*

## **1.2 Dx-SPLIT TYPE AIRCOOLED VARIABLE REFRIGERANT FLOW PACKAGES**

### **1.2.1 Scope**

*The scope of this section comprises of supply, installation, testing and commissioning of self contained air cooled split type variable refrigerant flow packages each comprising of an outdoor and multiple indoor ductable/non-ductable units conforming to these specifications and in accordance with the requirement of drawings and schedule of quantities.*

The Energy Efficiency Ratio (EER) for the complete unit shall comply with **ASHRAE 90.1-2001 table 6.2.1 B** attached as under.



**ASHRAE STANDARD 90.1-2001**

**Electricity Operated Unitary and Applied Heat Pumps-Minimum Efficiency Requirements.**

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
Air Cooled (Cooling Mode)	<65,000 Btu/h <sup>c</sup>	All	Split System	10.0 SEER	ARI 210/240
			Single Package	9.7 SEER	
	≥65,000 Btu/h and ≤135,000 Btu/h)	Electric Resistance (or None)	Split System and Single Package	10.1 EER	
		All other	Split System and Single Package	9.9 EER	
	≥135,000 Btu/h and ≤240,000 Btu/h)	Electric Resistance (or None)	Split System and Single Package	9.3 EER	ARI 340/360
			All other	Split System and Single Package	
	≥240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.0 EER 9.2 IPLV	
			All other	Split System and Single Package	

- a. Section 12 contains complete specifications of the referenced test procedure, including the referenced year version of the test procedure.
- b. IPLVs are only applicable to equipment with capacity modulation.
- c. Single-phase air cooled air-conditioners <65,000 Btu/h are regulated by NAECA. SEER value is those set by NAECA.

## 1.2.2 Outdoor Unit

*Outdoor unit shall be factory assembled, good for outdoor installation, constructed out of heavy gauge MS panels with weather proof painting. The units shall be factory wired with necessary controls duly tested prior to dispatch conforming to the following specifications.*

- a. All outdoor units shall consist of minimum two scroll compressors, both with inverter drive, capable to operate even when one compressor is unserviceable.
- b. Outdoor units of 16 HP or above shall consist of minimum two separate inverter driven compressors.
- c. The units shall be provided with duty cycling arrangement for multiple inverter compressors.
- d. The outdoor unit shall be modular in design to facilitate installation one after another close to each other. Preference would be given to compact units having smaller footprint.
- e. Outdoor units should be rugged of anti-corrosion design.
- f. The outdoor unit shall comprise of sub cooling feature to effectively use the entire coil surface through proper circuit/bridge in order to prevent flushing of refrigerant owing to large length of piping.
- g. The condensing unit shall be provided with state-of-the-art microprocessor based control panel.

*The outdoor unit shall be provided with Aero spiral design fan exhibiting low noise level characteristics complete with aero fitting grille to facilitate spiral discharge of airflow to effect reduction in pressure losses. The fan should be capable to respond to external static pressure of 5 mm.*

*The condensing unit shall be designed to facilitate fail safe operation when connected to multiple indoor units.*

*Following safety devices shall be integral part of the outdoor unit:*

- High pressure switch
- Fan drive overload protection switch
- Fusible plug

*Overload relay including overload protection for inverter driven compressor.*

### 1.2.2.1 Scroll Compressor

*The scroll compressor shall be an industrial quality rugged, cast iron, direct hermetic compressor with scroll plates, suction & discharge service valves. The compressor shall be complete with straight suction tube, centrifugal oil pump, oil charging valve, oil level sight glass, crank case heater and check valve on the scroll discharge port. The compressor shall be complete with the provision of two-point lubrication for each*

*motor bearing. The compressor shall be completely enclosed in a chamber with no leakage path and providing the capability for scroll plates to separate. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM.*

*The compressor shall be capable of functioning with inverter control as well. The inverter driven compressor shall preferably be with reluctance DC inverter for higher efficiency and reliability.*

#### **1.2.2.2 Condenser**

*Condenser shall be air-cooled type, suitable for outdoor installation and shall be suitable for operating at 46 deg C db and 24 deg C wb temperatures. Condenser shall be in copper tube & aluminium fin construction. Condenser coil shall be of minimum 4 rows deep and the fin spacing shall not exceed 2mm. The maximum face velocity across the coil shall not exceed 215 MPM. The condenser frame shall be constructed from heavy duty galvanized steel.*

*The condenser fan/s shall be of propeller type with 900 RPM variable voltage electric motor complete with IP-55 protection. Motor shall be speed controlled to ensure a stable operation for varying ambient, by a factory fitted direct acting head pressure activated variable speed drive. The condenser shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessories necessary with the equipment supplied.*

#### **1.2.3 Anti Corrosion Protective Treatment associated with Condensing Units, piping, Joints and U bends & refrigerant piping between outdoor and indoor units.**

*All interconnecting piping, joints and U bends within the condensing unit shall be painted with two coats of clear transparent polymer coating for protection against corrosion from ambient air pollution.*

*Two coats of protective coating shall be applied. Each coat shall have dry film thickness of 35 micron or more. The coating shall be strong, flexible and durable. It shall have good adhesive and abrasion resistance. It shall be resistant to moisture, UV, acid, alkali and other chemicals and capable of functioning between -25<sup>0</sup> C and 150<sup>0</sup> C.*

*The polymer shall be obtained by the mixing of base / monomer with a hardener / polymerizer. It may brush applied or with the use of a suitable gun.*

#### **1.2.4 Indoor Units**

*The indoor unit shall be basically a fan coil unit suitable for wall, floor and under ceiling installation of various types conforming to the following specifications.*

*Indoor units shall be either ceiling mounted cassette type, wall mounted type, floor mounted type or ceiling mounted ductable type in conformity with the design drawings and schedule of quantities. Each unit shall be provided with electronic control valve to modulate flow of refrigerant through the cooling coil responding to the space heat load variations.*

*Each indoor unit shall consist of PID controller for maintaining design room conditions besides microprocessor based thermostat for cooling/heating. The indoor unit shall also be provided with wired LCD type remote controller which shall memorize the latest malfunction code for ease in maintenance. The controller shall incorporate self diagnostic features. Such remote controllers associated with cassette type and hi-wall type indoor units shall incorporate inbuilt feature to be able to change fan speed and angle of swing flap individually as desired by the user.*

***The ceiling mounted 2 way/ 4 way cassette type indoor units shall comprise of an attractive moulded ABS plastic exterior enclosure provided with four way supply air grilles on the periphery and square return air grill at the centre with filter behind. Each cassette type indoor unit shall consist of high efficiency paddle type condensate water pump to facilitate forced disposal of condensate water and low gas detection system.***

***The hi-wall indoor units shall be suitable for installation on the wall preferably at lintel level. The specifications shall otherwise be similar to above.***

***Ceiling mounted ductable indoor units shall comprise of high static centrifugal fan, direct driven or belt driven through TEFC squirrel cage induction motor suitable for moderate amount of ductwork.***

*The housing shall be of light weight construction fabricated out of powder coated galvanized sheet steel single skin panels, internally insulated with 9mm thick closed cell elastomeric insulation material.*

#### 1.2.4.1 Cooling coil

*Cooling coil shall be of the fin and tube type, having aluminium fins, firmly bonded to seamless copper tubes. Face and surface areas shall be such as to assure rated capacity and the air velocity across the coil shall not exceed 170 MPM. The coil shall be factory tested under water at 21 Kg/Sqcm air pressure.*

#### 1.2.4.2 Fan Section

*The fan associated with non ductable indoor units shall be dual suction, aero dynamically designed, multi blade type, statically-dynamically balanced to ensure smooth circulation of air exhibiting lower noise level. The fan shall be direct driven type mounted directly on motor shaft supported from the housing.*

*Fan associated with ductable indoor unit shall be centrifugal double inlet double width forward curved type, preferably with variable pitch pulleys. The fan housing shall be statically-dynamically balanced at works to ensure noise and vibration free operation.*

#### 1.2.4.3 Filters

*Filters shall be as per **ASHRAE standards**. The filters shall also be high efficiency long life, cleanable, synthetic fibre media of approved make. Velocity through filters shall not exceed 105 MPM.*

#### 1.2.4.4 Commissioning Filters (Only Pre-filters)

*Each indoor unit shall be provided with one set of commissioning filters. The filters shall be replaced with pre-filters after commissioning of the system.*

#### 1.2.4.5 Insulation

*All indoor unit shall be factory insulated with minimum 9 mm thick closed cell elastomeric insulation material towards thermal/acoustic treatment.*

*Drain pan shall be insulated with minimum 9mm mm thick closed cell elastomeric insulation material. Fixing of coil section and drain pan shall be done in such a way to avoid direct metal contact with any other un-insulated metal part in order to avoid condensation.*

*Condensate drain piping around the indoor unit shall also be insulated with minimum 9mm thick closed cell elastomeric insulation preferably in tubing form.*

#### 1.2.5 Refrigerant Piping

*The copper refrigerant piping shall be carried out neatly enclosed between two cable trays to connect outdoor and indoor unit and shall run along with wires/cables suitable for **R410a** refrigerant. The refrigerant piping shall be carried out using hard drawn copper pipes & readymade copper fittings for pipe diameter exceeding 19mm.*

*Piping less than 19mm shall be carried out using soft seamless copper pipes. **Joints shall be affected by soldering/brazing process using silver rods.** Suitable sleeves shall be provided at all wall crossings as required. All pipe sleeves shall be sealed with fire retardant sealant. The refrigerant circuit shall include liquid line and gas shut-off valves besides expansion valve at the end of condenser. The refrigerant piping shall be carefully sized with necessary headers and should consist of accessories including Y-joints.*

*After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 350 psig. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum equivalent to 500  $\mu$  and held for another 24 hours prior to commencement of gas charging.*

*All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building element by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.*

All joints of refrigerant pipes shall be identified & marked with paint/tape indicating joints.

The liquid and suction refrigerant lines including all fittings, valves, strainer etc. shall be insulated with 13 mm thick closed cell elastomeric insulation material preferably in tubing form as specified in Schedule of Quantities.

To protect nitrile rubber insulation associated with exposed copper piping from degrading due to ultra violet rays & atmospheric conditions, it shall be covered with polysield coating. Fiberglass tape shall be helically wrapped & applied with two coats of resin with hardener to give smooth finish.

The recommended wall thickness of copper pipes being used for VRF application using high pressure refrigerant, R 410 a, is as under:

Copper Pipe Outer dia (mm)	Copper tube wall thickness (mm)
	Minimum requirement
Dia 6.4	0.8
Dia 9.5	0.8
Dia 12.7	0.8
Dia 15.9	1
Dia 19.1	1
Dia 22.2	1
Dia 25.4	1
Dia 28.6	1
Dia 31.8	1.10
Dia 34.9	1.21
Dia 38.1	1.32
Dia 41.3	1.43

#### **1.2.6 CENTRALIZED REMOTE CONTROLLER (TOUCH SCREEN TYPE)**

A multifunctional compact centralized controller shall be provided with the system.

The Graphic Controller must act as an advanced air conditioning management system to facilitate complete control of VRF air conditioning equipment, It should be user friendly through its touch screen, icon display and color LCD display.

It shall be able to control up to several groups of indoor units with the following functions:

Starting/stopping of Airconditioners as a zone or group or individual unit. Temperature setting for each indoor unit or zone.

*Switching between temperature controls modes, switching of fan speed and direction of airflow,  
enabling/disabling of individual remote controller operation.*

*Monitoring of operation status such as operation mode & temperature setting of individual indoor unit, maintenance information and troubleshooting information.*

*Display of air conditioner operation history.*

*Daily management automation through yearly schedule function with possibility of various schedules.*

*The controller shall comprise of wide screen user friendly color LCD display and can be wired by a non-polar 2 wire transmission cable upto a distance of 1 km away from indoor unit.*

### **UNIFIED ON/OFF CONTROLLER**

*Unified ON/OFF controller shall be supplied as optional accessory.*

*The controller shall be able to control minimum 15 groups, each group containing maximum 16 indoor units or 128 indoor units with the following functions :*



*On/Off as a zone or individual unit.*

*Indication of operation condition of each group. Select one of 4 operation modes.*

### **SCHEDULE TIMER**

*A schedule timer shall be supplied as an optional accessory. The timer shall be able to set operation schedule for all indoor units. The timer shall be able to set 8 pattern of schedule combined with centralized controller.*

## **3 Dx-SPLIT PACKAGES**

### **Scope**

*The scope of this section comprises supply, installation, testing and commissioning of self contained air cooled split type air conditioning units each comprising of an outdoor and single/twin indoor units conforming to these specifications and in accordance with the requirement of drawings and schedule of quantities.*

### **1.3.1 Outdoor Unit**

*Outdoor unit shall be an air cooled condensing unit suitable for outdoor installation conforming to the following specifications.*

#### **1.3.1.1 Unit Base & Casing**

*Base panel shall be constructed out of fabricated steel structure of adequate size. Casing panels shall be of 1.2 mm thick, welded construction, removable type to provide easy access to equipment and shall be bonderized and painted. Casing shall be complete with discharge outlets, grilles, space for refrigeration equipment, fans, condenser coil etc.*

### 1.3.2 Compressor

#### 1.3.2.1 Scroll Compressor

*The scroll compressor shall be an industrial quality rugged, cast iron, direct hermetic compressor with scroll plates, suction & discharge service valves. The compressor shall be complete with straight suction tube, centrifugal oil pump, oil charging valve, oil level sight glass, crank case heater and check valve on the scroll discharge port. The compressor shall be complete with the provision of two-point lubrication for each motor bearing. The compressor shall be completely enclosed in a chamber with no leakage path and providing the capability for scroll plates to separate. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM. Inverter compressors shall be provided where called for in BOQ.*

#### 1.3.2.2 Rotary Compressor

*The rotary compressor shall be an industrial quality rugged, cast iron, hermetic/ semi hermetic compressor with capacity control side valve, oil sump heater & differential pressure refrigerant oil flow system. The compressor shall be provided with multiple pressure lubricated rolling element bearing group shall support the rotating assembly. Suitable overload protection shall be provided & necessary isolating valves shall be provided at suction & discharge. The compressor shall be fitted with electrically operated oil heaters with built in thermostats. The heaters shall be automatically actuated when the compressor is stopped. Necessary time delay shall be provided for restart of compressor.*

*The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM. Inverter compressors shall be provided where called for in BOQ.*

#### 1.3.2.3 Condenser

*Condenser shall be air cooled in copper tube & aluminium fins construction. Condensers shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessory necessary with the equipment supplied.*

#### 1.3.2.4 Condenser Fan

*Fan shall be preferably propeller type suitable for fractional horse power drive with IP-55 protection.*

### 1.3.3 Indoor Unit

*The indoor unit shall be basically a fan coil unit suitable for wall, floor and under ceiling installation of various types conforming to the following specifications.*

*Indoor units shall be either ceiling mounted cassette type, wall mounted type, floor mounted type or ceiling mounted ductable type in conformity with the design drawings and schedule of quantities.*

*Each indoor unit shall consist of PID controller for maintaining design room conditions besides microprocessor based thermostat for cooling. The indoor unit shall also be provided with wired LCD type remote controller which shall memorize the latest malfunction code for ease in maintenance. The controller shall incorporate self-diagnostic features. Such remote controllers associated with cassette type and hi-wall type indoor units shall incorporate inbuilt feature to be able to change fan speed and angle of swing flap individually as desired by the user. **The ceiling mounted cassette type indoor units** shall comprise of an attractive moulded ABS plastic exterior enclosure provided with four way supply air grilles on the periphery and square return air grill at the centre with filter behind.*

*Each cassette type indoor unit shall consist of high efficiency paddle type condensate water pump to facilitate forced disposal of condensate water and low gas detection system.*

***The hi-wall indoor units** shall be suitable for installation on the wall preferably at lintel level. The specifications shall otherwise be similar to above.*

***Ceiling mounted ductable indoor units** shall comprise of high static centrifugal fan, direct driven or belt driven through TEFC squirrel cage induction motor suitable for moderate amount of duct work. The housing shall be of light weight construction fabricated out of powder coated galvanized sheet steel single skin panels, internally insulated with 9mm thick closed cell elastomeric insulation material.*

#### 1.3.3.1 Cooling coil

*Cooling coil shall be of the fin and tube type, having aluminium fins, firmly bonded to seamless copper tubes. Face and surface areas shall be such as to assure rated capacity and the air velocity across the coil shall not exceed 170 MPM. The coil shall be factory tested under water at 21 Kg/Sqcm air pressure.*

#### 1.3.3.2 Fan Section

*The fan associated with non ductable indoor units shall be dual suction, aero dynamically designed, multi blade type, statically-dynamically balanced to ensure smooth circulation of air exhibiting lower noise level. The fan shall be direct driven type mounted directly on motor shaft supported from the housing.*

*Fan associated with ductable indoor unit shall be centrifugal double inlet double width forward curved type, preferably with variable pitch pulleys. The fan housing shall be statically-dynamically balanced at works to ensure noise and vibration free operation.*

#### 1.3.3.3 Filters

*Filters shall be cleanable, synthetic fibre media of approved make. Velocity through filters shall not exceed 105 MPM and pressure drop across filters shall not exceed 5 mm of WG.*

#### 1.3.3.4 Insulation

*All indoor unit shall be factory insulated with minimum 9 mm thick closed cell elastomeric insulation material towards thermal/acoustic treatment.*

*Drain pan shall be insulated with minimum 9mm mm thick closed cell elastomeric insulation material. Fixing of coil section and drain pan shall be done in such a way to avoid direct metal contact with any other un-insulated metal part in order to avoid condensation.*

*Condensate drain piping around the indoor unit shall also be insulated with minimum 9mm thick closed cell elastomeric insulation preferably in tubing form.*

#### 1.3.4 Refrigerant Piping

*The copper refrigerant piping shall be carried out neatly to connect outdoor and indoor unit/s and shall run along with wires/cables. The refrigerant piping associated with ductable units shall be carried out using hard drawn copper pipes & readymade copper fittings for pipe diameter exceeding 19mm. Piping less than 19mm shall be carried out using soft seamless copper pipes. Joints shall be affected by soldering/brazing process using silver rods. Suitable sleeves shall be provided at all wall crossings as required. The refrigerant circuit shall include liquid line and gas shut-off valves at the end of condenser.*

*After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 21Kg/ Sqcm. Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum equivalent to 700mm Hg and held for another 24 hours prior to commencement of gas charging.*

*All refrigerant pipes shall be properly supported and anchored to the building structure using steel hangers, anchors, brackets and supports which shall be fixed to the building element by means of inserts or expansion shields of adequate size and number to support the load imposed thereon.*

*The liquid and suction refrigerant lines including all fittings, valves, strainer etc. shall be insulated with 13 mm thick closed cell elastomeric insulation material preferably in tubing form as specified in Schedule of Quantities .*

*To protect nitrile rubber insulation associated with exposed copper piping from degrading due to ultra violet rays & atmospheric conditions, it shall be covered with polysield coating. Fiberglass tape shall be helically wrapped & applied with two coats of resin with hardener to give smooth finish.*

## **Testing**

*Cooling/heating capacity of various air handling unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Air flow measurements shall be carried out by an anemometer and temperature measurements by accurately calibrated thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current*

### **1.4 INDUSTRIAL FANS**

#### **1.4.1 CENTRIFUGAL FANS:**

*Centrifugal fans shall be of high efficiency forward/backward curved approved make DIDW/SISW of specified Class and arrangement complete with access door, squirrel-cage induction motor, V belt drive, belt guard and vibration isolators. Type, direction of discharge / rotation, and motor position shall be as per the Approved for Construction shop drawings. The fan shall be complete with the following:*

#### **Housing:**

*Housing shall be constructed out of heavy gauge galvanized sheet steel welded/bolted construction. Housing for mounting of blower should be strong enough to hold the bearings preferably with twin rib spider arrangement. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans, however neoprene packing should be provided throughout split joints to make it air tight.*

*18 gauge galvanized wire mesh inlet guards of 5 cm sieves shall be provided on both inlets. Housing shall be provided with standard cleanout and door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.*

#### **Fan Wheel:**

*Fan Wheel shall be backward-curved non-overloading type OR forward curved type. Fan wheel and housing shall be statically and dynamically balanced, conforming to standard G 2.5. Fan outlet velocity shall not exceed 2000 FPM (610 MPM) and maximum fan speed shall be 1000 RPM.*

Shaft:

*Shaft shall be constructed of high quality steel, turned, ground*

*and polished. Bearings:*

*Bearings shall be of ball bearing, taper lock type for self-alignment, mounted directly on the fan*

*housing. Bearings shall be designed especially for quiet operation and shall be of the self-aligning, oil grease pack pillow block type.*

Motors:

*Fan motor shall be **high efficiency EFF-3** suitable for operation on  $415 \pm 10\%$  volts, 50 cycles, 3 phase AC power supply. The motor shall be TEFC, squirrel cage induction type having two speed and IP-55 protection, provided with class 'B' insulation, centrifugal fans, whenever used for smoke venting duty, motor shall be with class 'H' insulation. Motor name plate horse power shall exceed brake horse power by a minimum of 20%.*

*Motor shall be designed especially for quiet operation and motor speed shall not exceed 1450 rpm. The fan and motor combination selected for the particular required performance shall be energy efficient ensuring lowest noise level. The motor shall be of approved make.*

Drive

*Drive to fan shall be provided through belt with adjustable motor sheave and standard belt guard. Belt shall be of the oil resistant type.*

Vibration Isolation:

*MS base shall be provided for both fan as well as motor, built as an integral part, and shall be mounted on a concrete foundation through vibration isolators of approved make or cushy foot mountings. The concrete foundation shall be at least 15 cm above the finished floor level or as shown in approved for construction shop drawings.*

#### **1.4.2 INLINE FANS**

*Inline fan shall incorporate approved make SISW direct driven Centrifugal Fan with TEFC motor with IP- 44 protection. The fan assembly shall be encased in a sheet metal housing of 22 gauge GSS and with necessary inspection cover with proper gasket assembly. The fan material shall be galvanized sheet steel. Flanges shall be provided on both sides of the Inline fan to facilitate easy connection. Flexible anti- vibration joints shall be provided to arrest vibration being communicated to other equipment connected to the Inline fan. Motor shall be single phase/three phase as per required duty conditions.*

*All single phase fans shall be provided with speed regulator while all three phase fans shall be provided with opposed blade damper in GSS construction at fan outlet for air balancing. All inline fans shall be internally lined with 15mm thick open cell nitrile rubber insulation to achieve noise level of 40 db.*

#### **1.4.3 PROPELLER FANS**

*Propeller type, Ring/Diaphragm mounted fans shall be equipped with a TEFC Single phase motor with the impeller mounted directly on the shaft. The blades shall be die formed steel. The fan shall be fitted with gravity type louvers. The speed of fan shall not exceed 900 RPM. The fan speed can go up to 1400 RPM only in case of fans having diameter of 305 mm.*



### Installation

- a) The Contractor shall supply all foundation bolts, base frame wherever required, vibration eliminators etc. and shall ensure that all the above accessories are placed securely in proper position while the foundation is cast.
- b) Vibration eliminators shall be provided with an efficiency of not less than 80% wherever necessary.
- c) Fan inlet and outlet connections shall be affected using new generation with flexible canvas wherever necessary.

### Testing

*All the fans shall be tested for performance and the following test results shall be furnished:*

- a. Air flow rate in CFM.
- b. Static pressure at the fan supply end.

### Painting

*On completion of the erection and testing, the outside of the fans shall be painted with two coats of Synthetic Enamel paint of approved color over and under coat of primer.*

#### **1.4.4 AXIAL FLOW FANS:**

*Fans shall be Vane/tube axial type of approved make, complete with motor mount, direct driven and vibration isolation type suspension arrangement as per approved for construction shop drawings. The fan shall be complete with the following:*

- a. Casing:

*Casing shall be constructed out of heavy gauge galvanized sheet steel. Fan casing, motor mount shall be of welded steel construction. Motor mounting plate shall be minimum 20 mm thick and machined to receive motor flange. Casing shall be provided with wide hinged door which opens easily for removal of wheel, shaft and bearings. A small inspection door with handle and neoprene gasket shall also be provided.*

*Casing shall have flanged connection on both ends for ducted applications.*

*Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Casing shall be bonderized, primed and finish coated with enamel paint.*

***Vertically mounted fans shall also be installed in the same manner, however, fans shall be equipped with thrustbearings.***

b. Rotor:

*Rotor hub blades shall be die cast aluminum alloy construction. Blades shall be die formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Tip clearance between impeller and fan casing should be 1% of diameter. Fan blades mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual airflow values, as specified and quoted.*

c. Motor:

*Motor shall be high efficiency IE03 (where called for in the Schedule of Quantities) of approved make, squirrel cage, totally enclosed, fan cooled standard round frame, constant speed, continuous duty, single winding, suitable for  $415 \pm 10\%$  volts, 50 Hz, 3 phase power supply, provided with Class F/H insulation (where called for in the Schedule of Quantities). Motor name plate horse power shall exceed brake horse power by a minimum of 15%. Motor shall be specially designed for quiet operation. The speed of the fans shall not exceed 1000 RPM for fans with impeller diameter 300mm, and 1440 RPM for fans with impeller diameter 300mm or more. For lowest sound level, fan shall be selected for maximum efficiency or minimum horsepower. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit. The motor should withstand fire up to 2 hours at 250 deg C where called for in the Schedule of Quantities.*

*All normally operating fans (i.e. excluding emergency only) shall have 6 pole motors only.*

d. Vibration Isolation:

*The assembly of fan and motor shall be suspended from the ceiling by vibration isolation suspension of rubber in shear type of approved make.*

e. Accessories:

*The following accessories shall be provided with all fans.*

- i. Outlet cone for static pressure regain.
- ii. Inlet cone.

*Fan silencers may be provided where specifically called for in Schedule of Quantities.*

*Fans shall be factory assembled and shipped with all accessories factory mounted and fan shall be AMCA certified for sound & air performance.*

*All rotors shall be statically and dynamically balanced as per AMCA 204-05 standard to a minimum of BV-3 level.*

*The minimum acceptable total efficiency of the fans shall be 70% and the sound pressure should not exceed 80 db(A) at a distance of 3 meters. When measured in a hemispherical surface under reverberant room conditions. Fan performance shall be based on tests conducted in accordance to AMCA 210 for air performance and AMCA 300 for Inlet sound power levels. These fans shall be licensed to bear the AMCA seal for air and sound performance.*

*All the High Temperature Fans should either be EN-12101-3 or UL tested for High Temperature (UL Power & Smoke Ventilation listed) for a minimum of 250 Deg C for a minimum of 2 Hrs and should be UL or CE labeled.*

## 1.5 AIR WASHERS

### Scope

*The scope of this section comprises of supply, installation, testing and commissioning of packaged type Double Skin Air Washers of specific capacity set forth in the "Schedule of Quantities".*

*The housing/casing of the air washer shall be of double skin construction. The housing shall be so constructed that it can be delivered at site in total/semi knock down conditions depending upon size of the air washer, location & access available.*

*The framework shall be extruded aluminum hollow sections filled with preformed insulation section. Frames shall be assembled using mechanical joints to make a sturdy and strong framework for various sections.*

*Double skin panels (each not exceeding 750mm wide) shall be made out of 24 gauge pre-painted galvanized steel sheet on outside and 24 gauge plain galvanized sheets inside with 25 mm thick injected PU foam insulation in between. These panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.*

*Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Suitable doors with pressure die cast aluminum hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on galvanized steel channel frame work.*

*Marine light with switch, view window and proximity switch to be provided in the casing of each air washer. Factory Fabricated Plenums shall be provided as shown in design drawings.*

*The air washer sump shall be made out of SS-304A grade, 1.25mm thick stainless steel sheet with bolted construction having suitable stiffeners and FRP lining on the joints. The bottom tray shall be made out of 16 gauges GI with 1mm FRP lining from inside. The casing shall be of bolted construction designed for outdoor installation. The entire fan section shall be coated with epoxy based paint internally. The centrifugal fans shall be coated with epoxy paint to avoid moisture abuse.*

*The packaged air washer shall be complete but not restricted to the following:*

- a. 50mm thick aluminum wire mesh filters at the air intake.
- b. 200mm thick cellulose based paper fills preferably of imported origin. It shall provide extended and sufficient wetted surface to provide a water absorbing efficiency of 90% with air velocity not exceeding 500 FPM (2.54 MPS).
- c. FRP water header with equidistant slits for uniform water distribution over the paper fills.
- d. Drain, overflow, make-up and quick-fill connections with 20mm float valve of commercial grade brass.
- e. Suction screen constructed out of brass and shall be of sufficient area to maintain velocity not exceeding 25Cms/sec.
- f. All interior and exterior GI piping with valves and fittings to connect the water circulating pumps including 'Y' strainer etc.
- g. Cabinet type supply air fan section shall be completely factory assembled and tested of approved manufacture.
- h. Casing shall be of heavy gauge galvanized steel sheet, ribbed and re-enforced with access

panels as may be required.

*The fan shall be forward curved floor standing double inlet double width type preferably of imported origin. The wheel and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearings. The fan shall be selected for speed not exceeding 1000 RPM. Variable pitch pulley shall be provided to affect reduction in speed in winter if required. The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 2000 FPM (10.1 MPS). Fan housing with motor shall be mounted on a common steel base mounted inside the air handling housing on anti-vibration spring mounts or rubber mounts. The fan outlet shall be connected to casing with the help of anti-vibration flexible joints made out of imported fire retardant fabric with extruded aluminum frame/ flange on either both side. The centrifugal fans shall be epoxy coated in the factory prior to delivery.*

*Fans shall be driven by an electric motor as specified in the schedule of quantities. Motor ratings are only tentative and where a fan requires a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly. Motor ratings shall be at least 10% over limit load plus transmission losses.*

*Fan motors shall be of EFF-1 category and suitable for operation on  $415 \pm 10\%$  volts, 50 Hz, 3 phase, AC power supply and shall be TEFC squirrel cage induction type totally enclosed fan cooled with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type.*

- a) Vibration isolators for pumps and centrifugal fans.
- b) Pumps
  - i. The water distribution pumps shall be of heavy duty, vertical type mounted inside the tank. It shall be complete with adjustable bleed of arrangement to prevent concentration of undesirable salts.
  - ii. The pump shall be provided with single phase, self-tripping starter of North West or equivalent make.
- c) Limitation

*The air velocity limits are as follows:*

  - a. Velocity across wet media shall not be exceeding 500 FPM (2.54 MPS).
  - b. Velocity at fan outlet shall not be exceeding 2000 FPM (10.1 MPS).

## **1.6 FAN FILTER UNITS**

*The scope of this section comprises of supply, installation, testing and commissioning of packaged type Fan Filter Units (FFU) of specific capacity set forth in the "Schedule of Quantities".*

*The housing/casing of the FFU shall be of double skin construction. The housing shall be so constructed that it can be delivered at site in total/semi knock down conditions depending upon size of the FFU, location & access available.*

*The framework shall be extruded aluminum hollow sections filled with preformed insulation section. Frames shall be assembled using mechanical joints to make a sturdy and strong framework for various sections.*

*Double skin panels (each not exceeding 750mm wide) shall be made out of 24 gauge pre-painted galvanized steel sheet on outside and 24 gauge plain galvanized sheets inside with 25 mm thick injected PU foam insulation in between. These panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.*

*Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Suitable doors with pressure die cast aluminum hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on galvanized steel channel frame work.*

*Marine light with switch, view window and proximity switch to be provided in the casing of each FFU. Factory Fabricated Plenums shall be provided as shown in design drawings.*

*The fan shall be forward/backward curved, floor standing, double inlet double width type. The wheel and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame/spider and self-lubricated sealed eccentric type ball bearings.*

*The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 2000 FPM (10.1 MPS). Fan housing with motor shall be mounted on a common steel base inside the air handling housing on anti-vibration spring's mounts or rubber mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass.*

*Fans shall be driven by an electric motor as specified in the schedule of quantities. Motor ratings are only tentative and where a fan requires a higher capacity motor, the contractor shall clearly point out the requirement and make his offer accordingly. Motor ratings shall be at least 20% over limit load plus transmission losses.*

*Fan motors shall be suitable for operation on  $415 \pm 10\%$  volts, 50 Hz, 3 phase, AC power supply and shall be EFF1, TEFC squirrel cage induction type totally enclosed, fan cooled with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil- resistant type.*

*Fan Filter units should be provided with necessary viscous metallic filters as mentioned under subhead filters.*

## **1.7 EXTRACT FAN SECTION**

*The scope of this section comprises of supply, installation, testing and commissioning of packaged type Extract Fan Sections (EFS) of specific capacity set forth in the “Schedule of Quantities”.*

*The housing/casing of the EFS shall be of double skin construction. The housing shall be so constructed that it can be delivered at site in total/semi knock down conditions depending upon size of the EFS, location & access available.*

*The framework shall be extruded aluminum hollow sections filled with preformed insulation section. Frames shall be assembled using mechanical joints to make a sturdy and strong framework for various sections.*

*Double skin panels (each not exceeding 750mm wide) shall be made out of 24 gauge pre-painted galvanized steel sheet on outside and 24 gauge plain galvanized sheets inside with 25 mm thick injected PU foam insulation in between. These panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.*

*Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Suitable doors with pressure die cast aluminum hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on galvanized steel channel frame work.*

*Marine light with switch, view window and proximity switch to be provided in the casing of each EFS. Factory Fabricated Plenums shall be provided as shown in design drawings.*

*The fan shall be forward/backward curved, floor standing, double inlet double width type. The wheel and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame/spider and self-lubricated sealed eccentric type ball bearings.*

*The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 2000 FPM (10.1 MPS). Fan housing with motor shall be mounted on a common steel base inside the air handling housing on anti-vibration springs mounts or rubber mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass.*

*Fans shall be driven by an electric motor as specified in the schedule of quantities. Motor ratings are only tentative and where a fan requires a higher capacity motor, the contractor shall*

*clearly point out the requirement and make his offer accordingly. Motor ratings shall be at least 20% over limit load plus transmission losses.*

*Fan motors shall be suitable for operation on  $415 \pm 10\%$  volts, 50 Hz, 3 phase, AC power supply and shall be EFF1, TEFC squirrel cage induction type totally enclosed, fan cooled with IP-55 protection. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type. Provisions of separate GI sheet enclosure to locate the motor in hot air stream free area to be made (applicable for kitchen extract fan sections only).*

## **1.8 FILTERS**

### **1.8.1 Viscous Metallic Filters**

*Viscous metal filter shall be all metal, washable type. The filter media shall be composed of layers of crimped GI wire mesh. The velocity over face of filter shall not exceed 90 MPM and pressure drop shall not exceed 5mm for 50mm thick filter. The filter shall be of GI and suitable for mounting as required at site.*



1.8.2 Synthetic Fibre Filters(EU-3)

*Synthetic fibre filter shall be constructed out of 50mm deep non-woven synthetic fibre replaceable media secured with anodized ductile aluminium mesh on one side & 40 sieve HDPE mesh on the other side. All the layers to be duly stitched together & to be housed in 18G Aluminium anodized frame. The filter element shall have 11 folds/Rft. The filter shall have an efficiency of 90% down to 10 microns when tested as per BS: 2831 standard. It shall be suitable for operation under 100% Relative Humidity & 120 degree C temperature conditions. The velocity over the face of filter shall not exceed 105 MPM and the pressure drop across the filter shall not exceed 3 mm WG for 50mm thick filter. The filter frame shall be suitable for mounting in air handling unit as required at site.*

1.8.3 Minimum Efficiency Reporting Value Parameters (MERV-13)

ASHRAE Standard 52.2 Minimum Efficiency Reporting Value (MERV)	Composite Average Particle size Efficiency, Percentage in Size Range , um		
	Range1 0.30 – 1.0	Range2 1.0–3.0	Range3 3.0- 10.0
01.	n/a	n/a	E3 < 20
02.	n/a	n/a	E3 < 20
03.	n/a	n/a	E3 < 20
04.	n/a	n/a	E3 < 20
05.	n/a	n/a	20 < E3 < 35
06.	n/a	n/a	35 < E3 < 50
07.	n/a	n/a	50 < E3 < 70
08.	n/a	n/a	70 < E3
09.	n/a	E2 < 50	85 < E3
10.	n/a	50 ≤ E2 < 65	85 ≤ E3
11	n/a	65 ≤ E2 < 80	85 ≤ E3
12	n/a	80 < E2	85 ≤ E3
13	E1 < 75	90 < E2	90 ≤ E3
14	75 ≤ E1 < 85	90 < E2	90 ≤ E3
15	85 ≤ E1 < 95	90 < E2	90 ≤ E3
16	95 < E1	95 < E2	95 ≤ E3

1.8.4 Microvee Filters: (EU-7)

*Fine filters shall be designed to remove particles down to 3 microns as per BS: 6540 standard.*

*Filter shall comprise of aluminium sheet duly anodized. Filter element shall be made out of non-woven synthetic supported by anodized ductile aluminium mesh on one side & HDPE mesh not less than 40 sieve size on the other side with 11 folds/Rft of filtration area. All the layers to be dully stitched together. All sides to be sealed with ductile epoxy resin and filters shall be cleanable type using water/detergent. Rubber gaskets to be provided on the flange. Filter element shall be specially treated with antifungal and bacterial reagent to prevent growth*

*of micro-organisms shall be screwed into the frame by means of an aluminium clamp patti and brass screws. They shall comprise of housing made from MS angles/flats epoxy coated of size suitable to receive the required number of filters to handle specified Cfm for each AHU. All filters shall be installed in same plane. No zigzagging shall be allowed by means of threaded bolts.*

#### **1.8.5 HEPA Filter:**

*These filters shall remove particles greater than 0.3 microns with an efficiency of 99.99% when tested with cold DOP test. Filter shall comprise of specially treated glass fiber media, aluminium media separators housed in an aluminium sheet frame provided with double turned flanges and dosed cell neoprene gaskets. The housing shall be designed to install the hepa filter in the terminal location in RCC slab ceiling. It shall be suitable for mounting the HEPA filter. Housing assembly shall comprise of:*

- a) Bottom MS tee frame.
- b) Top MS angle frame.
- c) Clamping device for filter tightening.
- d) Provision for connecting manometer across the filter.
- e) Provision for top flexible PVC based connector.

*MS tee frame shall be mounted flush on the bottom surface of ceiling. It shall be securely welded at site to top MS angle frame which will be supported by brick masonry up stand all around the slab opening. The contractor shall ensure that the inner surface of the opening is smooth plaster finished and treated with epoxy paint by civil contractor. The top MS angle frame shall have provision to fix SS angle cleats by means of bolts. Cleats shall contain SS press down bolts with lock nuts. Flexible Rexene connectors shall be of suitable size to enable easy insertion and removal of HEPA filter into the terminal opening. The Rexene shall be screwed to supply air duct and MS angle frame in up stand by means of MS clamp patties. All MS components shall be epoxy painted.*

#### **1.8.6 Electrostatic Precipitator Section:**

*Electrostatic precipitator section shall be made of 16 gauge galvanized sheet, High bake epoxy powder coated, Washable type aluminum mesh pre-filter, Washable type aluminum mesh post filter, Stainless steel spiked ionizers to create high voltage DC field, aluminum collector plates which should be alternatively charged positive & negative with large collecting area with 14" deep cell, to work as magnet for charged smoke & oil particles.*

*An average efficiency of 90-95% in single pass as per DOP test method. Electrostatic Precipitator should be able to charge particles from 0.01 micron to 10 micron through solid state power supply. Collector cell should be of permanent type and slide out facility for easy removal for cleaning. Operating Voltage: 220V/1Ph/ 50Hz, Power consumption: 50 watts each unit. Ionizing Voltage: 12.5 – 13.0 kVDC, Collector Cell Voltage: 6.0 – 6.5 kVDC, System should be fitted with interlock switch for safety, the system should be able connected to a fan section to achieve airflow of 500 FPM across the air cleaner. The filter should have a constant pressure drop.*

## 1.9 VARIABLE FREQUENCY DRIVES

### Scope

*This section describes the type of frequency converter to be supplied for fan/ pump speed control. The drive shall not be a general purpose product, but should exhibit features acknowledging engineered design applicable to HVAC industry.*

The drives shall exhibit **IP-55 protection** unless otherwise captured in BOQ.

*The manufacturer shall demonstrate a continuous period of manufacture and development for at least 25 years.*

*The frequency converter shall be supported locally by the manufacturer who will provide full technical support, spares holding and troubleshooting capability from his own local facility. A training course shall be organized by the manufacturer for the Engineer In Charge / contractor / maintenance engineers.*

*The manufacturer shall provide full technical detail of the product, with catalogues, dimension drawings, weights etc. and each drive shall be provided with a full technical manual.*

*Equipment supplied must conform to recognized International Standards and be manufactured to ISO 9001, BS 5750 part 1 & 2 and carry the CE Mark on EMC Compliance.*

*Frequency converters shall be suitable for use in either a 'Stand Alone' mode, complete with all necessary protection or as part of centrally controlled system via a Serial Communication Loop to the main Building Management System (BMS) via in-built RS 485 port.*

### Technical Requirement

*The frequency converter (FC) shall convert Local Voltage  $V \pm 10\%$ , 3 Phase, 50/60 Hz utility power supply to an adjustable output voltage and frequency. The FC must be capable of delivering full value of fundamental true RMS output voltage to the motor equal to the mains input voltage to the FC at full load and speed. In the event the FC cannot meet this requirement an oversized motor at least one frame size higher must be selected. The FC manufacturer must document this capability.*

*The voltage to frequency ratio shall be suitable for fan control. It should not be possible to set a constant V/F ratio, to prevent damage to connected equipment and to optimize energy usage.*

*The FC shall work in conjunction with any IEC standard design motor and shall not require the motor to be de-rated, or cause the motor temperature to rise above the class 'B' rise expected on normal mains operation. The Motor shall not require an external blower even at slow speed running.*

*When selecting the FC, care shall be taken to ensure that protection against electro fluting of motor bearings and/or damage to the motor windings shall be provided. This shall be provided by the inclusion of:*

- a) Insulated motor bearings
- b) Soft switching IGBT's in the FC
- c) LC Filters fitted to the FC

*The FC shall use AMA (Automatic Motor Adaptation) techniques so that operators do not have to input motor characteristic and ensuring proper motor operation, optimize motor performance, improve start capabilities and compensate for motor cable variances.*

*The FC shall be capable of controlling parallel motors of mixed ratings, and allow disconnection of any machine whilst running without causing tripping. The FC shall be capable of running with no motor connected for service functions.*

*The FC shall be fully tested at the converter manufacturers works, including motor loading.*

*Certificates of Compliance should be available on request.*

*The FC shall be of sufficient capacity to provide a quality wave form so as to achieve full output torque of the motor, without causing additional heat rise.*

*The operating conditions shall include:*

- a) Minimum efficiency at 100% load- 96%  
at 20% load- 92%
- b) Rated input voltage (local voltage)  $\pm 10\%$ , 3 phase, 50/60 Hz  $\pm 2$  Hz.
- c) Working ambient temperature range  $-10^{\circ}\text{C}$  to  $+45^{\circ}\text{C}$ , humidity to 95% RH, and vibration of 0.7G.RMS in 3 directions
- d) Output frequency range - 0.5 to 1000 Hz.
- e) Output voltage range 0 to full mains input voltage, 3 phase even at full mains voltage- 10% input.
- f) The drive shall allow connection of motors one frame size larger and 4 sizes smaller than the nominal converter rating.
- g) VFD shall be limited to 110% of rated current for 60 seconds and 160% torque for 0.5 seconds
- h) The FC shall accept 0-10 VDC, 4-20 mA, or resistive inputs as a control signal.
- i) The FC shall provide two output relays to provide signals including - ready, run, tripped, and be programmable for other selected information. Two analogue outputs of 4-20 mA or 24 VDC shall be programmable to transmit speed or other parameters to the BMS In addition, 2 x digital outputs shall provide 24Vdc to signal choice of 27 conditions to the BMS.
- j) The FC shall log and display "Total kW-hrs consumed" and "Total Hours Run" by the motor without additional instrumentation and the facility to "Reset".
- k) 20 preset speeds shall be available (programmable values) for duties such as night setback, smoke extract and morning boost settings.
- l) The FC shall provide 4 skip frequencies of adjustable bandwidth to overcome mechanical or air resonance.
- m) A parameter lock shall be incorporated to prevent unauthorized resetting of parameters.
- n) The FC shall be capable of running from an external DC source during periods of mains interruption.
- o) Drive acoustic noise shall not exceed 65 dBA at full load and 60 dBA at 50%

#### load. Drive Design Requirements

*The FC shall contain as standard within its enclosure DC Link filtering with both inductive and capacitive elements to control the mains borne harmonics. The document 'Electrical Supply Industry Recommendation G 5/3 limits for harmonic currents in the UK or IEEE519, 1992 shall be used for the basis of calculation of THD for the point of common coupling. On request, the FC manufacturer shall provide THD figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, etc. feeding the FCs to allow this calculation to be made.*

*The FC shall comply with EMC (Electromagnetic compatibility) (RFI Control) document EN55011 as an integral part of its design, incorporating EMC/ RFI Filters to meet both EN55011 Class 1A (150metres) and Class 1B (50 meters). It shall conform to immunity standard IEC 801 parts 2-5. Must carry the CE Mark of Compliance.*

*The drive shall be capable of automatically reconnecting to a spinning fan, forward or reverse running, without tripping, following mains interruption or on transfer from bypass running.*

*The FC design shall comprise of a diode input bridge, fixed voltage DC link section with both inductors and capacitors to form a filter, and inverting bridge comprising IGBT's (Insulated Gate BiPolar Transistors). All equipment must be housed within the FC enclosure.*

*The inverting bridge shall be controlled by a 32 bit processor and ASIC's (Application Specific Integrated Circuits) to produce a VVC. Plus (Voltage Vector Controlled) enhanced PWM waveform naturally resulting in full motor voltage, torque and sinusoidal current of mains supply quality in the motor circuit. Other forms of current source or 6 pulse converters shall not be acceptable.*

*The FC shall protect itself against input transients to VDE0160 class W2; loss of mains phase (3 phase measurement); loss of motor phase (3 phase measurement); grounding of any output phase; loss of speed reference (runs at last setting/preset speed/close down-programmable).*

*The FC shall use overriding frequency fold back control techniques to prevent damage in the event of excessive load during either running or starting.*

*The FC shall model the motor in its software to predict motor overheating without the use of thermistors in the motor. When overheat is predicted, an alarm or automatic shutdown shall be initiated.*

*The FC shall exhibit near unity fundamental power factor at all loads and speeds, and should not require the addition of external A.C./D.C. line reactors for power factor improvement, harmonic control or prevention of zero voltage notching.*

*The output circuit shall be of such a design, as to allow unlimited switching of the motor circuit, at any load/speed without causing damage to the IGBT output stage and without needing auxiliary control switching.*

*FC shall have self-adjusting modulation frequency control from 2.0 KHz to 14 KHz. The control form shall be such as to allow the FC to deliver full output at all times without de-rating, by optimizing the switching frequency dependent on the output load.*

*Full galvanic isolation between power and control components shall be incorporated to ensure compliance with VDE 0160 PELV (Protective Extra Low Voltage) to*

*prevent damage to BMS interface and ensure operator safety. Short circuiting of the control terminals shall not damage the control card.*

*The FC shall include an AEO (Automatic Energy Optimization) circuit to continuously adjust the voltage to frequency ratio and optimize the motor magnetizing current based on the actual torque requirement of the motor at different speeds to optimize motor energy consumption and prevent heating of motor at low speeds.*

*The design shall include a full 2 zone, 2 setpoint PID controller as standard to provide closed loop control direct from upto 2 signal transmitters without the need for external signal conditioning.*

*The FC shall not exhibit an inrush current when a 'start' signal is given, and current must not exceed 110% at any time to prevent damage to connected equipment.*

*The FC design shall include a motor preheat circuit to prevent condensation forming in the motor during shutdown periods.*

*The FC shall not be damaged if it is energized with a 'start' signal without a motor connected.*

*The FC shall provide as standard:*

- a) Heat sink over-temperature protection.
- b) Under-voltage protection.
- c) Over-voltage

protection. Display to be in

selectable language.

*The Local Control Panel (keypad of FC) of FC shall display in 4 line alpha-numeric characters in plain English language, the following operating parameters:*

- a. Energy consumed in KW-Hr.
- b. Power consumed by motor in kW
- c. Run time of motor in Hours.
- d. Current drawn by the motor in Amperes.
- e. Voltage applied to motor terminals by FC in Volts
- f. DC link voltage in Volts
- g. Output Frequency in Hz.
- h. Percentage of maximum output frequency in %.
- i. Motor Speed in RPM
- j. Thermal Load on Motor in %

*Air curtains shall be vertical down throw type and shall comprise of twin centrifugal blowers, statically and dynamically balanced, designed for noiseless and continuous operation, motor etc. The enclosure shall be factory fabricated out of 18 gauge aluminium/CRCA sheet duly powder coated. The outlet shall be carefully designed to create laminar draft providing an invisible air curtain at critical junction isolating clean and semi-clean areas or as required.*

### **1.11 PHOTOHYDROIONISATION PLUS CELL**

*The UV tube duly encased in a hydrated catalytic matrix cell has the capability to generate hydro peroxides, super oxide ions, ozonide ions, hydroxide ions & a minimum of 01 billion bi polar ions. The catalyst cell must have at least 18000 hours of effective life with the local support to easily replace the UV lamp after its performance life. All parts and support must be locally available to ensure reliable performance at reasonable costs. The unit should be designed for supply air side of duct with a manufacturer warranty.*

*The optional Petri dish test should be available, if required.*

### **1.12 ODOUR REDUCTION UNIT**

Magneto Odor Buster (MOB(STP)) Odor Control System shall be provided to reduce dramatically or eliminate odor and Hydrogen Sulphide (H<sub>2</sub>S) released by Vent Air from odor producing wells of Sewage Treatment Plant (STP) or in Sewage exhaust air.

Vent Air from odor/H<sub>2</sub>S producing wells shall be extracted from free board or air column over liquid/sludge level. Extracted air shall be ducted to odor removal equipment called for in this specification. The extraction shall provide negative air pressure in the free board space. This shall prevent migration of H<sub>2</sub>S and odor bearing Vent Air from wet wells into the plant room. Air shall always infiltrate into the wet well from plant room and never vice versa. This shall keep the STP Plant Room free of odor and H<sub>2</sub>S.

The Odor Buster Equipment shall comprise Ozone Generation Compartment, Cold Plasma Cell, Fan Compartment, Mixing Air Chamber, and Electrical and Instrumentation Enclosure. Odor Buster unit shall comprise Cold Plasma Cell & multi ozone generating system operating at high voltage, to produce adequate quantity of ozone & reactive oxygen species at medium concentration. The system shall not require any consumable and maintenance shall be minimum. Feed air shall be plant non polluted air. Use of annular tube type corona with air as feed gas is not permissible, so as to prevent deposition of nitrogen oxides on the corona surface. To minimize maintenance and operational consumable, use of oxygen feed system is not permissible. This system must be air cooled type only.

The Electrical Compartment shall house all electrical components, controls, monitors, and instruments. The Electrical Compartment shall comprise sufficient number of electrical induction type transformers to drive ozone generator heads. All parts and components shall be factory installed complete with electrical and control wiring in one neat Stainless Steel Enclosure. No fieldwork shall be necessary except interconnect ducts, contact chamber, and electrical connections.

*The equipment should be suitably designed to be easily mounted on the wall or angle platforms near the exhaust air ducts.*



## 2.0 AIR DISTRIBUTION

### 2.1 SCOPE

*The scope of this section comprises of supply, fabrication, installation and testing of all sheet metal ducts and supply, installation, testing and balancing of grilles, registers and diffusers, in accordance with these specifications and the general arrangements shown on various drawings.*

#### **MATERIAL**

- i) All ducts shall be fabricated either from Galvanised Sheet Steel (GSS) conforming to IS: 277 or aluminium sheets conforming to IS: 737. The steel sheets shall be hot dip galvanized with MAT finish with coating of minimum 120 grams per square meter (GSM) of Zinc, GI sheets shall be lead free, eco friendly and RoHS compliant.
- ii) The thickness of sheets for fabrication of rectangular ductwork shall be as under. The thickness required corresponding to the longest side of the rectangular section shall be applicable for all the four sides of the ductwork.

Longest side (mm)	Minimum sheet thickness	
	For GSS	For Aluminium
750 mm and below	0.63	0.80
751 mm to 1500 mm	0.80	1.00
1501 mm to 2250 mm	1.00	1.50
2251 mm & above	1.25	1.80

- (iii) *Thickness of sheet for Round Ducts*

Diameter of duct, mm	Thickness of Sheet, mm	
	GI sheets	Aluminium Sheets
150 to 500	0.63	0.80
501 to 750	0.80	0.80
751 to 1000	0.80	1.00
1001 to 1250	1.00	1.50

1251 and above	1.25	1.80
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- iv) All sheet metal connections, partitions and plenums required for flow of air through the filters, fans etc. shall be at least 1.25 mm thick galvanised steel sheets, in case of  
*G.I. sheet ducting or 1.8 mm thick aluminium sheet, in case of aluminium sheet ducting and shall be stiffened with 25 mm x 25 mm x 3 mm angle iron braces.*
- v) Circular ducts, where provided shall be of thickness as specified in IS: 655 as amended upto date.
- vi) Aluminium ducting shall normally be used for clean room applications, hospitals works and wherever high cleanliness standards are functional requirements.

*Associated Items*

*Supply/ return air outlets, F.A. grilles and accessories shall be constructed from extruded aluminium sections.*

*Flanges for matching duct sections, stiffening angles (braces) and supporting angles shall be of rolled steel sections, and shall be of the following sizes.*

<b>Application</b>	<b>Duct Width</b>	<b>Angle size</b>
Flanges	Upto 1000 mm	35 mm x 35 mm x 3 mm
-do-	1001 mm to 2250 mm	40 mm x 40 mm x 3 mm
-do-	More than 2250 mm	50 mm x 50 mm x 3 mm
Bracings	Upto 1000 mm	25 mm x 25 mm x 3 mm
-do-	More than 1000 mm	40 mm x 40 mm x 3 mm
Support angles	Upto 1000 mm	40 mm x 40 mm x 3 mm
-do-	1001 mm to 2250 mm	40 mm x 40 mm x 3 mm
-do-	More than 2250 mm	Size and type of RS section shall be decided in individual

*Hanger rods shall be of mild steel and of at least 10 mm dia for ducts upto 2250 mm size, and 12 mm dia for larger sizes.*

*All nuts, bolts and washers shall be zinc plated steel. All rivets shall be galvanised or shall be made of magnesium - aluminium alloy. Self tapping screws shall not be used.*

## 2.2 CONSTRUCTION

### 2.2.1 Ducts

2.2.1.1 Ducts shall be fabricated at site or factory fabricated and shall be generally as per IS: 655 "Specifications for metal air ducts", unless otherwise deviated in these General Specifications.

2.2.1.2 The interior surfaces of the ducting shall be smooth.

2.2.1.3 All the ducts upto 600 mm longest side shall be cross broken between flanges by a single continuous breaking. Ducts of size 600 mm and above shall be cross broken by single continuous breaking between flanges and bracings. Alternatively, beading at 300 mm centres for ducts upto 600 mm longest side, and 300 mm centres for ducts above 600 mm size shall be provided for stiffening.

2.2.1.4 As far as possible, long radius elbows and gradual changes in shape shall be used to maintain uniform velocity accompanied by decreased turbulence, lower resistance and minimum noise. The ratio of the size of the duct to the radius of the elbow shall be normally not less than 1:1.5.

2.2.1.5 Flanged joints shall be used at intervals not exceeding 2500 mm. Flanges shall be welded at corners first and then riveted to the duct.

2.2.1.6 Stiffening angles shall be fixed to the sides of the ducts by riveting at *1.25 meters from joints for ducts of size 600 mm to 1500 mm, and 0.6 m from joints for ducts of size larger than 1500 mm. Bracings for ducts larger than 1500 mm can alternatively be by diagonal angles.*

2.2.1.7 Plenums for filters shall be complete with suitable access door of size 450 mm x 450 mm.

2.2.1.8 All factory fabricated duct shall be supplied in L sections, the length of any piece shall not be more than 1800 mm for duct with longest side of cross section as 600 mm and above and 3000 mm for rest.

### 2.2.2 Air Outlet and Inlets (Supply and Return)

2.2.2.1 All air outlets and intakes shall be made of extruded aluminium sections & shall present a neat appearance and shall be rigid with mechanical joints.

2.2.2.2 Square and rectangular wall outlets shall have a flanged frame with the outside edges

returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give upto 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminium sheet. The louvers shall be of aerofoil design of extruded aluminium section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminium sheet. Louvers may be spaced 18mm apart.

2.2.2.3 Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section aluminium sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminium section.

2.2.2.4 Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti smudge cones shall have the outer cone profile designed to reduce dirt deposit on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.

2.2.2.5 Towards fire protection, all kitchen extract ductwork shall be fabricated out of 18 gauge GSS and coated with approved fire retardant surface treatment (on internal and external duct surface) preferably sprayed at factory prior to dispatch in order to capture the flanges, corners and internal joints. These ducts should be finished off with 50mm thick mineral wool on the external surface the duct, enveloped in 0.1mm thick Aluminum foil, and joints sealed off with Aluminum tape.

#### 2.2.4 Duct Installation

*All ducts shall be installed generally as per the drawings and in strict accordance with approved for construction shop drawings prepared by the contractor.*

- a. The contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these specifications and drawings. This work shall meet with the approval of the Architect/ Engineer In Charges in all its parts and details.
- b. All necessary allowances and provisions shall be made by the contractor for beams, pipes or other obstructions in the buildings, whether or not the same are shown on the drawings. Where it becomes necessary to avoid beams or other structural work, plumbing or other pipes, and or conduits, the ducts shall be transformed, divided or curved to one side, the required area being maintained as approved or directed by the Architect/ Engineer In Charges.

- c. If a duct cannot be run as shown on the drawing, the contractor shall install the duct between the required points by any path available, subject to the approval of the Architect/Engineer In Charges.
- d. All duct work shall be independently supported from building elements or as required by the Architect/Engineer In Charges. All horizontal ducts shall be rigidly and securely supported, in an approved manner, within hangers formed of wire rope suspension arrangement with hot dipped galvanized (HDG) perforated channel under the ducts. The distance between two successive supports shall not be greater than 2 meter center to center. All vertical duct work shall be supported by structural members at each floor.
- e. Ducting on top of the ceiling shall be supported from the slab above, or from beams with the help of adequate strength dash fasteners, after obtaining approval of the Architect/Engineer In Charge. In no case shall a duct be supported from the ceiling hangers or be permitted to rest on a hung ceiling.
- f. All metal work in dead or closed down spaces shall be erected in time to occasion no delay to other contractors in the building.
- g. All ducts shall be totally free from vibration under all conditions of operations. Whenever duct work is connected to fans, that may cause vibrations in the duct, ducts shall be provided with two flexible connections located close to the unit in mutually perpendicular directions. Flexible connection shall be constructed of fire resistant flexible double canvas sleeves at least 100mm deep, secured properly and bolted at both ends. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both ends. The flexible connection shall be suitable for pressures at the point of installation.
- h. The two mating flanges of the ducts being joined with each other shall be made air tight by providing 2mm thick foam rubber insertion fixed on both mating flanges by means of good quality adhesive. Rubber strip shall also be provided between bottom surface of duct and angle iron at each duct support to avoid metal to metal contact.

### **2.3 FACTORY FABRICATED SPIGOTS**

*Spigots shall be readymade, circular in shape, fabricated out of 22 gauge galvanized steel sheet through spinning process. The spigot shall be provided with a circular opening with a cylindrical neck with grooves to facilitate fail safe flexible duct connection. Spigot shall have circular flange all around which shall be screwed to the main rigid ductwork.*

*Readymade gaskets shall be provided between circular flange and surface of rigid ductwork with pre-conceived round opening, and sealant applied to prevent leakage of air.*

## **2.4**      **VOLUME CONTROL DAMPERS**

- a. All dampers shall be multi-blade type of robust construction of galvanized steel and tightly fitted. The design, method of handling, and control shall be suitable for the location and service required.
- b. Dampers shall be provided with suitable links, levers and quadrants as required for their proper operation control or setting devices shall be made robust, easily operable and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times.
- c. Dampers shall be placed in ducts and at each supply air collar, whether or not indicated on the drawings, for the proper volume control and balancing of the system.

## **2.5**      **FIRE CUM SMOKE DAMPERS**

### **2.5.1**    **BARE DAMPERS**

- a. All supply and return air ducts/return air spaces at AHU room crossings and at all floor crossings shall be provided with approved make motorized fire and smoke dampers of at least 90 minutes fire rating as certified by CBRI Roorkee, India as per clause 10 of UL:555-1995. These dampers shall be multi-leaf type -Ruskin.
- b. *Fire damper blades and outer frame shall be formed out of 1.6mm (16G) galvanized steel sheet of length as mentioned in the approved for construction shop drawings titled as AHU Room Blow Up. The damper blade shall be pivoted on both ends using chrome plated spindles in self lubricated bronze bushes. Stop seals shall be provided on top and bottom of the damper housing made of 16 gauge galvanized sheet steel. For preventing smoke leakage, metallic compression side seals shall be provided. Dual side linkage shall be provided for better structural stability. The construction of the fire damper shall allow maximum free area to reduce pressure drop and noise in the air passage. In normal position damper blade shall be held in open position with the help of a 220 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.*
- c. For wall mounted fire dampers retaining **MS angles duly painted with black enamel paint shall be supplied and installed by HVAC Contractor** as per established installation procedure. Whereas the fire damper is also to be used for Smoke management (Smoke and fire damper) the same shall be as per UL-555 S-Class-II.
- d. Every motorized fire damper/ Smoke and fire damper shall be tested for in the factory and will be certified by the manufacturer in form of the test certificate.
- e. Fire dampers shall also be supplied with spring locked fusible link rated for 72°C (UL stamped) to close fire damper in event of rise in duct temperature.

- f. For fire dampers/ smoke fire dampers of size higher than one approved by certifying agency the damper shall be supplied in multiple units of size not exceeding the tested damper by CBRI. All the multiple units shall be housed in a common factory fitted sleeve.
- g. The fire dampers shall be mounted in fire rated wall with a duct sleeve 400mm/500mm long depending upon the wall thickness. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be slip on type. Minimum thickness of galvanized sheet shall be 18 gauge.
- h. The damper shall be installed in accordance with the installation method recommended by the manufacturer.

## **2.5.2 ACTUATORS**

*The actuator shall be maintenance free direct coupled spring return type suitable to work on 24 V electric supply. The torque rating of the actuator shall exceed at least by 15% over torque required to open/ close the damper. The selection of actuator size shall be the responsibility of the manufacture of the fire damper. Spring return time shall be 20 seconds or less at ambient temperature. Other features of the damper actuator shall be as under:*

- a. Actuator shall have tamper proof housing with IP-54 protection rating.
- b. Actuator shall have mechanical integrity of at least one hour at 900<sup>o</sup> C.
- c. Actuator shall have minimum 60000 safe position at rated torque. It shall be capable to withstand temperature of 75<sup>o</sup> C for 24 Hrs.
- d. Actuator shall have electronic over load or digital sensing circuit to prevent damage to actuator.
- e. Should be capable of changing direction of rotation by changing mounting orientation.
- f. Actuator shall have manual over ride facility.

*Damper actuator shall be such that it should close the damper in the event of power failure automatically & open in the same manner in case of power being restored.*

### **2.5.3 CONTROL PANEL**

*The Control panel shall be supplied by damper manufacturer fitted on damper compatible with damper actuators. The control panel shall have at least following features:*

- a. Power on lamps with 230 V/ 24 V Transformer.
- b. Damper close and open indication.
- c. Reset push button.
- d. Push button for manual running of actuator for periodic inspection.
- e. Auxiliary contacts 24V & 230V.
- f. Contact points to receive signal from smoke detector/fire alarm panel.
- g. Additional terminal shall be provided to have signal (audio or visual) in central control room.

*The control panel shall receive 230 V A/C supply & interconnecting wiring between control panel and actuator shall be carried out using fire proof cables.*

*The Contractor shall ensure that all electrical connections are suitably terminated. The HVAC Contractor shall also check continuity of electrical circuit as recommended by the manufacture. Fire damper inspection door will be provided in AC duct to facilitate access to the system.*



## **2.6**      **SUPPLY AIR REGISTERS**

*Supply air registers shall be of approved make and of mild steel construction with individually adjustable bars. Supply air registers shall be double deflection type, with removable key-operated volume control dampers. The outer frame should be made out of 20 gauge and louvers of 24 gauge MS sheet.*

- a. All registers shall be selected in consultation with the Engineer In Charges. Different spaces shall require horizontal or vertical face bars and different width of margin frames.
- b. All registers shall have a soft, continuous rubber gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers shall not be less than 80 percent.
- c. Registers shall be adjustable pattern as such grille bar shall be pivot able to provide pattern with 0 to 100 degree horizontal arc and up to 30 degree deflection up or down. Bars shall hold deflection settings under all conditions of velocity and pressure.
- d. Bars longer than 450 mm shall be reinforced by a setback vertical member.
- e. Registers shall be given a rust inhibiting prime coat and factory applied enamel finish of approved color.

## **2.7 SUPPLY AIR DIFFUSERS**

*Diffusers shall be of approved make and of mild steel construction, square in shape with flush fixed pattern or adjustable flow pattern. Diffusers for different spaces shall be selected in consultation with the Engineer In Charge.*

*All supply air diffusers shall be equipped with removable key-operated volume control dampers. Anti-smudge ring may be required in specific applications. The outer shell and diffusing assembly shall be made out of 18 gauge and 24 gauge MS sheet respectively.*

## **2.8 EXTRUDED ALUMINIUM GRILLES & DIFFUSERS**

### **2.8.1 RECTANGULAR / SQUARE CEILING DIFFUSERS**

*Rectangular /square ceiling diffusers shall be fabricated out of extruded aluminum sections powder coated in color approved by Architects/ Engineer In Charges. The four directional air flow diffuser shall consist of outer ring fixed to duct collar with concealed screws. Foam gasket shall be provided between outer ring and suspended ceiling. The central core shall be clip fixed to the outer ring. Opposed blade volume control damper in extruded aluminum construction shall be fixed to the neck of diffuser. The damper shall be adjusted after removing the central core. The diffuser shall be equipped with anti-smudge ring.*

*In case of grid type false ceiling, the entire diffuser assembly with plenum shall be independently hung from the ceiling through adjustable GI wires and the same shall be connected to the main duct through a flexible round duct.*

### **2.8.2 PLAQUE DIFFUSER**

*The Plaque diffusers shall be constructed out of Extruded Aluminum powder coated sections is designed to integrate with suspended ceiling arrangement preferably grid type.*

*The diffuser shall consist of a rear pan and a removable heavy gauge front flat panel attached to the rear pan through spring loaded locking posts. The flat panel may be removed whenever need arises to facilitate adjustment of the damper for air balancing.*

*The front panel shall be aerodynamic in appearance, rigid and preferably in single piece construction and free from any welding or forming blemishes.*

*The horizontal air discharge pattern shall be 360<sup>0</sup> type. Blank off baffles shall be provided to obtain one, two or three way blow pattern if specifically asked for in the “Schedule of Quantities”.*

*Diffusers shall be provided with following accessories:*

- I. Opposed blade damper
- II. Spiggot to facilitate round duct connection at neck.

*The performance criteria shall be in conformity with relevant ANSI/ASHRAE standards.*

### **2.8.3 SWIRL DIFFUSER**

*The diffuser face shall consist of fixed radially arranged air control blades. The supply air pattern shall permit specifically arranged internal air guidance elements or guide vanes. Such elements are not required for return/extract versions. Due to the rotary swirling motion of the air discharge, induction of room air occurs very quickly, resulting in decay of supply air velocity and temperature differential.*

*In order to stabilize horizontal discharge, all sizes must be mounted flushed with the suspended ceiling. The minimum height between floor & the diffuser face should be 2.6 M or less. The face plate shall be square. The supply air versions shall be supplied with top/side entry spigot with lip seals and Volume Control Damper.*

*The diffuser face shall be fabricated out of 1.2 mm thick galvanized steel sheet, pretreated and powder coated white. The spigot shall also be of 1.2 mm thick galvanized steel sheet & lip seal of soft rubber.*

*The performance criteria shall be in conformity with relevant ANSI/ASHRAE standards.*

### **2.8.4 MULTISLOT LINEAR DIFFUSER**

*Linear ceiling diffuser shall be multi-slot type. The diffuser shall be fabricated out of extruded aluminium sections. Each slot shall be 19mm wide. Each slot shall be equipped with air flow direction control louver mechanically fixed. Integral sliding type hit & miss type volume control damper in extruded aluminium construction shall be provided for each slot for fine control of air flow in supply air portion only. The damper shall be fabricated out of anodized extruded aluminium sections. Other sections of ceiling diffuser shall be powder coated in color & shade approved by the Engineer In Charges/Architects.*

*The linear diffuser shall be fixed in to a plenum chamber with concealed screws. Side end pieces or corner pieces shall be provided if required.*

### **2.8.5 MULTI LOUVERED GRILLES**

*For supply air double louvered grilles in extruded aluminium construction shall be provided with individually adjusted louvers along with volume control damper in extruded aluminium construction. The louvers shall be pivoted in Nylon bushes for smooth operation for return air grilles similar to supply air as described above will be provided but without volume control dampers. These grilles shall be painted as per approved powder coated shade.*

### **2.8.6 LINEAR GRILLES**

*Linear Grilles shall be fabricated out of extruded aluminium sections. Flanges shall be of 1.3mm thick extruded aluminium. Louvers shall be of extruded aluminium sections 3.7mm thick at the front and 2.2 mm at the rear with 15 degree deflection strong enough to withstand site abuse during installation. The sample of grille shall have to be got approved by the Engineer In Charges before delivery. The linear grilles shall be provided with removable/fixed internal core.*

*All sections of linear grille shall be powder coated in color/shade approved by the Architects/Engineer In Charges.*

*The linear grilles shall be fixed into a plenum chamber having GI spacers with concealed screws. End pieces or corner pieces shall be provided as required.*

### **2.9 FRESH AIR ARRANGEMENTS**

*Extruded aluminium construction duly anodized (20 microns and above) fresh air louvers with bird screen and extruded construction dampers shall be provided in the clear openings in the masonry walls of the air handling rooms having at least one external wall. Louvers, damper, pre- filters, ducts and fresh air fan, if required with speed regulator shall be provided as shown on drawings and in schedule of quantities.*

*Fresh air dampers shall be of the interlocking, opposed-blade louver type. Blades shall be made of extruded aluminium construction and shall be rattle-free. Dampers shall be similar to those specified in "Air Distribution". Fresh air fans and fresh air intake shall be as per the schedule of quantities.*

### **2.10 AIR TRANSFER DOOR GRILLE**

*Air transfer grilles in extruded aluminium construction shall be provided at the door of pantry and toilets wherever required. The air transfer grille shall be complete with matching rear flange. The grilles shall be anodized or powder coated in color and shade as approved by the Architects/Engineer In Charges.*

### **2.11 RAIN WATER PROTECTION LOUVERS**

*Louvers shall be manufactured out of extruded aluminium sections powder coated, outer flange 18mm wide & 45mm deep, louvers also of extruded sections of 1.2mm thickness.*

*A suitable rat mesh shall be provided using expanded metal mesh preferably aluminium of 1mm thickness having 12mm diamond shaped openings. Fixing screws shall be cadmium coated. The size of such louvers shall be physically measured after openings are internally plastered, often termed as rough opening.*

*Louvers shall be installed at external building fabric for fresh replenishment or exhaust air.*

## **2.12 PRE-INSULATED FLEXIBLE DUCTS**

### **2.12.1 General:**

*The scope of this section comprises supply, installation, testing and commissioning of flexible ducting conforming to these specification and in accordance with requirements of drawings and schedule of quantities.*

## 2.12.2 Type:

### a. Un-Insulated Flexible ducts

*Wherever required, uninsulated flexible ducts shall be made of double lamination, 0.05 mm thick aluminum foil followed by a layer of fire retardant metalized polyester film permanently bonded to a coated spring steel wire helix. Ducts shall be of “tear and puncture resistant” in construction.*

### b. Insulated Flexible Ducts

*Wherever insulated flexible ducts are incorporated in design, inner core of such an assembly should be made of fiber glass reinforced double layer of metalized polyester film laminate permanently bonded to a coated spring steel wire helix. Blanket of fiber glass insulation exhibiting resistance of R-3.6 (RSI - 0.64 m<sup>2</sup>K/W) having density not less than 16 Kg/CuM and thickness of 25 mm shall be wrapped over the inner core & covered with “tear and puncture” resistant outer jacket cum vapour barrier made out of preferably 0.05 mm thick aluminum foil.*

*The pre-insulated flexible duct shall comply with UL 181, BS 476 part VI & Part VII besides Class ‘1’ followed by Class ‘O’.*

## 2.12.3 Installation:

*Care must be taken to install all the flexible ducts in fully extruded position and bends made with adequate radius as per manufacturer’s recommended practices.*

### a. Hangers and Supports

*The flexible duct must be installed fully extended to produce optimum results. The maximum allowable sag, between any two adjacent suspension points, should not exceed 50 mm per meter.*

*The distance between any two adjacent suspension points may vary from 150 cm to 300 cm, depending upon the type of flexible duct in use.*

*Flexible ducts mounted above suspended ceiling should always be independently supported. Ducts mounted in these locations are susceptible to damage whenever ceiling panels need to be periodically interchanged, unless separately supported.*

b. Bending Radius

*All bends should be made as large as possible and should have a radius of not less than the diameter of the duct in use. This reduces un-favorable pressure losses and is particularly important for metal based products which are more susceptible to stress rupturing. Double bends should be avoided, however if un-avoidable, ensure that each radius is not less than  $R = 2 \times D$ .*

c. Flexible Duct to Conventional Duct Connection

Extra care should be taken when making connection to fixed conventional ducts, etc., and ensure that they do not become too stressed. An additional support is recommended to obviate this potential problem. **Readymade circular galvanized sheet steel spigots of approved makes shall be used to make such connections.**

*Metal based flexible ducts are particularly prone to fracturing due to stress caused as a result of sharp connection.*

*Connections to ceiling illumination “Low Pressure Plenums” should be served in the most direct manner similar to that described for conventional ducts.*

*Too many bends, when connecting to “Low Pressure Plenums” and/or any other type of air supplying component, may result in excessive pressure loss and the generation of noise.*

d. Longer Length Installation

*In the event where extreme length of flexible ducts is to be installed, round duct connectors made of galvanized sheets of at least 30 cm long should be used to connect the duct at every distance of 10 meters. Use metal or galvanized hangers as recommended to support the point where connections are made. Light railing is a good alternative hanging support when using long length of flexible ducts.*

e. Direct Contact with other services

*It should be emphasized that the flexible ducts must not be in direct physical contact with un-insulated heating or hot process pipes. If in the event where such situation cannot be avoided, additional 1” thick insulation should be wrapped around pipes that are in contact with the pre-insulated flexible ducts.*



## 2.13 Sound Attenuators

### Scope

*The scope of this section comprises of supply, installation and testing of rectangular silencers of approved make as shown on the drawings.*

### Material

- a. The outer casing shall be out of min.22 G galvanized steel in accordance with ASHRE (ISI) recommendations for high pressure rectangular duct work. Seams shall be lock formed and mastic filled.
- b. Interior elements of silencers shall be out of min.22 galvanized perforated steel.
- c. Acoustic fill shall be inorganic mineral fibre of density sufficient to obtain specified acoustic performance and shall be packed under 10% compression to eliminate voids due to vibration and setting. Material shall be inert, vermin and moisture proof.
- d. All materials of construction and acoustic fill shall be incombustible as per IS3144.
- e. Air-tight construction shall be provided by use of duct sealing compound at site by the air conditioning contractor.

### Acoustic Performance

*Silencer acoustic ratings shall include insertion loss and self-noise power levels and shall meet or exceed minimum performance.*

### Aerodynamic Performance

*Static pressure drop through silencers shall not exceed those listed in the silencer schedule at the indicated airflows.*

### Transitions

*Where transitions are required to adapt silencer dimensions to connecting duct work, they would be supplied by the installing contractor.*

Minimum Sound Attenuator Performance Requirement

Sound Attenuator Type		Minimum required Octave Band Centre				Acoustic Frequency Rating (Hz)				Face Velocity (MPS)	Pressure Drop (N/SqM)
		63	125	250	500	1K	2K	4K	8K		
900 mm Long	IL dB	4	7	12	19	25	23	17	11	6	50
	SN	47	36	39	37	34	35	33	25		
dB re 1pW for 0.5 SqM face area											
1500 mm Long	IL dB	6	10	18	30	42	34	23	14	6	50
	SN	47	36	39	37	34	35	33	25		
dB re 1pW for 0.5 SqM face area											

**2.14 TESTING AND BALANCING**

*After completion of the installation of the complete air distribution system, all ducts shall be tested for air leaks.*

*Before painting the interiors, air distribution system shall be allowed to run continuously for 48 hours for driving away any dust or foreign material lodged within ducts during installation.*

*The entire air distribution system shall be balanced using approved anemometer. Air quantities at the fan discharge and at various outlets shall be identical to, or less than 5 percent in excess of, those specified and quoted. Leakage in each air distribution system shall be within 3 percent so that supply air volume at each fan shall be identical to, or no greater than 3 percent in excess of, the total air quantity measured at all supply outlets served by the fan. Branch duct adjustments shall be made by volume or splitter dampers. Dampers shall be permanently marked after air balancing is complete so that these can be restored to their correct position if disturbed at any time. Complete air balance report shall be submitted to the Engineer In Charges for scrutiny and approval, and six copies of the approved report shall be provided with completion documents.*

## 4.0 **INSULATION**

4.1 All chilled water piping, chilled water equipment and ductwork shall be insulated in the manner specified here under :

### 4.1.1 **MATERIAL- ALTERNATIVE-1**

*Chilled water piping, condensate drain piping, floor/ceiling/wall and ductwork shall be insulated with closed cell elastomeric Nitrile rubber insulation material of properties as given below :*

AVERAGE PHYSICAL PROPERTIES OF INSULATION MATERIAL						TEST METHOD
Cell structure	Closed cell					--
Density (gm/cm <sup>3</sup> )	(0.04 - 0.07)					--
Thermal Conductivity (W/M.K)	Mean Temp.	-20°C	0° C	20°C	40°C	BS 874, Part 2 1986 DIN 52612
	K. Value	0.034	0.035	0.037	0.039	
Service Temperature Limit	(-40 deg C to 105 deg C)					--
Water Vapour Permeability (μ)	Minimum 7,000					DIN 52615
Water Absorption (% by volume)	1.5% Maximum					--
Ozone Resistance	Should be Excellent					--
Flammability	Class1 followed by Class 0					BS-476 Part 7 & Part 6

### 4.1.2 **MATERIAL- ALTERNATIVE-2**

*Chilled water piping, Condensate drain piping, floor/ceiling/wall ,refrigerant piping and ductwork under this section shall be insulated with closed cell elastomeric EPDM rubber insulation material of properties as given below:*

AVERAGE PHYSICAL PROPERTIES OF INSULATION MATERIAL		TEST METHOD
Cell structure	Closed cell	--
Density (gm/cm <sup>3</sup> )	(0.04 - 0.07)	--
Thermal Conductivity	0.038 W/M.K at 32 deg C average temperature	--
Service Temperature Limit	(-57 deg C to 125 deg C)	--
Water Vapour Permeability (μ)	Minimum 7,000	DIN 52615

AVERAGE PHYSICAL PROPERTIES OF INSULATION MATERIAL		TEST METHOD
Water Absorption (% by weight)	5	ASTM D 1056
Flammability & Smoke density	Class1 followed by Class 0	BS-476 Part 7 & Part 6 UL 94 ASTM E 84 JIS K 6911 AS 1530
CFC Criteria	CFC free	--
Nitrosamine content	Non-existent	US FDA
Microbial Growth resistance	Should discourage growth	UL 181
Effect on Copper and Stainless Steel	Non-Corrosive	DIN 1988
Crack resistance characteristics	Should not develop cracks	Ozone resistance test, ASTM 1149
Heat Stability— Exposure : 93 deg C – 7 days	Not to exceed 6	ASTM C 534

*No insulation shall be applied on pipes until the pipes are satisfactorily tested, as specified in section “PIPING”.*

#### **4.1.3 APPLICATION OF INSULATION**

*Cold insulation on pipes shall be applied as specified below :*

- a. Pipes shall be thoroughly cleaned with brush & linen and rendered free from all foreign matter and grease.
- b. Apply adhesive on the bare surface of pipes.
- c. Closed cell Elastomeric Thermal insulation material preferably in tubing form shall be fixed tightly to the surface. All joints to be sealed properly with vapour barrier compound.

*Condensate drain piping and refrigerant piping shall be insulated in the manner specified above.*

*All valves, fittings, strainers, etc in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and applied generally in the manner specified above, valves bonnets, yokes and spindles shall also be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.*

*Exposed pipe insulation shall be provided with necessary surface treatment as given here under:*

- a. Apply two layers of surface coating as under :
  - i. Apply a coat of composition prepared out of synthetic resin, crystalline silica & ethyl alcohol.
  - ii. Cover the insulated surface with lagging in the form of fire retardant glass fibre cloth, by wrapping it on wet coating.
  - iii. Subsequently, apply a coat of special composition and allow drying.
  - iv. Apply second coating thereafter achieving sufficient mechanical strength.

#### **4.1.4 DUCT THERMAL INSULATION**

*External thermal insulation of ductwork shall be carried out with XLPE/closed cell elastomeric insulation having thermal properties mentioned above and thickness mentioned in schedule of quantities. The contractor shall ensure availability of all accessories as mentioned under appendices for achieving perfect workmanship. Insulation of ducts shall be applied strictly as per the recommendations of manufacturers amended from time to time. However, application procedure shall generally be as given hereunder:*

- a. Apply adhesive on the bare surface after vigorously cleaning the duct using fresh linen.
- b. Closed cell elastomeric insulation material possessing class "O" properties in specified thickness to be fixed tightly to the surface with joints well butted.
- c. Longitudinal as well as vertical joints shall be sealed with the adhesive forming proper bonding.

*Circular ducts shall be insulated internally following procedure as mentioned above. In addition, insulated surface shall be secured with circular GI strips spaced at*

*regular intervals. A sample of insulated duct shall be displayed at site and approval sought prior to application.*

#### **4.1.5 THERMAL INSULATION OF DUCTS EXPOSED TO ATMOSPHERE :**

*Duct insulation shall be applied as follows:*

- a. Apply adhesive on the bare surface after vigorously cleaning the duct using fresh linen.
- b. Closed cell elastomeric insulation material of class "O" properties in specified thickness to be fixed tightly to the surface with joints well butted.
- c. Longitudinal as well as vertical joints shall be sealed with the adhesive forming proper bonding.
- d. Apply two layers of surface coating as under :
  - i. Apply a coat of composition prepared out of synthetic resin, crystalline silica & ethyl alcohol.
  - ii. Cover the insulated surface with lagging in the form of fire retardant glass fibre cloth, by wrapping it on wet coating.
  - iii. Subsequently, apply a coat of special composition and allow drying.
  - iv. Apply second coating thereafter achieving sufficient mechanical strength.

#### **4.1.6 Insulation For Floor/ Walls**

*Following procedure towards application of closed cell elastomeric material of properties as mentioned above for floor, ceiling and partition walls shall be adopted:*

- i. The underside of the roof slab , floor and wall surface to be thoroughly cleaned with wire brush and rendered free from bitumen or any other coating that exists.
- ii. Basic surface preparation using sandpaper.
- iii. Adhesive Pidilite, SR 998 to be applied thereafter, preferably in the evening and be left for overnight.
- iv. Finally next morning insulation to be applied using adhesive with longitudinal joints left open to facilitate inspection. Thereafter, CSE adhesive based tapes shall be

applied on such longitudinal joints.

***Area where insulation is to be carried out shall be barricaded & access shall be blocked.***

#### 4.1.7 Application of Aluminium foil for Exposed Walls

*Following procedure towards application of aluminium foil for walls towards vapour permeation treatment shall be adopted :*

- i. Walls shall be thoroughly cleaned with wire brush and rendered free from any foreign material.
- ii. Basic surface preparation using sand paper.
- iii. A layer of 0.1mm thick aluminium foil to be applied over prepared surface using adhesive. Longitudinal joints shall be sealed with adhesive based aluminium tape.
- iv. Finally gypsum board shall be fixed on the treated surface and epoxy paint may be applied thereafter. (By other agencies).

#### 4.1.8 **THERMAL INSULATION (UNDERDECK)**

*Underdeck thermal insulation of slab exposed to sun shall be carried out with sandwiched XLPE between aluminium air bubbles / closed cell elastomeric insulation having thermal properties mentioned above and thickness mentioned in schedule of quantities. The contractor shall ensure availability of all accessories as mentioned under appendices for achieving perfect workmanship. Insulation shall be applied strictly as per the recommendations of manufacturers amended from time to time. However, application procedure shall generally be as given hereunder:*

- d. Apply adhesive on the bare surface after vigorous cleaning using fresh linen.
- e. Closed cell elastomeric insulation material possessing class "O" properties in specified thickness to be fixed tightly to the surface with joints well butted.
- f. Longitudinal joints shall be sealed with the adhesive forming proper bonding.

#### 4.2 AHU Room Acoustic/Thermallining

##### 4.2.1 Scope

The scope of this section comprises of supply and application of insulation conforming to these Specifications.

#### 4.2.2 Material

Insulation material shall be processed Elastomeric, nitrile rubber, XLPE insulation or other approved equal. Samples of insulation material shall be submitted for approval to the Engineer In Charges prior to procurement. The physical properties of material shall be as given hereunder :

AVERAGE PHYSICAL PROPERTIES OF INSULATION						TEST METHOD
Cell structure	Open cell					--
Density (Kg/CuM )	(140 - 180)					--
Thermal Conductivity(W/mK)	Mean Temp.	-20°C	0° C	20°C	40°C	DIN : EN 12667
	K. Value	0.046	0.047	0.050	0.052	
Service Temperature Limit	(-20 ° C to 105° C)					--
Ozone Resistance	Should be Excellent					--
Flammability	Class1					BS-476 Part 7 -1997

AVERAGE PHYSICAL PROPERTIES OF INSULATION		TEST METHOD
Tensile Strength	190 K Pa	--
Resistance to chemicals	Organic Solvents	Shouldbe Excellent
	Dilute Inorganic acids	Should be good
	Mineral Oil	Should be good
Health aspects	Dust & Fibre free	--
Water Absorption	Non hygroscopic coating	

#### 4.2.3 Application of Insulation

Acoustic lining of ducts wherever specified shall be applied as under :



- a. Clean the surface of AHU room wall to be thoroughly cleaned with wire brush & rendered free from bitumen or any other coating that exists.
- b. Basic surface preparation using sandpaper.
- b. Adhesive to be applied thereafter, preferably in the evening and be left for overnight.
- c. Finally next morning Processed Nitrile rubber foam insulation to be applied & joints shall be sealed properly.

### 4.3 Duct Lining :

#### 4.3.1 Scope

*The scope of this section comprises of supply and application of acoustic insulation conforming to following Specifications.*

#### 4.3.2 Material

*Insulation material shall be processed Elastomeric, nitrile rubber or other approved equal. Samples of insulation material shall be submitted for approval to the Engineer In Charges prior to procurement. The physical properties of material shall be as given hereunder :*

AVERAGE PHYSICAL PROPERTIES OF INSULATION						TEST METHOD
Cell structure	Open cell					--
Density (Kg/CuM )	(140 - 180)					--
Thermal Conductivity(W/mK)	Mean Temp.	-20°C	0° C	20°C	40°C	DIN : EN 12667
	K. Value	0.046	0.047	0.050	0.052	
Service Temperature Limit	(-20 ° C to 105° C)					--
Ozone Resistance	Should be Excellent					--
Flammability	Class1					BS-476 Part 7 -1997
Tensile Strength	190 K Pa					--
Resistance to chemicals	Organic Solvents					Should be Excellent

	Dilute Inorganic acids	Should be good
	Mineral Oil	Should be good
Health aspects	Dust & Fibre free	--
Water Absorption	Non hygroscopic coating	

#### **4.3.3 Application of Insulation**

*Acoustic lining of ducts wherever specified shall be applied as under :*

- a. Clean the internal surface of the duct to make it free from dirt and dust.
- b. Apply adhesive on the the bare surface of duct.
- c. Processed Nitrile rubber foam shall be fixed tightly to the surface, joints sealed properly with tape of **same material**.

#### **4.4 Application of Insulation (For CHW pipes buried under Ground)**

*No insulation shall be applied on pipes until the pipes are satisfactorily tested, as specified in section "PIPING".*

*Chilled water pipes shall be insulated with rigid preformed sections of P quality polyurethane foam of density not less than 40Kg/CuM of the following thickness and as indicated in the Schedule of Quantities.*

Temp. Range (degree C)	PipeDia (mm)	Thickness (mm)
1.1-3.9	12-75	75
	100-300	100
4.4-12.2	12-75	50
	Over 75	75
12.8-15.6	All Sizes	40

*Cold insulation on pipes shall be applied as follows :*

- a. Pipes shall be thoroughly cleaned with wire brush and rendered free from all foreign matter and grease.
- b. One coat of Zinc chromate primer and two coats of CPRX compound shall be applied on the cleaned pipe surface.
- c. "P" quality polyurethane foam rigid sections shall be fixed tightly to the surface. All joints to be sealed properly with CPRX compound.
- d. Two layers of 500 G polythene sheet to be wrapped over the insulation to work as vapour barrier.
- e. 24 gauge x19mm square mesh GI wire netting shall be applied over polythene sheet butting all joints and shall be faced down with 20 gauge GI wire. Finally insulated surface shall be finished with two layers of sand cement plaster of thickness not less than 6mm each. Necessary curing shall be provided for sand cement plaster.
- g. *Finally, a layer of polyester membrane of 3 mm thickness shall be wrapped over the insulated surface towards water proofing treatment. All cross section and longitudinal joints shall be welded by torching process after necessary overlapping.*

*Upon completion of excavation, pipes shall be laid on PCC pedestals placed at regular interval and thereafter welded. A section of 18M or more as required may be pressure tested and held up on tripods with chain pulley block to facilitate insulation.*

## **5.0 ELECTRICAL INSTALLATION**

### **5.1 Scope**

*The scope of this section comprises of fabrication supply, erection, testing and commissioning of electrical control panels, wiring and earthing for all components of the HVAC system.*

### **5.2 General**

*Work shall be carried out in accordance with the Specifications, local rules, Indian Electricity Act 1910 as amended upto date and rules issued thereunder, regulations of the Local Fire Insurance Association and Indian Standard code of practice No. IS : 732- 1963 (revised) including Indian Electricity Rules 1956.*

### **5.3 Wiring System**

*All power wiring shall be carried out with 650/1100 volts grade PVC insulated, aluminum/copper conductor cables as per “Schedule of Quantities”, sized for starting current and continuous running current carrying capacity and by applying proper derating factor.*

### **5.4 Motor Control Centre**

#### **a. Construction Features:**

*Motor Control Centre (MCC) shall comprise of all the switch gears as detailed in bill of quantities and design drawings. All the switch gears including the bus bar chamber on the same board shall be of the same manufacturer for facility of interchangeability. The motor control shall be metal enclosed sheet steel cubicles, indoor type, deadfront, floor mounting type fabricated out of 14 gauge CRCA sheet steel. Removable gland plates shall be 3mm thick sheet. The size of the gland plate shall be sufficient enough to accommodate all cable sizes. The control panel shall be totally enclosed, completely dust and vermin proof. Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. The panel shall be in IP-54 enclosure. All doors and covers shall be fully gasketed with foam rubber and/or rubber strips and shall be lockable. All mild steel sheets used in the construction of control panels shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal. All panels and covers shall be properly fitted square with the frame and holes in the panel correctly*

*positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with hank nuts. Self threading screws shall not be used in the construction of control panels. A base channel of 75mmx40mmx5mm thick shall be provided at the bottom.*

*Knockout holes of appropriate size and member shall be provided in the MCC in conformity with the location of incoming and outgoing cables.*

*Facility shall be provided for the entry of all types of cables from bottom or top of control panel as per site requirements. Panel shall have independent vertical & horizontal Bus Bar alleys & cable alleys accessible from front as well as back of the panel.*

*Bus bar chamber shall be made out of sheet steel of thickness not less than 2mm with detachable covers on all sides. The joints shall be continuous welded. The detachable covers shall be secured to the box with sufficient number of cadmium plated iron screws to ensure dust tightness. Bus bar chamber of size upto 900 mm shall have detachable end cover so that the same can be extended.*

b. Bus Bars:

*Bus bar shall be made out of wrought aluminium alloy or electrolytic copper Grade E91 as the case may be of sufficient cross section so that a current density 100 Amps/Sqcm in case of aluminium and 150Amps/Sqcm in case of copper is not exceeded at nominal rating. The cross section of neutral bus-bar will be the same as that of the phase bus-bar of capacity upto 200Amps. The neutral bus bar should not be less than half the cross section of that of phase bus bar beyond 200Amps. The bus-bars should be suitably insulated with heat-shrinkable PVC sleeving and colour coded. Connections to bus-bars shall be made by the bolting arrangement by the aluminium alloy or the forged brass nuts and bolts, ensuring that the current density of the bus-bars at the point of connection does not exceed permissible limit and there is no heat due to bimetallic contact.*

*Minimum clearances between bus-bar throughout the panel shall be 32mm between phases and 25mm between phase to earth. Danger plate of approved shape and size be provided on each switch board without any extra charge. The bus-bar shall be supported on DMC/SMC and shall be rated for a fault level of 50KA for 1 sec & temperature rise on full load not to exceed 45 C above ambient i.e, total of 85 C.*

**5.5 Selection of components in MCC**

*Contractor shall use only one make of component for ease in maintenance and interchangeability. The rating of other components i.e, contactor, fuse, circuit*

*breaker, overload relay, single phasing preventer etc. shall be as recommended in these specifications.*

#### **5.6 Selection of Cables/Wires**

*The size of cables and wires for individual connection to outgoing MCCB/SFU/Isolator shall be suitably rated. Above 100 Amps. Solid links shall be used.*

*All power wiring shall be carried out with 650/1100 volt grade PVC insulated aluminium/copper conductor cables/wires sized for starting current and continuous rating of motors after applying derating factor as per the "Schedule of Quantities".*

#### **5.7 Cable Compartments**

*Cable compartment of minimum size of 400 x 400 mm or as shown in drawings shall be provided in the boards for termination of all incoming and outgoing cables entering from bottom or top. Adequate supports shall be provided in cable compartment to support cables. All incoming & outgoing switch terminal shall be brought out to the spring loaded terminal blocks in cable compartments and identified accordingly.*

*All the outgoing connections shall be brought on spring loaded (Elmex Type CSLT-1) terminals in the cable-alley. Minimum size of terminals for control and power wiring shall be 2.5 & 10 Sqmm respectively. No cable, however shall be terminated in to the switch/isolator/MCCB/contactors/over load relay, under any circumstances.*

#### **5.8 Meters and Indications**

*All meters shall be housed in a separate compartment or as shown in design drawings and accessible from front only. Lockable doors shall be provided for the metering compartment. All switches, contactors, push buttons, push button stations, indicating lamps shall be distinctly marked with a small description of the service fed.*

#### **5.9 Painting**

*Entire sheet metal works shall undergo seven tank process including passivating, sprayed with a high corrosive resistant primer and baked in oven. The finishing treatment shall be of two coats of synthetic enamel paint of approved colour & shade.*

*Degreasing : Concentration of chemical : 5% - 7% & 40 deg*

*C Derusting : Concentration of chemical : 25%*

*Phosphatising : Concentration of chemical : 3.5% & 40-50 deg C*  
*Passivation : Concentration of chemical : 0.05%-0/1% & 60-70 deg C*

*Two coats of zinc chromate primer should be applied after the above processing before baking in oven.*

*Wherever necessary filler putty is applied to make the surface smooth. Properly rubbed surface is to be given a coat of surface and baked in oven.*

#### **5.10 Testing**

*Motor control centre shall be tested at manufacturer's works. The test certificates shall be got approved before dispatch of MCC to site.*

### **5.11 Instrument Compartment**

*All instrument shall be flush mounted 144 mm square & suitably scaled. Instrument chamber should have sufficient space. Indicating lamps should have minimum 50mm space between them. They shall be accessible for testing and maintenance without any danger of accident and contact with live parts of circuits breaker and bus bar.*

### **5.12 Control Cables and Terminals**

*All control wiring shall be with minimum area of 1.5 Sqmm copper conductor. These shall be ferruled coded and identified at both ends as per IS specifications. A horizontal wire way shall be provided along the length of panel for taking the control wiring from one section to another control wiring when terminated, shall be terminated on the terminal block and identified for the duties to be performed. Each terminal shall be separately identified. Minimum 10% spare terminals shall be provided on every terminal block.*

### **5.13 Other Components**

#### **5.13.1 Moulded Case Circuit Breaker (MCCB)**

*The MCCB (moulded case circuit breaker) shall conform to the latest IEC 947-2 & IEC 947- 3–1989. The Service Short Circuit Breaking Capacity (Ics at 415VAC) should be as specified at the required level.*

*The MCCB shall be Current Limiting type and comprise of Quick Make – Break switching mechanism, preferably Double Break Contact system, arc extinguishing device and the Tripping unit, contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCBs shall be capable of defined Variable overload adjustment. All MCCBs rated 200Amps and above shall have adjustable Magnetic short circuit pick up.*

*The trip command shall over ride all other commands. The MCCB shall employ maintenance free double break contact system to minimize the let thru' energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. The manufacturer shall provide both the discrimination tables and let thru energy curves. The MCCB shall not be restricted to Line/ Load connections.*



*The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to Disconnection as per the IEC947-3 indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection.*

### **5.13.2 Miniature Circuit Breaker (MCB)**

*Miniature Circuit Breaker shall comply with IEC898 – 1996. The Miniature circuit breakers (MCB) shall be quick make and break type for 230 / 415 VAC 50 Hz application with thermal magnetic releases for over current and short circuit protection. The Breaking capacity shall not be less than 10 KA at 415VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Energy Class–3). MCBs shall be classified (B,C,D as per the IEC 898 standards) as per their Tripping characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.*

*The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection . All DP, TP and TPN miniature circuit breakers shall have a common trip bar independent to the external operating handle.*

### **5.13.3 Switch Fuse Units**

- a. High rupturing capacity fuse (HRC Fuse) shall carry ISI mark on it and shall be rated for duty as indicated on the drawing/schedule of Quantities. The rating of HRC fuse shall be as per the rating of motor/equipment. The rating of fuse shall be selected so as to provide discrimination.
  
- a. *The switch fuse units shall be three pole double break action with switched neutral. All switch fuse units shall be provided with the hinged doors duly interlocked with operating mechanism so as to prevent opening of the door when the switch is 'ON' position and also to prevent energizing the switch when the door is not properly secured. All contacts shall be silver plated and alive parts shall be shrouded. High rupturing capacity (HRC) fuse links shall be provided with switch fuse units and shall have rupturing capacity of not less than 31 MVA at 415 volts. All switch fuse units shall be provided with visible indicators to show that they are in 'ON or OFF' position. All switch units shall be of AC-23 category.*

### **5.13.4 Motor Starter**

*The Motor Starter shall be a combination starter consisting of motor protection circuit breaker and suitable contactor for remote starting.*

a. Motor protection circuitbreaker

*The motor protection circuit breaker must comply to the latest IEC 947-4 and the corresponding IS 13947-4. The motor protection circuit breaker should be suitable for AC3 duty at 415V. The motor protection circuit breaker should offer built in coordinated overload and short circuit protection. The motor protection circuit breaker should have built in single phase / phase loss preventor. The motor protection circuit breaker should offer separate ON/OFF indication and Fault signal contacts which should be wired onto the panel for indication. The motor protection circuit breaker should offer Type 2 coordination along with the contactor.*

b. Contactors

*The contactor should be suitable for AC3 duty at 415V and should comply to the latest IEC 947-4 and the corresponding IS 13947-4. The contactor should have minimum 10xIE rated making/breaking capacity as per the latest standard. The same should be suitable for Type 2 coordination along with motor protection circuit breaker. The contactor should have Class H insulation for the coil to prevent heating and to facilitate frequent start/stop function without heating.*

5.13.5 Earth Leakage CB/ Residual Current CB

*The ELCB/RCCB shall comply with IEC 1008. The ELCB/RCCB shall current operated independent of the line voltage. ELCB/RCCB shall work on the principle of core balance transformer. The ELCB / RCCB shall be rated for current sensitivity of a Min of 30mA and a Max of 300mA at 240/415VAC. The terminals shall be protected against finger contact to IP20 degree of protection. The ELCB / RCCB shall have a minimum of 20,000 electrical operations.*

Testing Provision for the Earth Leakage Circuit Breaker

*A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB and the operating handle shall move to the "OFF" position.*

5.13.6 Air Circuit Breaker (ACB) :

*The ACB shall conform to IEC 947-2-1989 & IS 13947 (Part –2). The Service Short Circuit Breaking Capacity shall be as specified and equal to the Short circuit Withstand Values. The ACB shall be provided for controlling the incoming supply feeder or as required and specified in schedule. Shall be available in 3 or 4 pole with modular construction, fixed or draw out, manually or electrically operated versions as specified. ACB shall be capable of providing short circuit, overload and earth fault protection (in absolute values ) if required, through microprocessor based control unit sensing the true RMS values to ensure accurate measurement meeting the EMI/ EMC requirements as per the standard.*

*The breaker should have 3 distinct positions – SERVICE / TEST / ISOLATED within the cubicle. It should be possible to withdraw the breaker for testing with the door closed. Safety interlock must be provided to prevent the ACB from falling out in a fully withdrawn position. The ACB shall be provided with a door interlock. The contacts should be copper and silver plated only with a feature of contact wear inspection indicating the life of the contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and inaccessibility to live parts.*

*All electrical closing of breaker should be with Electrical motor wound stored energy spring closing mechanism with Mechanical indicator to provide. ON/ OFF status of ACB.*

*For all ACBs the Operating handle should be provided for charging the spring in continuous action. The spring shall be released with ON/ OFF push button command in one operation at the correct speed independent of operator speed. A direct mechanical coupling should indicate the ACB in ON or OFF position thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. One set of NO / NC potential free contacts to be provided for operation on Building Management System. All accessories like shunt, under voltage motorized mechanism etc shall be front mounted, requiring no adjustments and can be fitted at site.*

*The manufacturer shall provide details of opening time and alvaniz with temperature to ensure discrimination and proper selection for feeders protection. All ACBs of 4000 A and above shall be a single ACB and Tandom operated will not be acceptable.*

#### **5.13.7 SAFETY FEATURES:**

1. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
2. It should not be possible to interchange two circuit breakers of two different

- thermal ratings.
3. There should be a provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism.
  4. Earthing bolts must be provided on the cradle or body of fixed ACB. ArcChute covers should be provided wherever necessary.
  5. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, voltmeter and ammeter of size not less than 96mm x 96mm, selector switches, fuses for potential circuit and current transformers.
  6. It should be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

#### 5.13.8 PROTECTIONS

1. The Electro magnetic and thermal release or Microprocessor based unit should be provided on circuit breaker for short circuit , over current and earth fault protection with adjustable settings.
2. Specific LED indications should be provided for over current and earth fault operation.
3. Relays should be CT operated through shunt trip for short circuit and earth fault protection.
4. Under voltage relays should be provided.
5. Minimum 6 NO and 6 NC auxiliary contacts shall be provided on each breaker. The contacts shall be rated 5 Amps.
6. Rated insulation voltage is 1000 volts AC.

#### 5.13.9 Push Button Stations

*Push button stations shall be provided for manual Start & Stop of equipment. Push button shall have ON & OFF indicating lamp in red and green colour. Push button shall be fabricated in 16 gauge sheet steel.*

*These station shall be factory fabricated. ON & OFF operations shall be carried out from front without opening the door. One set of NO & NC contact shall be provided in push button station as spare.*

#### 5.13.10 Toggle Switch

*The toggle switch shall be of minimum 5 Amps rating.*

#### 5.13.11 Thermal Overload

*The relay shall be factory calibrated, sealed and suitable for an ambient temperature at site or 50 deg C whichever is higher.*

*It should provide reliable and accurate protection against overload, single phasing and locked rotor conditions. Relays are to be provided with :*

- (a) Trip alarm contact
- (b) Trip lever for testing
- I Auto reset facility

*Rated insulation voltage shall be 660 volts AC.*

#### **5.14 Instruments**

a. General:

*The specifications hereinafter laid down shall cover all the meters and instruments.*

b. Instrument Transformers

(i). Current Transformers

*Current transformers shall be in conformity with IS : 2705 (Part I, II, III & IV) in all respects. All current transformers used for medium voltage applications shall be rated for 1 KV. However, the rated secondary current shall be 5 A unless otherwise specified. The acceptable minimum class of various applications shall be as given below :*

*Measuring : Class 0.5 to 1*

*Protection : Class 10 p*

*Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 35 MVA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identifications of poles. Current transformers shall be provided with earthing terminals, for earthing chassis frame work and fixed part of the metal casing (If any). Each CT shall be provided with rating plate indicating the following :*

- i. Name and make
- ii. Serial Number
- iii. Transformation Ratio
- iv. Rated Burden
- v. Rated Voltage
- vi. Accuracy Class

*Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat & clean manner.*

c. Potential Transformers

*Potential transformers shall be provided if specifically called for potential transformers shall comply with the requirements of IS: (Part I, II, III) in all respects.*

d. Measuring Instruments

i. General

*Direct reading electrical instruments shall be in conformity with IEC-51, BS:89 or IS :1248. The accuracy of direct reading shall be 1.0 for voltmeters and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The meters shall be suitable for continuous operation between -10 deg C and +50 deg C. All meters shall be of flush mounting type with square pattern. The meter shall be enclosed in a dust tight housing . The meters shall be provided with white dials and black scale markings. The pointer shall be black in colour and shall have zero position adjustment device which could be operated from outside.*

i. Ammeters

*Ammeters shall be of moving-iron type. The moving part assembly shall be with jewel bearings. The jewel bearing shall be mounted on a spring to prevent damage to pivot due to vibrations and shocks. The ammeters shall be manufactured and calibrated as per the latest edition of IS: 1248 or BS:89. Ammeters shall be instrument transformer operated, and shall be suitable for 5 A secondary.*

*Upto 30 Amps the ammeter shall be direct operated without current transformer on one phase only. Beyond 30 Amps the ammeter shall be CT operated with selector switch.*

iii. Voltmeters

*Voltmeters shall be of moving-iron type. The range for 400 volts, 3 phase voltmeters shall be 0 to 500 volts. The voltmeter shall be provided with protection fuse of suitable capacity.*

**5.15 Earthing**

a. General

*All non-current carrying metal parts of the electrical installation shall be earthed as per IS-3043. All metal conduits, trunking, cable sheathes, switchgear, distribution boards and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to control panel. Earthing shall meet the requirements of IER 1956.*

b. Earthing Conductor

*All earthing conductors shall be of high conductivity copper as specified and shall be protected against mechanical damage and corrosion. The size of the earth conductor shall not be less than half of the largest size of the current carrying conductor. The connection of the earth continuity conductor of earth and earth electrodes shall be strong and sound and shall be rigidly fixed to the walls, cable trenches, cable trays or conduits and cables by using suitable clamps made of non ferrous metals. Incoming power supply along with earthing upto MCC/AHU control panel shall be provided by other agency. The panel shall be earthed to building main earthing. The motor shall be double earthed to the panel.*

*The earthing shall be done with wires/flats under:*

S.No.	Equipment	Size of Earth Wire/Strip	
		GI	Copper
01.	Motors Upto 5 HP	2 Nos 8 SWG	2 Nos. 14 SWG
02.	Motors Upto 15 Hp	2 Nos 8 SWG	2 Nos 12 SWG
03.	Motors Upto 30 HP	2 Nos 4 SWG	2 Nos. 8 SWG
04.	Motors Upto 50 HP	2 Nos 25x6mm	2 Nos. 4 SWG
<i>Flat</i>			
05.	Motors above 50 HP	2 Nos 32x6mm	2 Nos. 25x3mm
<i>Flat.</i>			
<i>Flat.</i>	<i>Flat.</i>		

*AHU electrical panel shall generally be wall mounted type. Above stated specifications shall also stand good where applicable. The AHU motor shall be double earthed with two independent earth conductors as per the Indian Electricity Rules & Regulations-1956.*

#### **5.16 Medium Voltage Cable**

a. Type

*Medium voltage cables shall be aluminium/copper conductor, PVC insulated, PVC sheathed and steel wire armored or steel tape armored construction.*

b. Rating

*The cable shall be rated a voltage of 660/1100 volts.*

c. Construction

*The conductors shall be made of electrical purity aluminium 3/4 or H temper/copper. The conductor shall be insulated with high quality PVC base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of unvulcanized compound.*

*Armouring shall be applied over the inner sheath of bedding. Over the armouring a tough outer sheath of PVC sheathing shall be extruded. The armouring shall be of single layer, alvanized steel round wire or flat strip. Wire armour should be used for cable dia over inner sheath upto 13mm and strip armour to be used for higher dia.*

*The outer sheath shall bear the manufacturer's name and trade mark at every meter length.*

d. Core Identification

*Cores shall be provided with the following colour scheme of PVC insulation: Core 1 : Red/Black/Yellow/Blue*

*Core 2 : Red & Black*

*Core 3 : Red, Yellow & Blue*

*Core 4 : Red, Yellow, Blue & Black*



e. Current Rating

*The current ratings shall be based on the following conditions :*

- i. Maximum conductor temperature : 70 deg C
- ii. Ambient Air temperature : 43 deg C
- iii. Ground temperature : 30 deg C
- iv. Depth of laying : 75 CM

f. Short Circuit Rating

*Short circuit ratings for the cables shall be as specified in IS: 1554-Part I.*

g. Selection of Cables

*The cables shall be suitable for effectively earthed A/C system 415 volts, 3 Phase 50 Hz.*

*Cables have been selected considering the conditions of the maximum connected load, switch rating ambient temperature, grouping of cables and the allowable voltage drop. However, the contactor shall recheck the sizes before the cables are ordered and brought to site. Discrepancy if any, shall be brought to the notice of Engineer In Charge.*

h. Laying of Cables

*For laying of cables along building steel structure and technological structures the cables shall be taken by clamping with MS saddles screwed to the MS flat welded to the structure. MS saddles and flats are to be galvanized after fabrication so that there is no rusting during maintenance period.*

*For laying cables along concrete walls, ceiling etc . The cables shall be taken by clamping with MS saddles screws to the MS flat welded on to the inserts. Where inserts are not available the saddles shall be directly fixed in the wall using rowl steel plugs of sufficient capacity and MS flat spacers of minimum 2mm thick.*

*The MS saddles shall be spaced at an interval, not more than 500mm both for horizontal and vertical runs. However, at the bends, it shall be spaced within 300mm and where terminating to the equipment/junction box the cable shall be clamped immediately before such terminations. In the area prevailing with corrosive atmosphere, PVC saddles instead of MS saddles shall be provided.*

*Underground cables shall be laid not less than 750mm below ground. The width of the trench shall be 300mm minimum for single cable. For additional cables additional width of 150mm for each cable is to be added. The sand should be spread in trench as under.*

*The cushion of sand to be provided below and above the cable joint boxes etc must not be less than 80mm i.e, total depth of sand shall be 160mm minimum. The sand should be spread in trench as under.*

- i. After laying the cable in trench 80mm of sand should be put over the cable. The cable should then be lifted and placed over the sand bed and the balance 80mm of sand put over it.
- ii. Where cable is laid in rocky situation extra thick cushioning of sand as may be decided by site in charges shall have to be done without any extra cost.

*Filling of trenches shall be done after the sand cushioning and laying of tiles/bricks are carried out to the satisfaction of the engineer.*

## **5.17 Cable Trays**

- i. Trays shall have suitable strength and rigidity to provide adequate support for all cables.
- ii. Shall not have sharp edges, burrs or projections injurious to cable insulation.
- iii. Shall be adequately protected against corrosion.
- iv. Shall include fittings factory fabricated or other suitable means for change of direction and elevation in run.

### **5.17.1 Installation of Trays**

*Trays shall be installed as complete system supported properly and rigidly from the building structure.*

*Each run of cable tray shall be completed before the installation of cables.*

*Cable trays shall be accessible.*

*Non combustible solid barriers shall be used for segregating the cables of different systems on the same cable tray. Cable trays shall be grounded by 2 Nos earth strips. Trays shall not be used as equipment grounding conductor.*

**5.18 Testing**

*a. Cables shall be tested as per the requirements of IS 1554. The tests shall be incorporate routine test and acceptance tests. Type test certificate shall be furnished whenever demanded.*

*B Tests shall be carried out at site and submitted to project authorities.*

**5.19 Cable Identification Tag**

*Suitable cable identification tag shall be placed along the route of cable at every 10 meters and bends. The tags shall be of size 150mmx100mmx2mm aluminium sheet. It shall be punched with similar details as given below.*

<i>Cable from</i>	<i>MCC or AHP-1</i>
<i>Cable to</i>	<i>CDWP-1 or CT-1</i>
<i>Size of cable</i>	<i>2 Nos 3Cx 6 Sqmm.</i>

**5.20 Drawings**

*Shop drawing for MCC/control panels and wiring of equipment showing the route of cables shall be got approved by the Engineer In Charges before starting the fabrication of panel and starting the work.*

**6.0 AUTOMATIC CONTROLS AND INSTRUMENTS**

**a. Scope**

*The scope of this section comprises of the supply, erection, testing and commissioning of automatic controls and instruments conforming to these specifications and in accordance with the drawings and schedule of quantities.*

**b. Type**

*All automatic controls and instruments shall be of approved make as described in the various sections of these specifications.*

## **6.1 Automatic Controls :**

*Automatic controls required for various types of machines have been described in the various sections of these specifications and shown on the drawings. The individual safety controls and selected automatic controls, may be installed within the machines by the manufacturers before shipment. However, the following automatic controls, if not already installed on the machines, may be installed at site by the Contractor, as indicated in schedule of quantities. Sleeper/ Rotary/ Ball Valves shall be not acceptable. Both valve & actuators should be of same make. Characteristics of valves shall be of equal percentage type.*

### **a. Automatically balanced combination valves for air handling & fan coil units.**

*Valve shall be 2 way combined valve of PN 16 rating for flow limitation, controlling flow & Controlling Differential Pressure. The features shall facilitate dynamic balancing and water flow modulation at variable loads.*

*Valve should be of linear control characteristics and should be of pressure independent self balancing type.*

Valve should be equipped with **electronic modulating actuator** which can accept either of “**4-20 mAmps / 0-10 V DC**” signals. Operating voltage for actuator shall be 24 V AC. Alternatively, Valve shall be equipped with **electronic on/off actuator** with 230V AC power supply for fan coil installation.

*Differential Pressure controller should ensure 100% valve authority on all part loads.*

*Actuator shall be able to work against maximum closing pressure of 6 bar.*

*Measuring nipples should be provided to measure/verify actual pressure drop at site in order to optimize Pump head.*

### **b. Flow Switches**

*Flow Switches shall be provided in condenser water outlet and chilled water outlet at the water chilling machines, and at the water cooled condensing units as shown on drawings and as indicated in schedule of quantities. Flow switch shall prevent the compressor from starting unless the water flow is established in water lines.*

c. Thermostats

*Thermostats shall be fixed differential type as specified having sensing element located in the return air stream. All thermostats shall be supplied with the standard mounting boxes, as recommended by the manufacturer. The profile, mounting arrangement and exact location of the thermostats shall be as approved at site.*

- i) Thermostat for air conditioning application for AHUs shall be Honeywell with two stage temperature control model T678A having a range of 0/100 degree F. All AHUs shall be provided with two speed motor. The motor speeds shall be controlled by 2 stage thermostat upon sensing the return air temperature.
- ii) Snap-acting fixed-differential type thermostat for air conditioning applications for actuating the three-way diverting valve at each fan coil unit, as shown on drawings and as indicated in schedule of quantities.

*Thermostat shall be similar to Honeywell model T694A , T4039, or T6060 A heating/cooling thermostat, for range 56-84 degree F, differential 3 degree F, with OFF-HI-LO fan switch, temperature adjustment settings, switching off must break fan circuit .*

- iii) Snap-acting fixed differential heating thermostat for electric winter heating and reheat applications for putting on/off power supply to electric heating or reheat coils in air handling units as shown on drawings. Thermostats shall be similar to Honeywell model T451A, two stage thermostat or equivalent model.
- iv) Safety thermostat for electric winter heating and reheat application for cutting off power supply to strip heaters in case air flow across strip heater is not established. Thermostat shall be similar to Varma-Trafag model S95R, or approved equal.

f. Airstat

*Airstat may provided, as shown on drawings and included in schedule of quantities, within air handling unit containing electric strip heaters or reheat coils to prevent heaters from energizing unless the air flow is established.*

## 6.2 Instruments :

*Instruments required for different types of machines have been described in the various sections of these specifications and shown on the drawings. Following instruments may be provided in accordance with the specific requirements.*

### a. Thermometers

*Thermometers shall be V-form industrial type with range of scales as 32-120 degree F (0-50 degree C) for cooling applications of cooling only, and 32-212 degree F (0-100 degree C) for heating applications duly calibrated. Body shall be of aluminium alloy, anodized gold coloured surface against aggressive vapours. The casing shall be adjustable type to take any reading from the front. The glass capillary shall be triangular in shape with blue mercury filled in glass for better visibility. Graduation of scale shall be 1 degree in both readings. Thermometer shall be suitable for 1/2 FPT connections. Thermometers for chilled water pipe line shall be provided with long brass stem to facilitate ease in removal without damaging the insulation. MS socket to be welded on pipes shall also be provided with the thermometer.*

*Thermometers shall be provided at the following locations and as indicated on the drawings :*

- a) On supply and return of chillers, condensers and hot water generators.
- b) On supply and return at air handling units.
- c) On discharge of CHW and CDW pumps.

### b. Pressure Gauges

*Pressure Gauges shall be Fiebig or approved equal, installed on suction and discharge ends of pumps, chilled water supply and return at air handling units, inlet and outlet of chillers and condensers, as required. Gauges to be installed at suction end of pumps shall be compound type with 150mm dia having a range, 75cm-10Kg/Sqcm (30"- 150 psi) mercury vacuum and pressure. Discharge sides gauges at pumps and at all other locations shall be 150mm dia having a range, 0- 10 Kg/Sqcm (0-150 psi) pressure. Gauges shall be connected to the pipes by 6mm diameter copper tubing through 6mm dia. Shut-off-cocks, required for gauge protection during testing.*

### c. Room Thermometers

*Room thermometers shall be Taylor or approved equal, dial type, wall-hung temperature indicators, of appropriate range for cold stores and deep freezers, in accordance with the drawings and schedule of quantities.*

d. Electronic Thermometers

*Electronic Thermometers shall be of approved make electronic operated Digital Temperature Indicator in accordance with the drawing and as indicated in the schedule of quantities. The display shall be 3-5 digit liquid Crystal Display. The thermometer shall consist of fully solid state integrated circuits. The thermometer shall have front LED 'ON' indication and automatic low battery indication. The resolution shall be 0-1 degree centigrade. Thermometer shall be complete with suitable electronic sensor to accurately sense the temperature with sensor housed in suitable airwell/ thermowell for air temperature/water temperature measurement. The thermometer shall be suitable for operation on 9 V DC/230 V AC. The display unit shall be housed in attractive sheet metal cabinet with prominent display of conversion charts of deg F & C on front plate. Thermometer shall be complete with separable socket type interconnecting cables of 2m length suitable for installation within a radius of 2m of the thermowell or air sensing point. Thermometers may be installed at chilled water supply and return at air handling units, supply and return at chillers and condensers, hot water supply and return at hot water heat exchangers as shown on the drawings. Range of scales shall be 30 degree F- 120 degree F (0-50 degree C) for cooling application, and 30 degree - 212 degree F (0-100 degree C) for heating applications.*

**6.3 Calibration and Testing:**

*All automatic controls and instruments shall be factory calibrated and provided with necessary instructions for site calibration and testing. Various items of the same type shall be completely interchangeable and their accuracy shall be guaranteed by the manufacturer. All automatic controls and instruments shall be tested at site for accuracy and reliability before commissioning the installation.*

# GENERAL SPECIFICATION FOR CIVIL WORKS

1. Except for the items, for which particular specifications are given or where it is specifically mentioned otherwise in the description of items in the schedule of quantities the work shall generally be carried out in accordance with the "CPWD specifications 2009 Vol. 1 and Vol. 2 (with upto date corrections slips). (Hereinafter to be referred to as CPWD specifications) and instructions of Engineer-in-Charge. Wherever CPWD specifications are silent the latest IS codes/specification shall be followed.
2. The order of preference in case of any discrepancy as indicated in condition No. 8.1 under "Conditions of Contract" give in standard CPWD contract form may be read as the following:
  - i) Nomenclature of items as per schedule of quantities.
  - ii) Particular specification and special condition, if any.
  - iii) CPWD specifications.
  - iv) Architectural Drawings
  - v) Indian standard specifications of B.I.S.
  - vi) Sound Engineering Practice

A reference made to any Indian Standard specification in these documents, shall imply to the latest version of that standard. Including such revision/amendments as issued by the bureau of Indian standard upto last date of receipt of tenders. The contractor shall keep at his own cost all such publications of relevant Indian standard applicable to the work at site.
3. The proposed building is a prestigious project and quality of work is paramount importance. Contractor shall have to engage well experienced skilled labour and deploy modern T&P and other equipment to execute the work. Many items like stone masonry & stone cladding works, stone flooring, structural glazing, PVDF coating aluminium composite panel and other specialised flooring work, Wood work will specially require engagement of skilled workers having experience particularly in execution of such items.
4. Samples of all materials and fittings to be used in the work in respect of brand manufacturer and quality shall be got approved from the Engineer-in-Charge, well in advance of actual execution and shall be preserved till the completion of the work. Articles bearing BIS certifications mark shall only be used unless no manufacturer has got BIS 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.
5. The rates for all items of work shall unless clearly specialised otherwise include cost of all labour, material tools and plants and other inputs involved in the execution of the item.
6. The contractor (s) shall quote all inclusive rates against the items in the schedule of quantities and nothing extra shall be payable for any of the conditions and specifications mentioned. In the tender documents unless specifically specified otherwise.



7. Unless otherwise specified in the schedule of quantities the rates for all items shall be considered as inclusive of pumping/baling out water, if necessary, for which no extra payment shall be made. Those conditions shall be considered to include water from any source such as inflow of flood, surface and sub-soil water etc. and shall apply to the execution in any season.
8. The rate for all items in which the use of cement is involved is inclusive of charges for curing.
9. The foundation trenches shall be kept free from water while works below ground level are in progress.
10. The work shall be executed and measured as per metric dimensions given in the schedule of quantities, drawings etc. (FPS units wherever indicated are for guidelines only).

**APPENDIX - I**

**GUARANTEE PROFORMA FOR HVAC INSTALLATION**

1. The Contractor shall furnish the following guarantee:  
*“ We warrant that everything supplied by us including all components fitted into the equipment manufactured by others also, shall be in all respects free from all defects and faults in material, workmanship and manufacture and shall be of the highest grade and quality to acceptable standards for all materials of the type ordered and shall be in full conformity with all the specifications, drawings or samples if any and we shall be fully responsible for its efficient performance. This guarantee shall survive inspection for acceptance and payment for the equipment and installation, but shall expire (except in respect of the complaints notified to us) 12 months from the date of issue of completion certificate by the Architect/Engineer In Charges. The complaints, workmanship, manufacturer or performance of any of the equipment or part/parts thereof shall be notified by fax within 12 months from the date of issue of such completion certificate”.*
  
2. The Contractor shall replace such of these parts which require replacement under these conditions free of cost, charge and expenses to the purchaser. In addition, the Contractor shall be responsible for a period of 12 months from the date of issue of completion certificate for any defect that may develop or appear under the conditions provided by the Contractor or use thereof arising from faulty material design or workmanship in the equivalent or any part thereof or faulty installation of the equipment by the Contractor but not otherwise and shall correct such defects within one week from the date of notification at his own cost when called upon to do so by the purchaser who shall state in writing in what respect the portion is faulty.
  
3. Any faulty component replaced or renewed under the clause shall also be guaranteed for a period of six months from the date of such replacement or removal of until the end of the above mentioned period whichever is later.
  
4. If defects are not rectified within a reasonable time as mentioned in the written notice, the Architect/Engineer In Charges/Owner shall proceed to do so at the Contractor’s risk and cost without prejudice to any other right thereof.

**SIGNATURE AND STAMP OF THE CONTRACTOR**

**DATE :**

**APPENDIX-II**

***HVAC TENDER DRAWINGS***

<b>DRG. No.</b>	<b>DRAWING TITLE</b>
HVAC-01	HVAC LAYOUT- FIFTH FLOOR PLAN
HVAC-02	HVAC LAYOUT- SIXTH FLOOR PLAN
HVAC-03	HVAC LAYOUT- SEVENTH FLOOR PLAN
HVAC-04	HVAC LAYOUT- EIGHTH FLOOR PLAN
HVAC-05	HVAC LAYOUT- SLD OF VRF CURCUIT
HVAC-06	HVAC LAYOUT- VRF ODU PLACEMENT

## APPENDIX-III

### *INTERNATIONAL CODES AND STANDARDS*

*Apart from the specific equipment standards and specifications, the following broad certifying agency / standards will be considered while designing the system :*

- 1.1 ASHRAE – American Society for Heating, Refrigerating and Air-conditioning Engineers.
- 1.2 SMACNA – Sheet Metal and Air Conditioning Contractors National Association or Indian Standards –1982 Edition or IS277/655 Standards.
- 1.3 UL - Underwriter’s Laboratory ,USA.
- 1.4 AMCA - Air Movement & Control Association, International.
- 1.5 AHRI - Air-conditioning Heating & Refrigeration Institute
- 1.6 ANSI - American National Standards Institute
- 1.7 CSA - Canadian Standards Association
- 1.8 ISO - International Standards Organization
- 1.9 IEC - International Electrochemical Commission
- 1.10 EUROVENT - European Certification Program
- 1.11 UL - Underwriter’s Laboratory ,USA.
- 1.12 SMACNA – Sheet Metal and Air Conditioning Contractors National Association or Indian Standards –1982 Edition or IS277/655 Standards.
- 1.13 ASHRAE – American Society for Heating, Refrigerating and Air-conditioning Engineers–ASHRAE62.1-2010 Ventilation for Acceptable Indoor Air Quality.
- 1.14 AMCA - Air Movement & Control Association, International.

**APPENDIX-IV**

**LIST OF BUREAU OF INDIAN STANDARDS CODES**

<i>IS : 277-1992</i>	<i>Galvanized steel sheet (Plain &amp; corrugated) wire for fencing.</i>
<i>IS : 554-1985 (Reaffirmed 1996)</i>	<i>Dimensions for pipe threads where pressure tight joints are required on the threads.</i>
<i>IS : 655-1963 (Reaffirmed 1991)</i>	<i>Metal air ducts.</i>
<i>IS : 694-1990 (Reaffirmed 1994)</i>	<i>PVC insulated (HD) electric cables for working voltage upto and including 1100 volts.</i>
<i>IS : 732 - 1989</i>	<i>Code of practice for electrical wiring.</i>
<i>IS : 780-1984</i>	<i>Sluice valves for water works purposes.</i>
<i>IS : 822-1970 (Reaffirmed 1991)</i>	<i>Code of procedure for inspection of welds.</i>
<i>IS : 1239 (Part - I) - 1990</i>	<i>Mild steel tube</i>
<i>IS : 1239 (Part - II) - 1992</i>	<i>Mild steel Tubular and other wrought steel pipe fittings.</i>
<i>IS : 1255 – 1983</i>	<i>Code of Practice for installation and maintenance of Power Cables upto and including 33 KV rating (Second Revision)</i>

<i>IS : 1554 - 1988 (Part-I)</i>	<i>PVC insulated ( Heavy Duty) electric cables for working voltages upto and including 1100 volts.</i>
<i>IS : 1897-1983(Reaffirmed 1991)</i>	<i>Copper bus bar / strip for electrical Purposes</i>
<i>IS : 2379 - 1990</i>	<i>Color code for the identification of pipelines.</i>
<i>IS : 2551 - 1982</i>	<i>Danger notice plate</i>
<i>IS : 3043 – 1987</i>	<i>Code of practice for earthing.</i>
<i>IS : 3103 – 1975 (Reaffirmed 1999)</i>	<i>Code of practice for Industrial Ventilation</i>
<i>IS : 3837 – 1976 (Reaffirmed 1990)</i>	Accessories for rigid steel conduit for electrical wiring.
<i>IS : 4736 – 1986 (Reaffirmed 1998)</i>	Hot-dip zinc coatings on steel tubes.
<i>IS : 4894 - 1987</i>	Centrifugal Fan.
<i>IS : 5133 -1969 (Part-I) (Reaffirmed 1990)</i>	Boxes for the enclosure of electrical accessories.
<i>IS : 5312 (Part-I) -1984 (Reaffirmed 1990)</i>	Swing-check type reflux Non return valves for water works
<i>IS : 5424 – 1989 (Reaffirmed 1994)</i>	Rubber mats for electrical purposes.
<i>IS : 5578 &amp; 11353-1985</i>	Marking and identification of conductors
<i>IS : 6392 - 1971(Reaffirmed 1988)</i>	Steel pipe flanges.
<i>IS : 8623 – 1993</i>	Low voltage switchgear and control gear Assemblies (Requirement for type / partly type tested assemblies)

IS : 8623 - 1993	Bus Bar trunking system(Part - II)
IS : 8828 - 1996	Circuit Breakers for over current Protection For house hold and similar installation.
IS : 9537 - 1981(Part II)	Rigid Steel Conduits for electrical wiring
IS : 10810 - 1988	Methods of test for cables.
IS : 13947-1993 (Part-I)	General rules for low voltage switch gears and control gears.
IS : 13947-1993 (Part-II) <i>IEC 947 – 2</i>	Circuit Breakers
<i>IS : 13947-1993 (Part-III)</i>	<i>Switches, dis connectors and fuse for low voltage switch gear and control gear.</i>
<i>IS : 13947-1993 (Part-IV)</i>	<i>Low voltage switch gear and control Gear for contactors and motor starters</i>
<i>IS : 13947–1993 (Part-V)</i>	<i>Control Circuit Devices.</i>
<i>IEC</i>	<i>Relevant Sections.</i>
<i>NBC</i>	<i>National Building Code</i>
<i>ISHRAE</i>	<i>Indian Society for Heating, Refrigerating and Air-conditioning Engineers – ISHRAE1997 Edition.</i>

<b>APPENDIX-V</b>
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***I.S. SAFETY CODES***

- |  |  |
|--|--|
| IS : 659 – 1964 (Reaffirmed 1991)                | Safety Code for Air Conditioning.  |
| IS : 660 – 1963 (Reaffirmed 1991)                | Safety code for Mechanical Refrigeration.  |
| IS : 3016  | Code of Practice for Fire Precautions in Welding and Cutting operations.                                       |
| IS : 818   | Code of practice for Safety and Health Requirements in Electrical & Gas <i>Welding and cutting operations.</i> |
| <i>IS : 5216–1982 (Part-I) (Reaffirmed 1990)</i> | <i>Guide for safety procedure and es in electrical work.</i>   |
| <i>IS : 3696</i>                                 | <i>Safety Code for Scaffolds and Ladders.</i>  |



## ***PROFORMA FOR SCHEDULE OF TECHNICAL PARTICULARS***

### ***Air cooled Variable Refrigerant Flow System***

#### **Outdoor Units**

- a. Make and model
- b. HP of OutdoorUnit
- c. Capacity in TR(Nominal)
- d. Quantity
- e. Type
- e. *Permissible length of refrigerant piping from ODU to farthest IDU.*
- g. Type of compressor
- h. No. of compressors  
(Each Outdoorunit)
- i. No.of inverter driven compressors  
( *Each Outdoor unit*)
- j. Air entering temp. condenser  
in degC
- k. Dimension of ODU in mm  
(H x W x D )
- l. Are bigger ODUs, above 16 HP, provided with 2 separate inverter compressors for proper duty cycling and higher reliability

as specified.

- m. Confirm whether dedicated Intelligent touch controller with colored graphic LED display provided to act as BAS for VRF system.
- n. Confirm whether inverter driven scroll compressor is DC inverter? Also provide following information :

*External static pressure available in ODU.*

*Type of anticorrosion treatment on fins of ODU .*

*Type of Heat exchanger in ODU*

*Set up availability for Night time db relaxation*

*Confirm availability of features for reduction in fan noise and pressure loss on ODU*

*Is it possible to incorporate automatic address setting of each IDU & ODU ? Otherwise specify alternate function available.*

**Double Skin Air Handling Units**

- a. Manufacturer
- b. Model
- c. Type of Unit
- d. Overall dimension (mm)
- e. Noise Level

- f. Material and thickness of casing
- g. Material and thickness of drain pan
- h. Operating Weight (Kg)

**Centrifugal Fan for AHU**

- a. Manufacturer
- b. Model
- c. Type of fan
- d. Fan speed (RPM)
- e. No. of fans
- f. Fan wheel diameter (mm)
- g. Drive arrangement
- h. No. of belts in case of belt driven.
- i. Material and thickness of fan wheel and blades
- j. Material and thickness of housing
- k. Fan outlet area (SqM)
- l. Fan Outlet velocity (FPM)
- m. Total air quantity (CMH)
- n. Static pressure at outlet (M of water)
- o. Whether statically and dynamically balanced

- p. Type of bearings.

**Motor For AHU**

- a. Manufacturer
- b. Type
- c. Electrical Characteristics
- d. Motor Speed (RPM)
- e. Method of Starting
- f. Starter Manufacturer

**Cooling Coil for AHU**

- a. Manufacturer
- b. Type
- c. Material of tubes
- d. Material of fin
- e. Tube diameter
- f. Wall thickness of tubes
- g. Fin thickness
- h. Method of bonding of tube and fins
- i. No. of fins/cm
- j. No. of rows deep
- k. Total tube surface outside (SqM)
- l. Test pressure

- m. Coil face area

**Air Filters For AHUs**

- a. Manufacturer
- b. Type of filters
- c. Filter medium
- d. Material of frame work and its thickness (mm)
- e. Face area (SqM)
- f. Face velocity across filters (MPS)
- g. Pressure drop across filters (M of water)

**Controls for Air Handling Units**

- a. Electronic Expansion Valve
  - i. Make
  - ii. Model
  - iii. Details of Motor and Driver assembly
- b. Thermostats for AHU
  - i. Make
  - ii. Model
  - iii. Range
  - iv. Differential
  - v. Temperature Settings

vi. Electrical Characteristics

**Inline Fans**

- a. Manufacturer
- b. Motor Characteristics
- c. Whether speed regulator provided for single phase fans
- d. Whether Bird Screen provided
- e. Whether Gravity Louvers provided
- f. Efficiency(%)

**Insulation**

**A. Drain Pipe Insulation**

- a. Material
- b. Manufacturer
- c. Density
- d. Thermal Conductivity
- e. *Thickness*

**Electrical Accessories**

*Make of the following:*

- a. AHU Panels
- c. MCCBs

- d. MCBs
- e. Change Over Switch
- f. Star Delta Starter
- g. Direct On Line Starter
- h. Contactors/Over | Load Relays
- i. Current Transformers
- j. Single Phase Preventors
- k. Push Buttons
- l. Ammeter And Voltmeter
- m. Indication Lamps
- n. Power Cables
- o. Control Cables & Wires

**APPENDIX-IX**

**APPROVED MAKES OF EQUIPMENT & MATERIALS**

*List of approved makes of different equipment/materials to be used in this project.*

S.NO.	DETAILS OF EQUIPMENT AND MATERIALS	MANUFACTURER'S NAME
<b>EQUIPMENT</b>		
1.	Inverter Variable Refrigerant Flow System	Mitsubishi/ Hitachi/ Toshiba/ Voltas/ Blue Star/Daikin/Carrier/LG
2.	Compressor	Mitsubishi/ Hitachi/ Toshiba/ Blue Star/Voltas/Danfoss/Copeland
3.	Air Handling Units	Zeco/ Edgetech/ System Air/ Waves
4.	Cooling Coils for AHUs	Zeco/ Edgetech/ System Air/ Waves
5.	Centrifugal Fans (For AHUs, FATUs & Ventilation fan sections)	Nicotra/ Kruger / Lau/ Wolter
6.	Inline Fans	System Air/ Ostberg/ Lau
7.	Propeller Fans	Alstom/ Khaitan
8.	Extract Fan Sections & Fan Filter Units	Zeco/ Edgetech/ Roots/ System Air/ Waves
9.	Strip Heaters	Dasspass/ Equivalent
10.	Cellulose based Paper fills	Munters/ Glacier-Cor
11.	Air Curtains	Beacon / Thermadyne / Magneto/Zair
12.	Copper Pipes	Rajco/ Mandev/ Mexflow
13.	Voltage Stabilisers	Logicstat/ Shilpa
14.	V-Belts	Fenner India/Dunlop
15.	Refrigerant Pipes	Rajco/Mandev/Maxflow
16.	Y-Joints or Refnets	Mitsubishi/ Hitachi/ Toshiba/ Voltas/ Blue Star/Daikin/Carrier/LG



S.NO.	DETAILS OF EQUIPMENT AND MATERIALS	MANUFACTURER'S NAME
15.	Motors:	
15.1	High Efficiency Normal	Siemens/Bharat Bijlee/ ABB/ Havells/ Marathon
15.2	Fire Rated (Upto 250 deg C)	CMG/Rotomotive/Havells/Marathon
16.	Dry Scrubbers	Trion / Rydair/ Espair
17.	Variable Frequency Drives	Danfoss / ABB /Siemens
18.	Double Skin Plenum	Zeco/ Edgetech/ System Air/ Waves
19.	Axial Flow Fans	Greenheck/ System Air/ Kruger/ Lau
20.	Split Units	Mitsubishi/ Hitachi/ Voltas/ Blue Star
21.	Compressor/s for above	Mitsubishi/ Hitachi/ Danfoss/ Copeland

S.NO.	DETAILS OF EQUIPMENT AND MATERIALS	MANUFACTURER'S NAME
<b>AIR DISTRIBUTION</b>		
1.	GS Sheet	SAIL/ ISCO/ Tata Steel/ National/ Jindal
2.	Factory Fabricated Ducts	Rolastar/ Zeco/ Ductofab/ Waves
3.	Flanges & Accessories for the above ducts	Rolamate/ Zeco / Ductofab/ Waves
4.	Wire rope suspension arrangement	Gripple/ Ductmate
5.	Pre-Insulated Glass Wool Duct-Board	UP Twiga/ Kimmco
6.	<b>Fine Filters/ Hepa Filters/ Activated carbon filters</b>	Thermadyne/ Spectrum/ Anfilco/ SAGI Cofim
7.	Pre Filters	Thermadyne/ Spectrum/ Anfilco/ SAGI Cofim /Aer Team
8.	Metallic air Filters	Zeco/ Edgetech/ System Air/ waves
9.	Antivibration canvass sleeve	Zeco/ Edgetech/ System Air/ Waves
10.	Extruded Aluminium grilles & diffusers	Dynacraft/ Titus /Servex/ Air Master/ Mapro
11.	Plaque Type diffusers	Dynacraft/ Titus/ Servex/ Air Master/ Mapro
12.	Swirl Diffusers	Trox/ Titus/ Dynacraft/ Air Master/ Mapro
13.	Jet Nozzles	Trox/ Titus/ Dynacraft/ System Air/ Air Master/ Mapro
14.	Air transfer grilles	Dynacraft/ Titus/ Servex/ Air Master/ Mapro
15.	Smoke cum Fire Dampers a. Bare Dampers  b. Actuators	Greenheck / Ruskin/ Dynacraft/ Servex/ Mapro  Belimo/Joventa / Siemens

S.NO.	DETAILS OF EQUIPMENT AND MATERIALS	MANUFACTURER'S NAME
<b>AIR DISTRIBUTION</b>		
16.	Sound Attenuators	Intertec /Ruskin/ Dynacraft/ Mapro
17.	Intake Louvers	Dynacraft/ Ruskin/Servex/ Air Master/ Mapro
18.	Duct Dampers	Dynacraft/Ruskin/ Servex/Air Master/ Mapro
19.	Motorized Volume Control Dampers	Dynacraft/ Ruskin/ Air master/ Servex/ Mapro
20.	Actuators for above	Belimo/ Joventa/ Siemens
21.	Dash fastners/ suspension accessories with anti-seismic feature	HILTI/ Fischer/ Canon
22.	Pre – insulated Flexible Ducts (Aluminum foil on both outer as well as inner skin)	Atco / UP Twiga/ Global
23.	Un-insulated Flexible ducts	Atco/Sphere
24.	Spigots	Dyna craft/ Servex/ Mapro/ Air Master
25.	Fire retardant Flexible connections for ducts	Zeco/ Edgetech/ System Air/ Waves/ servex/ Mapro
26.	Kitchen Hoods	Continental/ Aster Technologies
27.	Fire Sealant	3M/ Hilti
28.	Round/ Elliptical ducts	GP Spira/ Ductofab/ Waves
29.	Fire retardant coating on ductwork	Paramount-Polytreat/ Promat /Cischem

S.NO	DETAILS OF EQUIPMENT AND MATERIALS	MANUFACTURER'S NAME
<b>INSULATION</b>		
1.	Fiber Glass	UP Twiga/ Owens Corning
2.	R P Tissue	UP Twiga/ Owens Corning
3.	Closed Cell Elastomeric Insulation material- EPDM	Aeroflex/ HT Armaflex
4.	Adhesive for closed cell insulation material	Pidilite / Aero seal Glue/ Cischem
5.	Expanded Polystyrene	Beardsell / Styrene Packing
6.	XLPE insulation	Aerolam/Supreme/K-Flex/Armacell
7.	Adhesive for Expanded Polystyrene	Unishield/ Polyshield
8.	Aluminium Tape	3M/Magic
9.	Aluminium foil	INDALCO/BALCO
10.	PUF pipe supports	MalanpurEntech/Bestopuf
11.	Polyster Membrane	Shelko/Bituplus
12.	External surface treatment of insulated surface of ductwork & piping to achieve mechanical strength and UV protection.	Paramount-Polytreat/ Cischem/ Polybond

S.NO.	DETAILS OF EQUIPMENT AND MATERIALS	MANUFACTURER'S NAME
<b>ELECTRICALS</b>		
1.	MCC & AHU Panels:  Category A  Category B	Tricolite/ Advance/ Adlec  India Tech/ Neptune Systems/ Modern Switchgears/ESSAAR/
2.	Air Circuit Breaker	L&T/ Schneider/Siemens
3.	MCCB	L&T/ Schneider/ Siemens
4.	MCB	Legrand/ L& T/ Schneider
5.	Cables	Gloster/ Skytone/ CCI/ KEI/ Rallison
6.	Cable Glands	Commet
7.	Cable Lugs	Dowels
8.	Cable trays	Rico/ Indiana/ Profab
9.	E L C B	Schneider/ L& T
10.	Changeover switch	L&T/ HH Elcon/ Socomec
11.	Contactors	L&T/ Schneider/ Siemens
12.	Overload Relay	L&T/ Schneider/ Siemens
13.	Indicating Lamp/Push button (LED type)	L&T(ESSBEE)/Vaishno(2XVLDIL-B1) / Seimens
14.	SFU/FSU	L&T/ EE/ Siemens / GE Power
15.	HRC Fuses & fuse fittings	L&T/ EE/ Siemens / GE Power
16.	Current Transformers	Automatic Electric /Kappa
17.	Rotary switches	Salzer/L&T/Kaycee
18.	Toggle Switches	L&T/Kaycee
19.	Selector Switches	Salzer/L&T/Kaycee

S.NO	DETAILS OF EQUIPMENT AND MATERIALS	MANUFACTURER'S NAME
<b>ELECTRICALS</b>		
20.	Time delay relay	Schneider
21.	Ammeter/Voltmeter (Digital)	Enercon / Schneider
22.	Ammeter/Voltmeter (Analog)	AE
23.	Time Clock	L&T/ Schneider
24.	KWH Metre (Digital Type)	L&T/ Schneider
25.	Under Voltage Relays	L &T/ C&S
26.	Over Voltage Relays	L &T/ C&S
27.	MS Conduits (ISI Marked)	BEC/ AKG
28.	PVC Conducts – FRLS	BEC/ AKG/ Polypack
29.	PVC Wires – FRLS (Halogen free)	Finoloex/ Skytone/ KEI
30.	Fire Survival Cables	FrTek / AFW/ Belden
31.	Factory fabricated distribution board	Legrand/ Schneider/ L &T

**NOTE:**

**Make of any other equipment not mentioned above will require approval from the Engineer In Charges before execution.**

<b>APPENDIX- X</b>
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**LIST OF EQUIPMENT & ACCESSORIES WHICH CONTRACTOR HAS TO BRING, KEEP AND MAINTAIN, AT HIS OWN COST, AT SITE DURING THE CURRENCY OF THE CONTRACT IN GOOD CONDITION.**

<i>PLANT/EQUIPMENT</i>	<i>NUMBER</i>
01. Hydraulic Test Machine	4
02. Floor mounted drill machine	2
03. Hand drill machine with drill bits	6
04. Hammer Drill machine with drill bits	2
05. Lock forming machine for duct fabrication	2
06. Hand held lock closing machine	2
07. Electric Pittsburg Seamer for closing Pittsburg joints	2
08. Electric Slitting shear for making cut outs	2
09. Collar cutting machine	2
10. Mechanized saw for cutting angles & channels	2
11. Duct smoke test kit	2
12. Thermometers	2
13. Water line pressure testing kit	2
14. For application of closed cell elastomeric insulation	
i. 1200 long steelscale	2
ii. 1200x900 size 40mm thick commercial plyboard	2
iii. Knives of following sizes	
Large Knives 250mm – 300mm long	4
Medium Knives 150mm – 200mm long	4
Small Knives 100mm- 150 mm long	4

- |     |   |   |
|-----|---|---|
| 15. | 50mm-100 brush for adhesive application                         | 5 |
| 16. | Tripods with chain pulley blocks                                | 4 |
| 17. | <i>Hoisting system for lifting the factory fabricated ducts</i> |   |
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*and any other equipment required for efficient execution of work within the stipulated period.*



**APPENDIX XI**

**(Refer Para 5.20 (2) of CPWD Works Manual 2019)**

**FORM OF SUPPLEMENTARY AGREEMENT**

*This Agreement made this day the ..... 20..... between ..... hereinafter called the First Party which expression shall include his heirs, executors and administrators/their successors and assigns and the Director, IIT Kanpur, hereinafter called the Second Party, which expression shall include his successors and assigns, shown as under :*

1. That this Agreement shall be called as Supplementary Agreement to the Agreement No. .... relating to the Name of work: ..... entered into by the parties to this Agreement.
2. That WHEREAS the First Party has substantially completed the execution of the work described in and covered by the Agreement No. .... except the items mentioned in the Schedule annexed to this Agreement and whereas the items of the work mentioned in the Schedule annexed to this agreement cannot now be executed on account of non completion of the sanitary work, electric installation and some other work; and whereas both the parties are desirous that the items mentioned in the Schedule annexed to this Agreement should be executed by the First Party after the completion of the sanitary work, electric installation and some other work, it is hereby further agreed as under :
  - (a) That First Party shall and will execute the work covered by the items mentioned in the Schedule annexed to this Agreement at the rates and as per the terms and conditions of the original Agreement No. whatsoever called upon to do so by the Engineer-in-Charge, within a period of one year from the date hereof.
  - (b) That the First Party shall have absolutely no claim of whatsoever nature against the Second Party for doing the work mentioned in the Schedule annexed to this Agreement as required under clause (a) above, except that which he would be entitled to under the original Agreement No.....
  - (c) That the First Party shall have to execute all the items which the Engineer-in-charge consider necessary.
  - (d) That the First Party shall start with the work of the remaining items mentioned in the Schedule annexed to this Agreement within ..... days from on the receipt of a letter to the effect from the Engineer-in-Charge or from any date fixed in the said letter and shall complete the said work within the time fixed by the Engineer-in-Charge or as extended by him from time to time.
  - (e) That on the due execution and completion of this Agreement by the parties, the bill of the First Party in relation to the work already done by him under the Original Agreement No. .... shall be provisionally finalized by the Second Party and payment on account, if any amount due, shall be made to the First Party provided that the Second Party shall have a right to retain such amount as

is considered reasonable by him as a security for the execution of the work mentioned in the Schedule annexed to this Agreement and the Second Party shall have right to deal with the said amount of security as he thinks proper under the terms and conditions of the Original Agreement. Further, on the due execution and original completion of this Agreement, the First Party shall be entitled to claim back his security deposit relating to the work in question, subject to the right of the Second Party to retain such amount as he thinks reasonable as mentioned above soon after the maintenance period of three months or six months, as the case may be mentioned in clause of the Original Agreement, is over.

- (f) That the final bill relating to the entire work under the two agreements shall be prepared after the completion of the entire work covered by Agreement No. .... and this Agreement. (3) Except as modified by this Agreement the said Agreement No. .... shall remain in full force and effect.

*IN WITNESS WHEREOF THE ABOVE MENTIONED PARTIES HAVE PUT THEIR SIGNATURE ON THIS DAY THE.....*

<b>PREAMBLE</b>
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***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, thumb bolts, hinges, factory fabricated access door and providing, installing, MS hangers with dash fasteners, foam rubber insertions, nuts, bolts and screws as required. Making all joints air tight using rubber insertions in addition multi-louvered manually adjustable dampers shall be provided in various branch ducts as required or shown on drawings for proper balancing of air flow. All primer coated MS hangers, dampers, base frames etc. shall be painted with black enamel paint.
15. All registers and diffusers shall be provided with a soft continuous rubber gaskets between their periphery and the surface on which these have to be mounted.
16. MS registers and diffusers shall be given, at the factory, a rust resistant primer coat and enamel paint finish of approved colour. Aluminium grilles and diffusers shall be fabricated out of extruded aluminium sections.
17. After completion of the installation, the entire air distribution system shall be tested for leaks and balanced in accordance with the specifications.
18. **Mode of Measurement**

*The mode of measurement for the various items, unless otherwise specified, shall be as follows :*

18.1 Ducting

*Payment for ducting shall be made on the basis of the external surface area of the ducting including all material and labour for installed duct.*

*The rates per SqM of the external surface shall include MS angle iron /GSS flanges, gaskets for joints, nuts & bolts , duct supports & hangers, vibration isolation pads or suspenders, dash fasteners, inspection doors, dampers, turning vanes, major hardwares such as thunder bolts, hinges, handles in extruded aluminium construction and any other item which will be required to complete the duct installation except external insulation and acoustic lining.*

*The external area shall be calculated by measuring the overall width and depth (including the corner joints) in the centre of the duct sections and overall length of each duct section from flange face in case of duct lengths with uniform cross section. Total area will be arrived at by adding up the areas of all duct sections.*

*In case of taper pieces average width and depth will be worked out as follows :*

W1 = width of small cross section

W2 = width of large cross section

D1 = depth of small cross section

D2 = depth of large cross section

$$\text{Average width} = \frac{W1 + W2}{2}$$

$$\text{Average depth} = \frac{D1 + D2}{2}$$

*Width and depth in the case of taper pieces shall be measured at the edge of the collar of the flange for duct sections fitted with angle iron flanges, otherwise at the bottom of the flange where flanges are of duct sheet.*

*For the circular pieces the diameter of the section mid-way between large and small diameters shall be measured and adopted as the mean diameter for calculating the surface at the taper piece.*

*For the face length of taper piece shall be the mean of the lengths measured face to face from the centre of the width and depth of flanges.*

*Duct measurements for calculation of area shall be taken before application of insulation.*

*For the special pieces like bends, branches, and tees etc. same principle of area measurement as for linear lengths shall be adopted except for bends and elbows, the length of which shall be the average of the lengths of inner and outer periphery along with curvature or angle of the piece.*

## 18.2 Uninsulated Piping

*Payment for uninsulated piping shall be made on the basis of linear measurement including all materials and labour for installed pipe. The linear rate per meter/feet for each nominal diameter shall include all pipe fittings, flanges, unions, gaskets for joints, bolts and nuts, pipe supports and hangers, vibration isolation devices or suspenders, flexible connections and any other item required to complete the pipe installation except valves of any kind and strainers. the length of the pipe section with flanges shall be from flange face to flange face.*

*For fitting like bends, elbows, branches and tees etc. same principle of linear measurement as for pipe sections shall be adopted except for bends, the length of which shall be the average of the lengths of inner and outer periphery along the curvature.*

## 18.3 Duct Insulation

*This item is provided separately for various thickness and shall be paid for on area basis of uninsulated duct. The area of the duct to be insulated shall be measured before application of insulation.*

## 18.4 Grilles & Diffusers

*All extruded aluminium grilles and diffusers shall be paid on the basis of actual measurement at site. Diffusers shall be counted physically at site and accounted for. Area of linear grilles shall be derived based on width and linear length and paid for on actual area basis.*

## 18.5 Exhaust Hoods

*All kitchen exhaust hoods shall be measured and accounted for the area derived from plan dimensions.*