

**TENDER NO: Nov/2020 Dated 13.11.2020**  
**INVITATION OF TENDERS for**  
**WORKS OF HVAC FOR TINKERING LAB EXTENSION OF R & D BLOCK IN**  
**PHASE II CONSTRUCTION OF**  
**CAMPUS OF**  
**INDRAPRASTHA INSTITUTE OF INFORMATION TECHNOLOGY DELHI**  
**AT OKHLA-III, DELHI**



INDRAPRASTHA INSTITUTE of  
INFORMATION TECHNOLOGY DELHI



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**Indraprastha Institute of Information Technology, New Delhi (IIIT-Delhi)**

DATED: 13.11.2020

**TENDER NOTICE**

1. Last Date & Time of issue of tender documents from 13.11.2020
2. Last Date & Time of receipt of tender 25.11.2020 upto 3.00 p.m.

CE, IIIT-Delhi, Okhla, New Delhi-110020 on behalf of Registrar, IIIT-Delhi invites sealed item rate tenders from eligible contractors for similar works.

Name of work: **HVAC for Tinkering Lab extension of R & D Block in Phase II construction of Campus of Indraprastha Institute of Information Technology (IIIT-Delhi) Campus, Okhla Phase-III, New Delhi.**

Location : Ground floor of R & D Block  
Estimated cost of work put to tender : Rs. 6 Lacs  
Time of completion : 1 Month

Earnest Money Deposit: **Rs. 12,000/- (Rupees Eleven thousand only)** is to be submitted with tender document as earnest money. The above payment shall be made in the shape of deposit at pay order/demand draft of a scheduled bank issued in favour of **IIIT Delhi Collection** payable at New Delhi.

Works to be completed in coordination with the interior/electrical works contractor . No extra for non-availability of fronts or coordination with main agency shall be payable on account of the same.

Tender documents can be downloaded from IIITD website ([www.iiitd.ac.in](http://www.iiitd.ac.in)) and submitted with non refundable DD of Rs. 500/- in favour of IIIT Delhi Collection as cost of tender.

1. The tenders shall be placed in sealed envelopes with a name of work and due date written on the envelope and addressed to the CE, IIITD. Complete tender documents shall be submitted by the approved contractors in **two envelopes**. **1<sup>st</sup> envelope** shall contain the earnest money in the shape of Demand Draft / Pay Order of a scheduled Bank requisite shape as per condition & eligibility criteria and cost of tender as stated above in case of the downloaded version.
2. The eligible contractors who have carried out similar works in IIIT-D/Govt Deptts/PSU/Reputed Pvt sector /MNCs are to submit the **experience certificates** for the works and registration certificates with Govt. Depts. if any. The said certificates along with the EMD be enclosed in **Envelope-1**. Performance certificates must be submitted by the vendors for the works .
3. Experience of having successfully completed similar works during last seven years ending on the 30th Oct 2020. The Similar works shall mean works of Heating Ventilation and Air-conditioning works. The value of executed works shall be brought to current costing level by enhancing the actual value of work at simple rate of 7% per annum calculated from date of completion to last date of receipt of tenders.

Three similar works not less than 40% of est.cost	Rs 2.40 lacs each Or
Two similar works not less than 60% of est cost	Rs 3.60 lacs each Or
One similar work not less than 80% of est cost	Rs 4.80 lacs each

4. One completed works of any nature either part of 3) or separate one costing not less than 40% of estimated cost ie Rs 2.40 lacs with some Central/State/Autonomous/Central PSU/State PSU/local authority formed under any Act published in Central/State Gazette.
5. The applications not supported with requisite experience certificates, GST registration certificate, TIN no. and ITCC in **Envelope-1** shall not be entertained
6. Average Annual Turnover over HVAC works should be at least Rs 4.80 lacs during immediate last 3 consecutive financial years ending 31st Mar 2020.
7. Should not have incurred any loss in the more than two years in the last five years ending 31st Mar 2020.
8. Should submit solvency certificate of 40% of estimate ie for 2.40 lacs from their bankers .
9. The 2<sup>nd</sup> **envelope** shall contain the financial bids including Priced Schedule of Quantities, Form of Tender, Conditions of Tender, Articles of Agreement, Brief Specifications, Condition of contract, Drawings all duly signed by the authorized signatory of the firms.

All these envelopes are to be put in a single envelope duly super-scribed the name of work, and addressed to CE, (IIITD) and with their address. Incase the tenderer does not fulfill the laid down eligibility criteria or fails to deposit the earnest money in prescribed form, financial bid shall not be opened.

Tenderers shall seal the tender affix their initials and put stamp on each and every page of tender document before submission. The tender of the contractor, who submits in-complete tender document or submits more than one tender for one work, shall not be considered at all.

Tenders will be received by the **CE up to 3.00 P.M on 25.11.2020** and will be opened by him or his authorized representative in the office of Registrar, IIITD on the same day at 3.30 P.M.

First the Technical Bids will be opened and screened .The bids shall be examined whether the EMD is in order and the bidder meets the minimum eligibility criteria specified above. . Those bidders whose EMD is in order, meets the minimum eligibility criteria, has submitted all the required documents and meet the technical requirements shall be considered for opening of financial bid. Conditional tenders would not be accepted. Financial bids in respect of contractors who do not fulfill above criterion shall not be opened.

No Xerox / certified copies of tenders shall be accepted, if submitted these tenders shall be rejected.

**CE**

## **CONDITIONS**

1. The time allowed for carrying out the construction work will be 1 months from the 3rd day after the date of written orders to commence the work.
2. The site for the work is available.
3. During execution of works, because of some unforeseen circumstances to enable him to complete the work as per terms of the contract, shall not relieve the contractor from any liability or obligations under the contract and he shall be responsible for the acts, defaults and neglects of any sub-contractor, his agents or workmen as fully as if they were the acts, defaults or neglects of the contractor, his agents or workmen.
4. The Contractor shall be required to deposit an amount equal to 5% of the tendered value of the work as performance guarantee in the form of an irrevocable bank guarantee bond of any scheduled bank or State Bank of India in accordance with the form prescribed or in the form of fixed deposit receipt etc. within 4 days of the issue of letter of acceptance. The performance guarantee shall have the validity up to 3 Months .
5. Tenderers are advised to inspect and examine the site and its surrounding at their own cost 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, means of access to the site, the accommodation they may require and in general shall themselves obtain all necessary information as to risk, contingencies and other circumstances which may influence or affect their tender. A tenderer shall be deemed to have full knowledge of the site whether he inspects it or not and no extra charges consequent on any misunderstanding or otherwise shall be allowed. The tenderer shall be responsible for arranging and maintaining at own cost all materials, tools and 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 specification of the work to be done, local condition and other factors having a bearing on the execution of the work.
6. The Accepting Authority (IITD) does not bind himself to accept the lowest or any other tender and reserves to him/herself the authority to reject in whole or part, any or all of the tenders received without the assignment of any reason. All tenders in which any of the prescribed conditions are not fulfilled or for any condition including that of conditional rebate is put forth by the tenderer shall be summarily rejected.
7. Canvassing, whether directly or indirectly, in connection with tenders is strictly prohibited and the tenders submitted by the contractor who resort to canvassing will be liable to rejection.

8. The Accepting Authority reserves to himself the right of accepting the whole or any part of the tender and the tender shall be bound to perform the same at the rates quoted.
9. Tenders shall remain open for acceptance for a period of 60 days from the date of opening of the tenders. If any tenderer withdraws his tender before the said period for issue of letter of acceptance, whichever is earlier or makes any modification in the terms and condition of the tender which are not acceptable to the IIITD, then IIITD shall, with out prejudice to any other right or remedy, be at liberty to forfeit 50% of the said earnest money absolutely besides black listing of the tenderer.
10. The notice-inviting tender shall form a part of the contract document. The successful tenderer/contractor shall, sign the necessary contract documents consisting of the notice inviting tender, all the documents including additional conditions, specification and drawings, if any forming the tender as issued at the time of invitation of tender and acceptance thereof with any correspondence leading thereto within the time specified in the letter communicating the acceptance of the tender. In case of delay, the earnest money may be forfeited and the tender cancelled or the contract enforced as per the terms of the tender and the invitation to tender and the tenderer shall thus be bound by the condition of contract even though the formal agreement has not been executed and signed within the specified time by the tenderer.
11. The work shall be carried out as per general of conditions of contract for central PWD works 7/8 (Tender Contract) and form part of the agreement/document.
12. Contract is liable to be terminated by the IIITD without payment of any compensation, if subsequent to the acceptance of tender the contractor is black-listed by, or enters into partnership or employs any black listed contractor of the IIITD or any other department, or Govt. or its, undertakings.
13. Cost of Bidding
  - 13.1 The bidder shall bear all costs associated with the preparation and submission of his Bid, and the Employer will in no case be responsible and liable for those costs.
14. Clarification of Bidding Documents
  - 14.1 A prospective bidder requiring any clarification of the bidding documents may notify the Employer in writing/mail at the Employer's address indicated in the invitation to bid not later than 3 days before the Date of Submission of Tenders.  
Email- [admin-project@iiitd.ac.in](mailto:admin-project@iiitd.ac.in)
15. Currencies of Bid and Payment
  - 15.1 The unit rates and the prices shall be quoted by the bidder entirely in Indian Rupees. All payments will be invariably made in Indian Currency (Indian Rupees.)

16. PROTECTION OF ENVIRONMENT AND OTHER LAWS:

The contractor shall take all reasonable steps to protect the environment on and off the Site and to avoid damage or nuisance to persons or to property of the public or others resulting from pollution, noise or other causes arising as a consequence of his methods of operation.

During continuance of the contract, the contractor and his sub-contractors shall abide at all times by all existing enactments on environmental protection and other local Acts/ Laws/ rules made there under, regulations, notifications and bye-laws of local authorities or any other law, bye-laws, regulations that may be passed or notification that may be issued in this respect in future by the State/ Local authority.

For and on behalf of the  
REGISTRAR  
Indraprastha Institute of Information Technology,  
New Delhi

**TENDER**

I/We have read and examined and understood 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 IIITD 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 respect in accordance with, such conditions so far as applicable.

We agree to keep the tender open for sixty (60) days from the due date of its opening and not to make any modifications in its terms and condition.

A sum of Rs..... Rupees (.....) has been deposited in demand draft of a scheduled bank issued by a scheduled bank as earnest money. If I / we, fail to furnish the prescribed performance guarantee within prescribed period, I / we agree that the said Director, IIITD or his successors in office shall without prejudice to any other right or remedy, be at liberty to forfeit the said earnest money absolutely. Further, if I / we fail to commence work as specified, I / we agree that Director, IIITD 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 hereby declare that I / we shall treat the tender documents drawings and other records connected with the work as secret / confidential documents and shall no 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:

Signatures of Contractor

Address:

Postal Address

Occupation:



## **LETTER OF SUBMISSION**

The CE  
Indraprastha Institute of Information Technology, Delhi  
Okhla Phase-III  
(Behind Govind Puri Metro Station)  
New Delhi-110020.

I/We, the undersigned, have read and examined in detail, the HVAC specifications and all bidding documents and hereby declare that:

### **Price and Validity**

1. All the rates quoted in our proposal are in accordance with the terms and conditions as specified in the bid document. All the prices and other terms and conditions of this proposal are valid for a period of 60 calendar days from the date of opening of bid.
2. We do hereby confirm that our bid prices include all taxes/levies/GST indicated separately.
3. We hereby declare that if any tax law is altered, we shall pay the same.
4. The quoted rates are inclusive of ESI , PF and Green Tax no extra on such heads would be payable on such account.

### **Earnest Money**

We have enclosed EMD in the form of demand draft no....., dated.....favoring IIIT, Delhi payable at New Delhi issued / drawn on .....Bank for Rs.\_\_\_\_\_/ - (Rupees \_\_\_\_\_ Thousand only), as desired.

### **Deviations**

We declare that all the works shall be performed strictly in accordance with the technical specifications and other tender conditions with no deviations.

### **Qualifying Data:**

We confirm that all information/data have been submitted as required in tender document.

We hereby declare that our proposal is made in good faith, without collusion for fraud and the information contained in the proposal is true and correct to the best of our knowledge and belief. I/We agree that in case any information is found to be incorrect the tender is liable to be rejected at any point of tendering process.

Bid submitted by us is properly sealed and prepared so as to prevent any subsequent alteration and replacement.

We understand that you are not bound to accept the lowest or any bid you may receive.

Thanking you,  
Yours faithfully,  
(Signature and seal of Tenderer with name, designation and contact no.)

**ACCEPTANCE**

The above tender (as modified by you as provided in the letters mentioned hereunder) is accepted by me for and on behalf of Registrar, IIITD for a sum of

Rs. ----- (Rupees -----)

The documents referred to below shall form part of this contract Agreement:-

- NIT
- Performa for Agreement
- Additional conditions.
- Special conditions
- Schedule of Quantities
- Drawings
- General conditions of contract for CPWD Works-2012 with up to date correction slip

For & on behalf of  
Registrar  
IIIT-Delhi

Signature. ....

Dated.....

Designation.....

## SCHEDULES

### **SCHEDULE 'A'**

Schedule of quantities (Enclosed)

: Enclosed

### **SCHEDULE 'B'**

Schedule of materials to be issued to the contractor

NIL

### **SCHEDULE 'C'**

Tools and plants to be hired to the contractor

NIL

### **SCHEDULE 'D'**

Extra schedule for specific requirements/documents for the work, if any,

NIL

### **SCHEDULE 'E'**

Schedule of component of Cement, Steel, other materials, Labour etc. for price escalation.

NIL

### **CLAUSE 10 CC**

Component of Cement - expressed as percent of total value work,

N / A

Component of Steel-expressed as percent of total work.

N / A

Component of civil (except cement & steel) / Electrical construction Materials-expressed as percent of total value of work.

N / A

Component of labour-expressed as per cent of total value of work.

N / A

Component of P.O.L. - expressed as percent of total value work.

N / A

### **SCHEDULE 'F'**

Reference to Latest General Conditions of contract.

**Name of Work:** HVAC Works in Tinkering Lab Extension of R & D Block of Indraprastha Institute of Information Technology (IIIT-Delhi) Campus, Okhla Phase III , New Delhi.

Estimated cost of work: Rs.6 lacs

- i. Earnest money: Rs. 12,000/-
- ii. Performance Guarantee- The contractor, for due and faithful performance of the Contract, shall obtain and submit to the Owner such security of 5% of the Contract Value within 7 days after the receipt of the Letter of Acceptance, in the form of BG Performa as appendix to tender from a scheduled Bank /FD providing such security shall be subject to the approval of the Owner. The cost of complying with the requirement of this Clause shall be borne by the Contractor.

**Period of Validity of performance Bond**

The performance bond shall be valid as at Conditions Cl 4 and till the Contractor has executed and completed the Works in accordance with the Contract. This security shall be returned to the contractor within 14 days of the issue of the said Completion Certificate.

**Claim under Performance Security**

Prior to making a claim under the performance security the Owner shall, in every case, notify the Contractor stating the nature of the default in respect of which the claim is to be made.

**Security Deposit** : Retention money shall be Five percent (5%) of the value of executed works and will be deducted from each and every payment made to the contractor against running account bill submitted for the work done at site. 50% of retention money will be released along with the payments of final bill and balance 50% will remain with Employer until the Defects Liability period is successfully over.

- iii. Defect Liability period 12 months from date of completion.
- iv. **Liquidated damages** - In case of delay on account of reasons attributable to the Contractor Liquidated Damages shall be levied .The amount of Liquidated Damages payable by the Contractor to the Employer would be 0.25% of the value of order for each calendar day of delay subject to a maximum of 5% of the value of order after which Employer reserves the right to terminate the contract without prejudice to the rights of the Employer.

General Rules & Direction:

Officer inviting tender: Registrar (IIITD)

**Definitions**

2(v) Engineer-in-Charge CE

2(viii) Accepting Authority Registrar, IIITD

2(x) Percentage on cost of materials and labour to cover all overheads and profits.	15%
2(xi) Standard Schedule of Rates	DSR-2016
2(xii) Department	IIIT-Delhi
9(ii) Standard CPWD contract Form	CPWD form 8 -2010 with up to date correction slips.

**Clause 1**

- |   |        |
|---|--------|
| (i) Time allowed for submission of Performance Guarantee From the date of issue of letter of acceptance | 4 days |
| (ii) Maximum allowable extension beyond the period (Provided in (I) above)                              | 7days  |

**Clause 2**

Authority for fixing compensation under clause 2.	Director, IIITD
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**Clause 2A**

Whether clause 2A shall applicable	No
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**Clause 5**

Number of days from the date of issue of letter Acceptance for reckoning date of start	3 days
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Time allowed for construction	1 months
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**Clause 6, 6A**

Clause applicable - (6 or 6A)	Clause 6A
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**Clause 7**

Gross work to be done together with net payment /adjustment or advance for material collected, if any since the last such payment for being eligible to interim payment.	Rs 3 Lakhs.
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**Clause 10A**

List of testing equipment to be provided by the contractor at site lab.	As required
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**Clause 10 B (ii)**

Whether Clauses 10B (ii) (iv) shall be applicable	Yes
-----do-----10B(iii) -----	No
<b>Clause 10CA Escalation</b>	<b>Not Applicable</b>
<b>Clause 10CC Escalation</b>	<b>Not Applicable</b>
<b>Clause 11</b>	
Specification to be followed for execution of work	CPWD Specifications 2007, Part I & II with Up-to-date correction slips  General Specification for HVAC works -2017
<b>Clause 12</b>	
Deviation limit beyond which clauses 12.2 & 12.3 shall Apply for building work	100%
<b>Clause 16</b>	
Competent Authority for deciding reduced rates.	Director, IIITD
<b>Clause 17</b>	
Contractor liable for Damages defects during maintenance period	Applicable
<b>Clause 18</b>	
List of mandatory machinery, tools & plants to be deployed by the contractor at site	As per the site requirement.
<b>Clause 36(i)</b>	
Requirement of Technical Representative (s)	As per requirement.
<b>Clause 25</b> Arbitration Clause	As per special conditions

## SPECIAL CONDITIONS

1. In the event of the tender being submitted by a firm, it must be signed by a person duly authorized through a power of attorney issued by all the partners and a certified copy of the power of attorney should be enclosed with the forwarding letter or separately by each member thereof, or in the event of the absence of any partner, it must be signed on his behalf by a person holding a power of attorney authorizing him to do so and such power of attorney shall be produced with the tender and it must disclose that the firm is registered under the Indian partnership Act.  
Each and every signature given shall be separately witnessed. A Contractor or a contractor who himself / themselves has/have tendered or who may tender for the work shall not witness the tender of another person for the same work. Failure to observe this condition would render tenders of the contractors tendering as well as witnessing the tenders liable for summary rejection.
2. The conditions for item rate tender only will be applicable as given in general conditions of contract for central PWD works 2010. As mentioned there in also, in event no rate has been quoted for any items leaving space bolts in figure (s), word(s) and amount blank, it will be presumed that the contractor has included the cost of this/these item(s) in other item(s) and rate for such items will be considered as zero and work will be required to be executed accordingly.
3. Rates quoted as percentage below/above in the tender will be summarily rejected.
4. It must be understood that the work has to be completed as per the time provided in the contract and as such time is the essence of the contract.
5. The quantities furnished in the bills of quantities are only probable quantities liable to alternation by omission, deduction or addition, and it would be clearly understood that the contract is **not a lump sum contract** and the IIITD do not, in any way, assure the tenderer or guarantee that the said probable quantities are correct or that the work would correspond thereto. Payments will be regulated on the actual quantities of work authorizedly done and measured at the accepted rates. No claims due to change in quantities (+ or -) will be entertained. The drawings, forming parts of complementary installations work specifications and the bills of quantities, of the contract, are explanatory of and are to one another, representing together the works / to be carried out. If neither the drawings nor the specifications nor the accepted bills of quantities include any part/parts the intention to include which is nevertheless clearly inferred and which are obviously necessary for the proper completion of the works/ installations, all such parts shall be supplied and executed by the contractor at no extra charge. Anything contained in one or another of (a) the drawings, (b) the specifications and (c) the accepted bills of quantities and not found in the others will be equally binding as if it were contained in each of them.
6. No alterations, which are made by the tenderer in the drawings, specifications, conditions or probable quantities accompanying this notice will be recognized and if any such alterations are made the tender, will be invalid. Conditional tenders will however be liable for rejection.
7. The tenderer must obtain for himself on his own responsibility and at his own expense all the information necessary, including risks, contingencies and other circumstances to enable him to make a proper tender and to enter into a contract with the IIITD. He must examine the drawings, specifications, conditions and so on and must inspect the site of work, examine the nature of the ground and the

- subsoil (so far as is practicable) and acquaint himself with local conditions, means of access to the work, storage facilities or areas for staff colony, the nature of the work, in fact all matters pertaining thereto before he submits his tender.
8. The tenderer shall also bear all expenses in connection with the preparation and submission of his tender and attendance for subsequent negotiations/clarifications.
    - (I) Omission, neglect or failure on the part of the tenderer to obtain requisite and reliable information on any matter affecting his tender, the contract and the construction, completion, maintenance, (dismantling and disposal) of the work shall not relieve the tenderer whose tender is accepted from any liability in respect of the contract.
    - (II) The tenderer whose tender is accepted shall not be entitled to make any claim for increase in the rates quoted and accepted excepting in pursuance of any specific provision in the contract.
  9. The Contractor, upon award of work, shall furnish the following details for the approval of the Engineer in charge:
    - 9.1. The names of manufacturers of specialized items such as patented water proofing systems / materials, doors, flooring tiles, false ceilings, insulating materials, wind mill, cement, steel, glazing, and any other materials etc. which he proposes to use in the work.
    - 9.2. The makes and types of fittings, materials, subject to the makes and type stipulated in the specifications, which he proposes to use in the work.
    - 9.3. The details of licenses granted to him and/or to professional qualified and/or licensed technical personnel on his staff who will be engaged on the work (and submit, if called for, the licenses for inspection by the Officer in charge in consultation with Engineer in charge).
    - 9.4. Only approved agencies/ skilled workers shall be deployed to carry out requisite specialized items of work. The Officer/ Engineer in charge's decision in consultation with Architect's/ in this regard shall be binding to all the parties concerned.
  10. The rates quoted in the bills of quantities shall unless specified otherwise will be for all heights, depths deemed to be for finished work in-situ/ item by item as provided for, and shall include cost for all necessary material and labours, all necessary tools and plants and machinery, sheds, marking out, clearing site, etc. and for all taxes, octroi, excise, VAT works contract and any other tax or duty levied by Government, Central or Local, or Local Authority, GST indicated separately ,if any as applicable.
    - 10.1. The rates shall be firm and not be subject to any variations in exchange rates, in taxes, duties etc. in railway freight and the like including labour conditions, etc. The rates are not subject to escalation.
  11. It will be the sole responsibility of the contractor to procure all the equipments/ materials and other materials required for the work.
  12. The IITD further reserves the right to delete or reduce at any time, any section of the bills of quantities with out assigning any reasons whatsoever there for and no claim will be entertained in this regard.



13. The tenderer whose tender is accepted is bound to execute formal agreement with the IIITD within one week of the date of intimation of award of work in accordance with the draft agreement which will include conditions of tender, form of tender (general conditions of contract for central PWD works 2010), Articles of Agreement, Bills of quantities, Conditions of contract, Special conditions if any, the drawings and specifications, but his liability under the contract shall commence from the date of written order to commence work whether the formal agreement is drawn or not.

The Contractor shall bear all expenses in connection with the execution of the said agreement including fees for stamping and registration of documents as required.

14. The Security Deposit will bear no interest what so ever until the date of release.
15. a) The contractor, upon award of work, shall submit a memorandum of procedure giving the outline of his general scheme, programme and time table, in the form of a chart that shall be scrutinized and approved (with modifications as necessary), which shall become the approved programme for execution. The approved programme shall be the basis for assessment of comparative progress under the relevant conditions of contract.  
(b). Over and above, the contractor has to supply programme chalked out showing important milestones to be achieved and the progress actually achieved compared with, the target of the same in the programme and shortfall, if any planned for being made up in the programme for next month.
16. (a) The work in general shall conform to the CPWD Specifications 2007 with up to date correction slips & any other latest civil specification published by CPWD, New Delhi and the "Specifications for works".  
(b) In case items not covered by the general specifications referred above, reference shall be made to the appropriate I.S. Code.  
(c) Should there be any difference in the particular specifications of individual item of work and the description of item as given in the Schedule of quantity, the latter shall prevail, which will be as per the relevant drawing.  
(d), In case of any work for which there is no specification in I.S. specifications or in the specifications forming part of tender documents or in case there is any variation, such work shall be carried out in all respects in accordance with the instructions to be issued by the Engineer in charge.
17. On acceptance of the tender the Contractor shall in writing and at once inform the IIITD and the Architects / HVAC Consultant the name of his accredited representative(s) who will be responsible to take instructions from the Architects / Officer in Charge.
18. The work of any part of it shall not be transferred, assigned or sublet without the written consent of the IIITD.
19. The Contractor shall be required to co-operate and work in co-ordination with and afford reasonable facilities for such other agencies / specialists / interior designers / consultants as may be employed by the Architects / HVAC

Consultant/ Officer in Charge on other works / sub-works in connection with the project/scheme of which this work forms a part.

20. The Contractor shall get the necessary insurance done for their personal employed/ company insurance, third party insurance, marine insurance, all risk insurance or any other insurance as required.
21. *The Contractor shall make arrangements of carrying water and electricity beyond one point where same shall be provided and recovery @1% of the cost of works shall be effected accordingly.*
22. The Contractor is required to comply with all Acts of Government relating to labour, safety, environment and other Rules and Regulations made there under from time to time and to submit at the proper times all particulars and statements required to be furnished to the appropriate Authorities.

**23. Delay and extension of time**

If in the opinion of the Architect/Owner the Work is delayed:

- a) By force majeure, or
- b) By reason of any exceptionally inclement weather, or
- c) By reason of proceedings taken or threatened by or dispute with adjoining or neighboring owners or public authorities arising otherwise than through the Contractor's own default, or
- d) By the works or delays of other Contractor or tradesmen engaged or nominated by the Owner or the Architect and not referred to in the Schedule of Quantities and/or Specification, or
- e) By reason of Architect's /Owner Instructions to delay work, or
- f) By reason of civil commotion, local combination of workmen or strike or lock-out affecting any of the building traders, or
- g) In consequence of the Contractor not having received in due time necessary Instructions from the Architect /Owner for which he shall have specifically applied in writing,

Then the Architect/HVAC Consultant /Owner shall make a fair and reasonable extension of time for completion of the Contract Work; in case of such strike or lock-out the Contractor shall, as soon as may be, give written notice thereof to the Architect/ HVAC Consultant /Owner, 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 Architect to proceed with the work.

24. **Failure by Contractor to comply with Architect's Instructions**  
If the Contractor after receipt of written notice from the Architect requiring compliance fails within ten days to comply with such further drawings and/or Architect's Instructions the Owner with the consent of the Architect may employ and pay other persons to execute any such work whatsoever that may be necessary to give effect thereto, and all costs incurred in connection therewith shall be recoverable from the Contractor.

## **25. Termination or Abridgment of Contract by the Owner**

- a) If the Contractor being an individual or a Firm commit any 'Act or Insolvency' or shall be adjudged an Insolvent or being an Incorporated Company or Society shall have an order for compulsory winding up made against it or pass an effective resolution for winding up voluntarily or subject to the supervision of the Court and of the Official Assignee of the Liquidator in such acts of insolvency or winding up shall be unable within seven days after notice to him requiring him to do so, to show to the reasonable satisfaction of the Architect that he is able to carry out and fulfill the Contract, and to give security therefore, if so required by the Architect, or
  - b) If the Contractor (whether an individual, Firm, Incorporated Company or Society) shall suffer execution to be issued, or
  - c) Shall suffer any payment under this Contract to be attached by or on behalf of any or the creditors of the Contractor, or
  - d) Shall assign or sublet this Contract without the consent in writing of the Architect first obtained, or
  - e) Shall charge or encumber this Contract or any payments due or which may become due to the Contractor there under, or
  - f) If the Architect shall certify in writing to the Owner that the Contractor:
    - i. Has abandoned the Contract, or
    - ii. Has failed to commence the works, or has without any lawful excuse under these Conditions suspended the progress of the works for 14 days after receiving from the Architect/ HVAC Consultant /Owner written notice to proceed, or
    - iii. Has failed to proceed with the works with such due diligence and failed to make such due progress as would enable the works to be completed within the time agreed upon, or
    - iv. Has failed to remove materials from the site or to pull down and replace work for seven days after receiving from the Architect written notice the said materials or work were condemned and rejected by the Architect under these conditions, or
    - v. Has neglected or failed persistently to observe and perform all or any of the acts, matters or things by this Contract to be observed and performed by the Contractor for seven days after written notice shall have been given to the Contractor requiring the Contractor to observe or perform the same, or
    - vi. Has to the detriment of good workmanship or in defiance of the Architect's Instructions to the contrary sub-let any part of the Contract,
26. Then and in any of the said cases the Owner with the written consent of the Architect may, notwithstanding any previous waiver, after giving seven days' notice in writing to the Contractor, determine the Contract, but without hereby affecting the powers of the Architect or the obligations and liabilities of the Contract the whole of which shall continue in force as fully as if the Contract had not been so determined and as if the works subsequently executed had been executed by or on behalf of the Contractor. The costs of these works are therefore recoverable from the Contractor. And further, the Owner under instructions of the Architect, by his Agents or servants may enter upon and take possession of the works and all plants, tools, scaffolding, sheds, machinery, steam and other power utensils and materials lying upon the premises or the adjoining lands or roads, and use the same as his own property or may employ

the same by means of his own servants and workmen in carrying on and completing the works or by employing any other Contractor or other person or persons to complete the Work, and the Contractor shall not in any way interrupt or do any act, matter or thing to prevent or hinder such other Contractor or other person or persons employed for completing and finishing or using the materials and plant for the Work. When the Work shall be completed or as soon thereafter as convenient the Architect shall give a notice in writing to the Contractor to remove his surplus materials and plant, and should the Contractor fail to do so within a period of 14 days after receipt thereof by him, Owner shall sell the same, and shall give credit to the Contractor for the amount realized. The Architect shall thereafter ascertain and certify in writing what (if anything) shall be due or payable to or by the Owner for the value of the said plant and materials so taken possession of by the Owner and the expense or loss which the Owner shall have been put to in procuring the works to be completed, and the amount, if any, owing to the Contractor and the amount which shall be so certified shall thereupon be paid by the Owner to the Contractor or by the Contractor to the Owner, as the case may be, and the certificate of the Architect shall be final and conclusive between the parties.

27. If at any time after the commencement of the work the Owner shall for any reason whatsoever not require the whole thereof, as specified in the tender, to be carried out, but need to abridge the Contract, the Owner shall give notice in writing of the fact to the Contractor who shall have no claim to any payment or compensation which he might have derived from the execution of the work in full, but which he did not derive in consequence of the whole amount of the work not having been carried out. The Contractor shall in this case, however, be entitled to payment for the work already executed by him in accordance with the agreed rates. The Owner shall also take over all building materials as might have been ordered for the work, but orders for which cannot be canceled, if delivered within a reasonable time, and shall pay for them at cost price. The Contractor shall also be allowed to remove his tools and plants from the site.
28. Termination of Contract by Contractor
  - a) If payment of the amount payable by the Owner under Certificate of the Architect for beyond two months from date of issue of certificate due to reason not attributable to the contractor.
  - b) The Owner commits any 'Act of Insolvency', or
  - c) If the Owner (being an individual, or firm) shall be adjudged an Insolvent, or (being an Incorporated Company or Society) shall have an order made against him or pass an effective resolution for winding up, either compulsorily or subject to the supervision of the Court or voluntarily, or if the Official Assignee or the Owner shall repudiate the contract, or if the Official Assignee or the Liquidator in any such winding up shall be unable within fifteen days after notice to him requiring him so to do, to show to the reasonable satisfaction of the Contractor that he is able to carry out and fulfill the Contract and to make all payments due, and to become due there under and, if required by the Contractor, to give security of the same, or

- d) If the works be stopped for three months or more under a continuous spell under the order of the Architect / HVAC Consultant or the Owner or by any injunction or other order of any Court of Law,
29. Then and in any of the above said (Clause28) cases the Contractor shall be at liberty to determine the Contract by notice in writing to the Owner, through the Architect, and he shall be entitled to recover from the Owner payment for all works executed and cost of the material supplied and lying at site for the purpose of the Contract as on the said day of the termination. No other claim for idle labour , loss of overheads , profits shall be entertained nor shall any other claim on account of the delay in completion of the work /availability of site/ unwarranted conditions whatsoever shall be tenable, even if it is caused by circumstances beyond the Contractor's control.

### **30. Procedure for Settlement of Disputes**

#### **30.1 Engineer's Decision**

If a dispute of any kind whatsoever arises between IIIT-Delhi and the contractor in connection with, or arising out of , the contract or the execution of the works, whether during the execution of the works or after their completion and whether before or after any repudiation or other termination of the contract, including any dispute as to any opinion, instruction, determination, certificate or valuation of the engineer, the matter in dispute shall, in the first place, be referred in writing to the engineer, with a copy to all parties. Such reference shall be made within one (1) month of arising of any such dispute and state that it is made pursuant to this clause. No later than one (1) month after the day on which he received such reference the engineer shall give notice of his decision to IIIT-Delhi and the contractor. Such decision shall state that it is made pursuant to the reference under this clause.

Unless the contract has already been repudiated or terminated, the contractor shall in every case, continue to proceed with the works with all due diligence and the contractor and IIIT-Delhi shall give effect forthwith to any / every such decision of the engineer unless and until the same shall be revised, as hereinafter provided, in an amicable settlement or an arbitral award. If either IIIT-Delhi or the contractor be dissatisfied with any decision of the engineer, or if the engineer fails to give notice of his decision on or before one (1) month after the day on which he received the reference, then either IIIT-Delhi or the contractor may within a further period of one (1) month from the day on which it / they receive(s) the notice of such decision, or on the day on which the said period of notice of / for decision expired, as the case may be, give notice to the other party, with copy for information to the engineer, of its / their intention to commence arbitration. Such notice shall establish the entitlement of the party giving the same to commence arbitration, as hereinafter provided, as to such dispute and no arbitration in respect thereof may be commenced unless such notice is given. If the engineer has given notice of his decision as to a matter in dispute to IIIT-Delhi and the contractor and no notification of intention to commence arbitration as to such dispute has been given by either IIIT-Delhi or the contractor as herein provided, the said decision shall become final and binding upon IIIT-Delhi and the contractor.

### 30.2. **Amicable Settlement**

Where notice of intention to commence arbitration as to a dispute has been given in accordance with sub-clause 22.1, arbitration of such dispute shall not be commenced unless an attempt has first been made by the parties to settle such dispute amicably. Provided that, unless the parties otherwise agree, arbitration may be commenced on or after one (1) month from the day on which notice of intention to commence arbitration of such dispute was given, whether or not any attempt at amicable settlement thereof has been made or result achieved.

### 30.3. **Arbitration**

Any dispute in respect of which:

- a. the decision, if any, of the engineer has not become final and binding pursuant to the first sub-clause above,
- b. amicable settlement has not been reached within the period stated in the second sub-clause above,

shall be finally settled, unless otherwise specified in the contract, by arbitration to be held in New Delhi in English, under the provisions of the Arbitration and Conciliation Act 1996, including any statutory reenactment(s) / amendment(s) thereof and Rules made thereunder, by the arbitrator. The Director of the Institute shall appoint one person as the sole arbitrator. Either party shall be limited in the proceeding before such arbitrator to evidence or arguments put before the engineer for the purposes of obtaining the said decision pursuant to the first sub-clause herein. No such decision shall disqualify the engineer from being called as a witness and giving evidence before the arbitrator on any matter whatsoever relevant to the dispute. Arbitration proceedings shall not be commenced prior to the completion of the works, unless any major pre-requisite criticality is discerned by the arbitrator, and the obligations of IIIT-Delhi, the engineer and the contractor shall not be altered by reason of the arbitration. The works shall not be stopped on account of the said process of arbitration and the contractor shall not be relieved of his responsibilities for the completion of the work under any circumstances whatsoever.

### 31.2. **Contractor to provide everything necessary**

The Contractor shall provide everything necessary for the proper execution of the Work according to the intent and meaning of the Drawings, Schedule of Quantities and Specifications taken together whether the same may or may not be particularly shown or described therein provided that the same can reasonably be inferred there from, and if the Contractor finds any discrepancy in the Drawings or between the Drawings, Schedule of Quantities and Specification he shall immediately and in writing refer the same to the Architect who shall decide which is to be followed.

### 31.3. **Materials and Workmanship to conform to Descriptions**

All materials and workmanship shall so far as procurable be of the respective kinds described in the Schedule of Quantities and/or Specification and in accordance with the Architect's Instructions, and the Contractor shall upon the request of the Architect furnish him with all invoices, accounts, receipts and other vouchers to prove that the materials comply therewith. The Contractor shall at his

own cost arrange for and/or carry out any test of any materials which the Architect may require.

**31.4. Assignment and Sub-letting**

The whole of the works included in the Contract shall be executed by the Contractor and the Contractor shall not directly or indirectly transfer, assign or underlet the Contract or any part share thereof or interest therein without the written consent of the Architect, and no undertaking shall relieve the Contractor from the full and entire responsibility of the Contract or from active superintendence of the Work during its progress.

**31.5. Removal of improper work**

The Architect shall, during the progress of the Work, have the power to order the removal, from the Site or works within such reasonable time or times as may be specified in the order, of any materials which in the opinion of the Architect are not in accordance with the Specification or the Instructions of the Architect, the substitution of proper materials, and the removal and proper re-execution of any works executed with materials or workmanship not in accordance with the Drawings, Specifications or Instructions and the Contractor shall forthwith carry out such order at his own cost. In case of default on the part of the Contractor to carry out such order, the Owner shall have the power to employ and pay other persons to carry out the same, and all expenses consumed thereon or incidental thereto as certified by the Architect shall be borne by the Contractor, or may be deducted by the Owner from any moneys due or that may become due to the Contractor.

## **ADDITIONAL CONDITIONS**

1. General conditions of contract for Central PWD Works 7/8 (Tender of Form) shall be part of the agreement.
2. The work shall be carried out strictly as per CPWD specifications 2007, Part I & II with up to date correction slips. Wherever no specification is available in the above said document, drawings and specifications supplied with bill of quantities shall be applicable
3. The Contractor shall have to clear the site for the work of all overlying rubbish /garbage/dumped refuse material prior to commencement of the work in case required at no extra cost. The contractor shall take approval from the Engineer /Officer in Charge in writing for collection and stacking of materials.
4. The contractor must follow CPWD Safety Code as provided in general conditions of contract for CPWD Works.
5. Any damage done by the contractor or his workmen to any existing work during the course of execution of the work shall be made good by him at his own cost.
6. Contractor shall clear the site thoroughly of all rubbish etc. left out of his materials immediately on completion of the work and properly keep the site clean around the building to the satisfaction of the Engineer- in-Charge.
7. The preference of the codes will be IS codes.
8. The rates are inclusive of all staging, material and labour as required for the works. The items in the bill of quantities include all the materials, labour, and installation, complete as a finish items unless otherwise stated.
9. Unless specifically mentioned otherwise, quoted Rates shall be deemed to include work to be carried out at all curvatures, heights, depths, inclinations and locations, and in wet/foul locations, as and when they are encountered. The rates quoted for the various works as specified in the Priced Schedule of Quantities are work in all types of soils/rock and prevailing Site conditions including earth work, excavation, shoring, execution of various other items of work, i.e., laying of pipes, joining, concreting, masonry, plastering, etc. in and under water and dewatering as required. Nothing extra is payable on this account.
10. All security precautions shall be taken during dismantling work. The site shall be fenced /barricaded with suitable material during construction period .No payment shall be made for fencing/barricading work. Fencing/barricading shall be done immediately after possession of site and shall be removed after completion of construction period
11. No space on site/otherwise for labour huts shall be provided by IITD, cost of same shall be borne by contractor.
12. The general condition of contract for Central P.W.D. Works has reference of various laws /acts /rules. The settlement of any disputes and arbitration, only Indian arbitration and conciliation act 1996 shall be applicable.



13. In case any specific brand of material has been specified either the same brand or of approved make of same specifications shall be used. The contractor shall take approval in advance for all such materials.
14. Costs for all materials and labour for the preparation of samples, market research, etc. shall be borne by the Contractor within his quoted Rates and nothing extra shall be payable for this. The works shall not be proceeded with without approval of the sample. In case sample is rejected and works cannot be proceeded with the IIITD shall be at liberty to terminate the contract and the Contractor shall have no claim for the works under such circumstances whatsoever.
15. The contractor should take utmost care to avoid any damage to the existing flooring, electrical works/cables, telephone cables, false ceiling, sprinkler system, fire alarm etc. in place. In case of any damage, it would be the responsibility of the contractor to restore the same immediately.

**CORRIGENDUM TO FORM 7/ 8 / 9 (CPWD) MUST BE READ ALONG WITH THE PAMPHLET**

S.No	FOR	READ
1	Government of India/Owner	Indraprastha Institute of Information Technology Delhi
2	C.P.W.D. or Government or Department	Indraprastha Institute of Information Technology Delhi
3	CPWD -7/8/9	CPWD 7/8/9
4	President / President of India	Chairman ,BOG,IIITD
5	Chief-Engineer	Director ,IIITD
6	Superintending Engineer	CE, IIITD
9	Administration Head	Registrar ,IIITD
11	CPWD Code, Paragraph '90	Shall be applicable to IIITD works
12	DSR'2007	Shall be applicable to IIITD works
13	CPWD specifications 2007 part - I& II	Shall be applicable to IIITD works
14	DSR (Internal) 2007 for Electrical works	Shall be applicable to IIITD works
15	CPWD specifications (Internal) 2007 for Electrical works	Shall be applicable to IIITD works
16	DSR External 2007 for Electrical works and specifications	Shall be applicable to IIITD works
17	Provision of Section 12 Sub-Section (i) of the works man compensation	Shall be applicable to IIITD works
18	CPWD safety Code framed from time to time	Shall be applicable to IIITD works
19	CPWD maternity benefits to labour	Shall be applicable to IIITD works
20	Model Rules of the protection of health and sanitary appointment for workers employed by CPWD	Shall be applicable to IIITD works
21	CPWD contractor labour Regulations	Shall be applicable to IIITD works

## **SPECIFICATIONS:**

### **1. GENERAL:**

- 1.1. Without forgoing the requirements of the conditions of Tender and the Conditions of Contract the works in general shall conform to the "Specifications 2007" published by CPWD, New Delhi and the "Specifications for works" stated in this tender. In case items not covered by the general specifications referred above, reference shall be made to the appropriate I.S. Codes. If there is any difference in the particular specifications of individual item of work and the description of item as given in the Schedule of quantity, the latter shall prevail. In case of any work for which there is no specification in I.S. specifications in the specifications forming part of tender documents or in case there is any variation, such work shall be carried out in all respects in accordance with the instructions to be issued by the Engineer-in-charge. The term Officer in Charge appearing in the specifications shall mean supervisor and be in Charge of the work or his authorized representative as the context may demand. All corrections to "Specifications 2007" or latest revisions of I.S. Code/ Specification shall be deemed to apply to this contract.
- 1.1.1. Materials bearing ISI certification mark certification shall be given highest preference for use in the works. Where the Contractor is required to do, perform, execute (etc.) any work or service or the like, it shall be deemed to be at his own cost. Absence of terms providing, Supplying, installing, fixing, etc. shall not even remotely entitle the Contractor to any additional payment there for
- 1.1.2. The rates accepted in the Schedule of Quantities apply to all floors, heights, depths, leads, lifts, spans, sizes, shapes, locations, etc. unless a distinction has been included in the very Schedule.
- 1.1.3. The Specifications and the Schedules may have been divided into various sub-heads for convenience only. This does not limit applicability of one to the other nor does it absolve the Contractor of his responsibility to complete any trade / item of work as reasonably inferred from one or more of such sub-heads.
- 1.1.4. The Schedule of Quantities is not necessarily based on "Schedule of Rates - Delhi 2007 or any of its later/ earlier versions. Hence the Schedule of Quantities shall be read and construed according to explanations given herein and intentions gathered there from. A mere parallel drawn from the said Schedule of Rates shall therefore not form a basis for a variation and, or additional payment.
- 1.1.5. All work under this contract is deemed to be performed above subs soil water level. However, removal of water collected from rains and the like shall be treated as part of contractual risk/obligation.
- 1.1.6. Screws, bolts, nuts, washers, hold fasts, lugs, anchors, clamps, plugs, suspenders, brackets, straps and fasteners of the like are deemed to be included in the rates of various items unless the Schedule of Quantities expressed a different intention.
- 1.1.7. Resetting any displacements, making good holes/chases and such other incidental jobs are included in rates of respective items for which these are required.

## **2. DRAWINGS, SPECIFICATIONS, INTERPRETATIONS ETC.:**

In general, drawings shall indicate the dimensions, positions and type of construction, the specifications shall stipulate the qualities and the methods and performance criteria, and the schedule of quantities shall indicate the provisional quantities and the rates for each item of work. However, the above documents being complementary, what is called for by any one shall be as binding as if called for by all. In case of contradictory requirements between specifications and schedule of quantities, the requirements given in the schedule of quantities shall prevail.

Special conditions being mainly an amplification of General Conditions, they shall be read in conjunction with each other.

Work indicated on the drawings and not mentioned in the schedule of quantities or specifications or vice versa, shall be deemed as though fully set forth in each. Work not specifically detailed, called for, marked or specified, shall be the same as similar parts that are detailed, marked or specified.

### **Special Note**

**Though every care is taken while preparing this document to cover all necessary matters, specifications, general conditions, special conditions, provisions for smooth and complete execution of work, however in case of any omission in the tender/ contract document, latest correction slips of general conditions of contract for CPWD works 2010 will be the reference manual but not in supersession to aforesaid conditions.**

**GENERAL INSTRUCTIONS FOR SITE VISIT**

I, \_\_\_\_\_, aged \_\_\_ years, son/daughter of \_\_\_\_\_, presently residing at \_\_\_\_\_ and authorized by \_\_\_\_\_ (name of tenderer) ("Tenderer") to solemn this affidavit on behalf of the Tenderer, solemnly affirm on oath as hereunder: The Tenderer confirms that the Tenderer has duly undertaken the visit of the proposed project site of IIITD located at Okhla Phase III , New Delhi,.

The Tenderer has inspected and examined its surroundings and has satisfied itself about the site conditions and site logistics. The Tenderer confirms that it is aware of the ground conditions and nature of the site, means of access to the site and the accommodation area required for establishing the labour camp. The Tenderer agrees and confirms it shall be solely responsible for arranging and maintaining the aforementioned at its own cost including 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.

The Tenderer confirms and agrees that the submission of the tender implies that the requisite site visit has already been undertaken and that the Tenderer has acquainted itself with the local conditions and other factors having a bearing on the execution of the Work.

**DEPONENT  
VERIFICATION**

I, \_\_\_\_\_, aged \_\_\_ years, son/daughter of \_\_\_\_\_, presently residing at \_\_\_\_\_ and authorized by Tenderer verify that the information mentioned above is true and correct to the best of my knowledge and belief.

**DEPONENT**

## AGREEMENT

AN AGREEMENT is made this -----BETWEEN the Indraprastha Institute of Information Technology. A State University established by Govt Of NCT of Delhi ,and with its registered office at IIITD Campus , Okhla Phase III , New Delhi 110020, which expression shall include its successor, unless repugnant to or Excluded by the contract here of and assignees of and represented by its Registrar, IIITD the first party (hereinafter called the Authority) and by its sole proprietor/partners/Director.of M/s -----and having registered office at ----- (which expression shall be including his / its successor's heirs, executors, representative and or assignees of the second party (hereinafter called the contractor}).

WHEREAS the Authority has, under tender Notification No. -----

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-----.  
WHEREAS the contractor has submitted tender for carrying out the work as above as per the tender document page ---- to ---- and has represented that in conformity with his / its obligation contained in the tender as modified by the correction slips and corrigendum contained he / it shall carryout the same truly, faithfully and honestly.

THE SAME has been accepted by both the parties on the terms and conditions, corrections, corrigendum contained in the tender as modified as well as the letter of acceptance Issued party No.1 annexed here to as.

The same shall be binding on both the parties.

IN WITNESS WHEREOF, the parties have signed the deed of agreement on the date, month and year referred to above.

Date: -----

At New Delhi.

Signed by \_\_\_\_\_

Party No.1

Party No.2

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WITNESS

1. ----- Party No.1

2. ----- Party No.2

# SPECIFICATION FOR HVAC WORK

## **UNITARY AIRHANDLING UNITS- (CEILING SUSPENDED - DOUBLE SKIN)**

### 1. UNITARY AIR HANDLING UNITS

#### 1.1 SCOPE

The scope of work comprises the supply, installation, testing and commissioning of the Air-handling units conforming to these specifications and in accordance with the requirements of the Schedule of Equipment, DBR, drawings and BOQ.

#### 1.2 TYPE

The air handling units shall be double skin construction, draw-thru type comprising of various sections, filter section, coil section and fan section, mixing box, (wherever the return air and fresh air are ducted) as shown on drawings and included in schedule of quantities.

#### 1.3 CAPACITY

The air handling capacities, maximum motor horse power and static pressure shall be as shown on Drawings and in Schedule of Quantities.

#### 1.4 CASING

Double skinned panels shall be 40+/-2 mm thick. Double Skin Panels shall be made of 0.6mm Pre-coated GSS on outside and 0.6mm Galvanized sheet inside with CFC – FREE P.U. insulation of 42 (+/- 5%) kg/Cu M injected in between with an internal gasket between the skins to interrupt the thermal bridge of the panel. Outer sheet of panels shall be made of galvanized pre coated sheet of 0.6mm thickness to ensure mechanical strength, air leakage, thermal bridging and thermal transmittance. There should not be any metal to metal contact between inner and outer skins of AHU casing to ensure thermal bridging. AHU shall be with thermal break casing.

The entire framework shall be mounted on an aluminium alloy or galvanized steel or heavy duty engineering composite material channel base as per manufacturer's recommendation. Panels shall be assembled together to form an enclosure that is capable of low air leakage potential. Handles shall be made of hard nylon and all access panels should be openable with Allen key arrangement. Units supplied with various sections shall be suitable for on site assembly with continuous foam gasket. All fixing and gaskets shall be concealed.

Units shall have hinged, quick opening access door in the fan section and also in filter section where filters are not accessible from outside. Access doors shall be double skin type.

Condensate drain pan shall be fabricated from 18 gauge stainless steel sheet with all corners welded. Drain pan externally insulated (If Drain pan is outside the unit), with 10mm thick closed cell Polyethylene foam/ equivalent suitable insulation with necessary dual slope to facilitate fast removal of condensate. Necessary supports will be provided to slide the coil in the drain pan

#### 1.5 MIXING BOX

AHUs requiring mixing boxes as specified in Schedule of Quantities shall be complete with fresh and return air dampers.

1.6 **DAMPER**

Dampers shall be opposed blade type. Blades shall be made of double skinned aerofoil aluminum sections with integral gasket and assembled within a rigid extruded aluminum alloy frame. All linkages and supporting spindles shall be made of aluminium or nylon, turning in teflon bushes. Manual dampers shall be provided with a Bakelite knob for locking the damper blades in position. Linkages shall be extended wherever specified for motorized operation. Damper frames shall be sectionalized to minimize blade warping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure.

1.7 **MOTOR AND DRIVE**

Fan motors shall be energy efficient and shall be 415±10% volts, 50 cycles, three phases, totally enclosed fan-cooled squirrel cage induction class F, with IP-55 protection. Motors shall be especially designed for quiet operation. Motor shall be suitable to operate with direct driven plug fans and frequency converter. Frequency converter (VFD) shall be supplied by the AHU manufacturer for all AHUs with direct driven plug fans for the complete control of motor. rpm. The motor shall conform to IS: 325. "Three phase induction motors" having class F insulation. The fan motor shall have the efficiency level of **IE-3**.

1.8 **FAN**

Fans shall be backward curved plug fan with aerofoil design blades so as to give maximum efficiency for given duty condition. The entire fan with casing will be certified by a reputed, internationally acclaimed certifying body which will be a 3<sup>rd</sup> party like Eurovent or ARI or AMCA and the entire Fan + Motor assembly will be balanced at supplier's works before dispatch. Fans driven by variable frequency drive shall be backward inclined irrespective of static pressure value. Fans shall be selected for minimum efficiency of 70%. Plug fan in fan array shall have individual VFDs for every motor fan set. Fan motor assembly shall be statically and dynamically balanced as per relevant ISO/AMCA/EUROVENT standard. **Certified computerized selection for AHU shall be with fan selection.**

Motors shall be mounted inside the AHU casing on slide rails for alignment and be totally enclosed, fan cooled with class 'F' insulation. The fan impeller assembly shall be statically and dynamically balanced.

Both fan and motor assemblies shall be mounted on powder coated MS/galvanized steel (depending on size) base frame.

Heavy duty anti-vibration mounts shall be provided for isolating the unit casing. Flame retardant, waterproof silicone rubber impregnated flexible connection shall be provided at the fan discharge.

1.9 **COOLING COILS**

Chilled water coils shall have 12.5 to 15 mm dia (O.D) tubes minimum 0.35 mm thick with sine wave aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across the coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper

drainage. The coil shall have suitable size header with chilled water supply & return connections protruding out of AHU casing by minimum 150 mm. Each coil shall be factory-tested at 21 kg per sq. m air pressure under water. Tube shall be mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 4 - 5 fins per cm. Water pressure drop in coil shall not exceed 10 PSIG.

**Coil performance shall be certified by a third party like Eurovent/AHRI.**

#### 1.10 **AIR FILTERS**

The air used in an air-conditioning systems must be filtered to maintain a clean atmosphere in the conditioned space. The concentration of contaminants in the air and the degree of cleanliness required in the conditioned space will determine the type of filter or filters that must be used .

##### 1.10.1 **Type of filters**

###### 1.10.1.1 **Pre – filters**

Cleanable metallic viscous type filter made out of aluminium wire mesh or of dry cleanable synthetic type minimum 50mm thick, shall be provided on the suction side of AHU as a standard equipment with the unit. These filters shall have the efficiency of 90% down to 10 micron particle size. When these filters become loaded or full of dirt, it is removed from service and replaced by another filter. The dirty filter can then be washed in a cleaning solution in a tank, dried and then given a bath of viscous oil. Face velocity across these filters shall not exceed 155 MPM.

###### 1.10.1.2 **Dry Fabric (fine) Filters**

These filters shall have efficiency of 99% down to 5 micron particle size as per EU 7 standard. These filters are provided only where special cleanliness standard is required such as for library, lab, wards, OTs etc. These are provided on the discharge side of AHU after fan section and are always backed by pre – filters provided on the suction side of AHU. Face velocity across these filters shall not exceed 155 MPM.

#### 1.11 **ACCESSORIES**

Each air handling unit shall be provided with manual air vent at high point in the cooling coil and drain plug in the bottom of the coil.

#### 1.12 **FRESH AIR INTAKES**

Extruded aluminium construction duly anodized (20 microns and above) fresh air louvers with bird screen and dampers shall be provided in the clear openings in masonry walls of the air handling unit rooms having at least one external wall. Louvers, dampers, pre-filters, ducts and fresh air fan with speed regulator shall be provided as shown in Drawings and in Schedule of Quantities. 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 intakes shall be as per the requirements of Schedule of Quantities.

#### 1.13 **INSTALLATION**

The air handling unit shall be so installed as to transmit minimum amount of vibration to the building structure. Adequate vibration isolation shall be provided by use of rubber/neoprene pads and/or vibration isolation spring mountings.



1.14 **PAINTING**

Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.

1.15 **PERFORMANCE DATA**

Air handling unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation. Computerized selection for Ceiling Mounted Unit shall be provided through 3<sup>rd</sup> party certified software.

1.16 **TESTING**

Cooling capacity of various air handling unit models will be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated mercury-in-glass 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.

**HI -WALL TYPE CHILLED WATER UNIT**

1. **GENERAL**

The contractor shall supply and install chilled water Hi-Wall unit wherever indicated. The system shall be complete in all respects and comply with the specifications as given.

2. **HI WALL TYPE CHILLED WATER UNITS**

**UNIT**

The units shall be wall mounted type. The housing of the unit shall be of powder coated galvanized steel and shall include pre filter, fan section, cooling coil, coil section in built motorized valve, etc. The body shall be light in weight and shall be able to cordless remote control with LCD display flush with the wall.

The fan shall be Aerodynamically designed cross flow turbo fan type. The fan shall be mounted directly on motor shaft having supported from housing. The fan shaft shall be statically and dynamically balanced. The fan shall be direct driven type.

The cooling coil shall be of seamless copper tubes, and shall have continuous aluminium hydrophilic fins. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of air flow. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes. The coils shall be tested against leaks.

Unit shall have filter cleanable type of resin net (with mold resistant) fixed to an integrally moulded plastic frame. The filter should be slid away type but neatly inserted.

Unit shall have a external attractive panel for supply and return air. Unit shall have bottom / down supply air grilles and return air grille in top.

Each unit shall have a 2 way motorized valve.

## **CONTROL**

Each unit shall be with corded remote controller to operate maintain inside conditions.

## **TESTING**

The indoor unit shall be tested to measure air quantity and coil performance by measuring temperature difference, and then calculating the capacity.

## **INLINE/AXIAL/PROPELLER FAN**

### **1. SCOPE**

The Scope of this section comprises supplying, storing, erection, testing and commissioning of Inline Fan, Axial Fan & Propeller Fan conforming to these Specifications and in accordance with requirements of schedule of quantities.

### **2.0. INLINE FAN/AXIAL FANS**

#### **2.1 INLINE FAN**

The Inline fans shall be cabinet/circular type meeting the site requirement and as per manufacturer standard specification.

- i. Housing shall be constructed of strong galvanized steel in riveted construction.
- ii. Fan Wheel shall be backward/forward curved type, Fan Wheel shall be statically and dynamically balanced.
- iii. Shaft shall be constructed of steel.
- iv. Bearings shall be of the ball-bearing type mounted on the fan housing. Bearings shall be designed especially for quiet operation and shall be of the self-aligning, self lubrication type.
- v. Motor shall be suitable for 230 volts, 50 cycles, 1 phase power supply direct driven centrifugal impeller, SPDP/TEFC Squirrel Cage induction motor. Motor name plate horsepower shall exceed brake horsepower by minimum of 10%. Motor shall be designed specially for quiet operation and motor speed shall be as per manufacturer standard.
- vi. Drive to fan shall be direct driven.
- vii. All accessories required for proper installation and commissioning.

#### **2.2 AXIAL FLOW FAN**

- i. The fans shall be of the direct driven axial type with cast aluminum airfoil propellers.
- ii. The casing shall be constructed of continuously welded steel and include integral punched inlet and outlet flanges to prevent air leakage. The casing and motor base shall be constructed from precision laser cut and formed members of heavy gauge steel to prevent vibration and rigidly support the motor. Motor support brackets shall be welded to fan casing for increased strength.
- iii. Motor shall be suitable for operation on  $415 \pm 10\%$  Volt, 50 Hz, AC supply with EFF-1 ratings & "H" class insulation.
- iv. Blades shall be airfoil design. Hub and blades shall be a high strength cast aluminum alloy. Blade pitch shall be manually adjustable with out removing from the fan casing. Rotors shall be statically and dynamically balanced. A tapered lock bushing shall be used to mount the propeller to the motor shaft.
- v. All the Steel casings and structural components shall be coated with Permatector, an electrostatically/as per standard applied thermosetting polyester urethane.

- vi. Fan performance shall be based on tests conducted in accordance to AMCA 210 (meets BS848 part 1), licensed to bear the AMCA Air and noise label in accordance with AMCA Publication 211 and comply with the requirements of the AMCA Certified Ratings Program.
- vii. The motor assembly shall be fire rated for high temperature application (250 °C for minimum of 2 hours).
- viii. All required accessories as required as per site requirement.

### 2.3 PROPELLER FAN

- i. Propeller fans shall be direct – driven, three or four blade type, mounted on a steel mounting plate with orifice ring.
- ii. Mounting plate shall be of heavy gauge sheet steel construction, streamlined venturi inlet (reversed) for supply applications. The mounting plate size shall suit the fan size.
- iii. Fan blades shall be constructed of aluminium or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the factory.
- iv. Motor shall be standard (easily replaceable) single phase, permanent split capacitor or shaded pole for small sizes, totally enclosed with pre – lubricated sleeves or ball bearings, designed for quiet operation. Motor for larger fan shall be suitable for 415 + 10% volts, 50 cycles, 3 phase, power supply. Motors shall be suitable for either horizontal or vertical services.
- v. All required accessories as required as per site requirement.

### 2.4 INSTALLATION

- i. The Contactor shall supply all required bolts, base frame (wherever (wherever required), vibration isolators any other accessories and shall assure that the components are placed securely in proper position.
- ii. Vibration isolators shall be provided with an efficiency of not less than 80%.

### 2.5 TESTING

All the fans shall be tested for performance at the factory and the following test results shall be furnished.

- i) C F M
- ii) Static pressure at the specified flow rate
- iii) KW input to motor

## **VARIABLE FREQUENCY DRIVE (VFD)**

### 1. GENERAL REQUIREMENT

This specification covers the requirements for furnishing complete Variable Speed Drives (VSD) and appurtenances as specified herein. All standard and optional features shall be included within the VSD.

The frequency converter shall be suitable for AHU application.

- a. The VSD module shall be tested to UL 508C. The appropriate UL label shall be applied.
- b. The VSD module shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.
- c. The VSD shall be UL listed for a short circuit current rating of 50 kA .

## 2. TECHNICAL REQUIREMENT

- a) The following ratings wall or frame mountable offering shall be available:  
3-phase, 380 to 480 VAC, +10%...-15% (0.75 to 250 kW)
- b) The VSD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.
- c) When properly sized, the VSD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor and shall not cause the motor temperature to rise above expected class on normal mains operation. The motor shall not require an external blower even at slow speed running.
- d) VSD shall operate with supply frequencies from minimum 47Hz to up to 63Hz.
- e) The overload rating of the VSD shall be 110 % of its rated light duty current for 1 minute every 10 minutes. Overload ability shall be available at all times – not only at start. f) Efficiency at Rated Power shall be 98%
- g) A scalar and vector control modes shall be supported and there shall be independent control chains and parameters for both of the motor control modes.
- h) The drive shall support various motor types Asynchronous motor, permanent magnet motor (vector), SynRM (vector).
- i) The VSD shall have at least two (2) programmable Analogue Inputs. Both inputs shall accept current (0 to 20 mA or 4 to 20mA) or voltage (0 to 10 VDC) signals. The signal type selection, voltage or current, shall be made via VSD user interface. DIP-switches or jumpers are not allowed for input type programming. j) The VSD shall have at least two (2) programmable Analogue Outputs (0 to 20 mA or 4 to 20 mA) out of which one shall be software configurable to be either voltage (0 to 10 VDC) or current output. Analog I/Os shall have an inaccuracy of  $\leq 1$  % of full scale in both current and voltage modes.
- j) The VSD shall have at least six (6) programmable digital inputs (24 V<sub>AC</sub> and 12 to 24 V<sub>DC</sub>, PNP or NPN providing flexibility in interfacing with external devices.
- k) The VSD shall have at least three (3) programmable digital Form-C relay (changeover) outputs.
- l) Drives shall have distinct Color Codes for easy terminal identification.
- m) Drive Shall have Safe Torque off as a Standard feature which does the function of Emergency Stop without any additional emergency Push button. Safe Torque off Shall confine to EN61800-5-2 Standard.

## 3. ENVIRONMENTAL LIMITS

- a. Drive shall be designed for ambient temperature of -10°C to +50°C Manufacturer's statement on output currents in different ambient temperatures (40, 45 and 50 °C) for continuous 24h/day operation shall be provided in writing for design purposes.
- b. VSDs shall be designed to operate in ambient conditions of relative humidity minimum up to 95 % (without condensation) and up to 1000 meters above sea level. The de-rating above 1000 meter altitudes shall be less than or equal to 1 % per 100 m.
- c. Contamination levels according to IEC 60721-3-1, IEC 60721-3-2 and IEC 60721-3-3 shall be in operation for chemical gases class 3C2 and for solid particles class 3S2
- d. VSDs shall be suitable for safe operation up to 4000 m altitude in neutral grounded TN electrical systems. The nominal VSD ratings shall be applicable

4. **Protection Class**

- a. Wall or frame mountable VSDs shall be available in **IP21 for Panel mounted requirement**
- b. Both IP21 and IP55 protection class wall and frame mountable VSDs shall have identical output current and ambient ratings.
- c. VSDs protection class (IP class) shall remain even without the control panel to ensure dust and water protection at all times.

5. **STANDARD FEATURES**

- a. **EMC Compliance** : The EMC compliance according to EN 61800-3 Class C2 (emissions) and 2<sup>nd</sup> environment (immunity) shall be met without external filters with maximum cable lengths of 100 meters. b. **Harmonic Mitigation technique:** VSDs shall provide inbuilt choke which offer current harmonic reduction complying to IEC/EN 61000-3-12. This inbuilt choke shall be with variable inductance value that provides current harmonics reduction not only at full load but also at partial loads. External chokes are not acceptable
- b. The control panel shall include **Hand-Off-Auto** selections and manual speed control. The drive shall incorporate “bumpless transfer” of speed reference when switching between “Auto” and “Hand” modes.
- c. Two independently adjustable acceleration and deceleration ramps with 1 to 1800 seconds adjustable time ramps. There shall be a possibility to use **start delay** before acceleration to ensure that all start conditions have been fulfilled.
- d. There shall be a **run permissive** circuit for damper or valve monitoring signal.
- e. The VSD shall include an **override input**. Upon receipt of a contact closure from the VSD external **fireman’s control station**, the VSD shall operate at an adjustable preset speed or PID controlled speed. The mode shall override all other inputs (analogue/digital, serial communication and all keypad commands) and force the motor to run at the adjustable, preset speed or PID controlled speed. “Override” shall be displayed on the control panel. Upon removal of the override signal, the VSD shall resume normal operation. Motor rotation direction shall be selectable in override mode by using internal parameters or digital input.
- f. **Real-time clock** and calendar shall be available as standard for giving true time and date information to fault event history. Real time clock shall be possible to use with timed functions, which shall allow controlling the VSD and its functions based on time of the day, day of the week, seasons of the year, holiday periods and holiday dates and special working periods and working days..VFD Should have this feature without the need of option Card and battery
- g. The VSD shall be capable of starting into a **coasting load** (forward or reverse) up to full speed and accelerate or decelerate to a setpoint (flying start) without safety tripping or component damage, with all supported motor types (induction motor, permanent magnet motor and synchronous reluctance motor).
- h. A **motor heating** function shall be supported by the VSD to prevent condensation and corrosion of the motor.
- i. There shall be built-in counters for calculating **energy savings** achieved with the VSD. VSD shall be capable of displaying energy saved value in kWh unit. It shall also display saved CO2 value. Drive shall also have Provision to monitor actual energy consumption

of the equipment during Last hour / Last day /Last month as well without the need of additional energy Meter.

- j. Two independently adjustable acceleration and deceleration ramps with 0.1 to 1800 seconds adjustable time ramps. There shall be a possibility to use start delay before acceleration to ensure that all start conditions have been fulfilled.
- k. The VSD shall have three (3) programmable critical frequency or critical speed lockout ranges to prevent the VSD from operating the load continuously on an undesirable speed range (skip frequencies).
- l. Drive Shall have settable load curve can be used to detect abnormal load situations that do not cause a fault or warning. For example, detecting a broken belt between the motor and load, broken fan blades or dirt accumulated in a pump.
- m. Minimum Cable distance between the Motor and Drive Shall be 100m without any need of additional output Choke.
- n. There shall be an Embedded interlock logic Safety feature available in the drive to confirm that equipment position, such as dampers, and sensor status are correct before operations begin.
- p. Drive shall have Safe Torque off feature to disconnect the Drive from Motor without the need of any additional emergency Stop Push button . Safe Torque off shall confirm to EN 61800-5-2 Standard Q. Drive Shall have Speed controlled cooling fan for Smooth and Quiet operation and conventional cooling with fixed speed is not acceptable

#### 6. **PID CLOSED LOOP CONTROLLER**

- a) Two (2) PID closed loop controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VSD, using the microprocessor in the VSD for the closed loop control
- b) There shall be two parameter sets for the first PID loop controller e.g. for night setback, summer and winter set points etc.

#### 7. **User Interfaces – Detachable Control Panel & Serial Communication**

- a) The control panel shall include a backlit LCD. The display shall be in complete words, in a language selectable by the user from a list of 14 languages, for programming and fault diagnostics. Faults should be displayed in plain text format. Control panel shall be capable of showing parameters in the form of analog, Bargraph ,Numeric formats
- b) The control panel shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate “bumpless transfer” of speed reference when switching between “Auto” and “Hand “modes. There shall be a possibility to reset the VSD and a dedicated “Help” button on the control panel. Help button shall provide context sensitive assistance for programming and troubleshooting.
- c) The control panel shall provide an easy to use I/O menu, where the user can see the status and function of all the analog and digital inputs and outputs.
- d) Engineering units shall be freely configurable for the user to display.
- e) The control panel shall contain a back-up information of the VSD settings. Back-up information shall be possible to be saved on the control panel both manually and automatically.
- f) The user shall be able to take a screen capture snapshot of the display with the control panel and be able to download the screen capture for user’s computer for further purposes.

- g) The user shall be able to connect a PC tool with a USB cable to the control panel to be able to set up and control the VSD. It shall be possible to connect the USB cable without using any tools.
- h) The control panel shall be standard across the VFD series and detachable in all types of VSD, IP21, IP42, IP54 and IP55 protection class VSD without tools to allow easy commissioning and programming of multiple VSDs.
- i) The VSD shall include pass code protection against unauthorized parameter changes. The pass code and the protection level shall possible to be defined by the user.
- j) The VSD shall have an EIA-485 (RS-485) port for serial communications as standard. BACnet protocol using BACnet MS/TP layer & Johnson Controls N2 protocol shall be embedded into the VSD memory. k) There shall be following optional protocols available as plug-in and inbuilt options:
- k) LonWorks, PROFIBUS-DP, CANopen, DeviceNet, ControlNet, EtherCAT, Ethernet POWERLINK and with a two port option Modbus/TCP, EtherNet/IP, PROFINET.
- l) Displays Shall be Hot Swappable and Shall have Real time clock feature without need of additional add on Card and battery

## 8. HVAC MACROS FOR EASE OF PARAMETERIZATION

The VSD shall support below HVAC macros for ease of parametrization:

- a) Pump & Fan control
- b) Override function
- c) PID Control
- d) HVAC default configuration
- e) Timer function
- f) Motor potentiometer
- g) User load curve
- h) Reference ramping
- i) Preset speed setting

## 9. PROTECTION FUNCTIONS IN VFD

The following protection functions shall be available

- a) Overvoltage controller
- b) Undervoltage controller
- c) Motor earth-leakage monitoring
- d) Motor short-circuit protection
- e) Motor overtemperature protection
- f) Output and input switch supervision
- g) Motor overload protection
- h) Phase-loss detection (both motor and supply)
- i) Under load supervision (belt loss detection)
- j) Overload supervision
- k) Stall protection
- l) Loss of AI signal monitoring
- m) Heat Sink over temperature Cut off

## 10. PRODUCT COMPLIANCE

- a) Standards and directives Low Voltage Directive 2006/95/EC
- b) EMC Directive 2004/108/EC

- c) Quality assurance system ISO 9001 and
- d) Environmental system ISO 14001
- e) CE, UL, cUL, and EAC approvals
- f) Galvanic isolation according to PELV
- g) RoHS2 (Restriction of Hazardous Substances)
- h) EN 61800-5-1: 2007; IEC/EN 61000-3-12;
- i) EN61800-3: 2017 + A1: 2012 Category C2 (1st environment restricted distribution);
- j) Safe torque off (EN 61800-5-2)

## **CONTROLS**

### 1. **SCOPE**

This chapter covers the requirements of equipment safety controls, refrigerant flow controls, system controls, and variable speed drive (VSD). For chilling units all the controls shall be microprocessor based.

### 2. **EQUIPMENT SAFETY CONTROLS**

#### 2.1 **Compressor**

##### 2.1.1 Compressor shall be provided with the following safety controls:-

- High discharge pressure (HP) safety (cut out) to stop the compressor automatically, in case discharge pressure exceeds a preset safe value. This safety shall operate when discharge head pressure exceeds the set point. Only manual resetting shall be provided for this safety.
- Low suction pressure (LP) safety (cut-out) to stop the compressor automatically, in case suction pressure falls below a pre-set value. This safety shall operate when the suction pressure falls below the set point. Automatic resetting shall be provided for this safety, with adjustable cut-in and cut-out pressures. This safety shall be used for pumping down the system for shutting off the refrigeration plant.
- Oil pressure (O.P) safety (cut-outs) to stop the compressor, in case lubricating oil pressure falls below a safe set value. A time delay mechanism shall also be provided, so as to permit running of the compressor upto a maximum period of 90 seconds, with the oil pressure differential below the set value and allow it to continue normal operation if the pressure differential builds up to the set value within that time, or otherwise shut-down the compressor. Only manual resetting shall be provided for this safety.
- High bearing oil temperature cut-out (for centrifugal compressor only). This shall be provided with a manual reset only.
- High lubricating oil temperature cut-out (for centrifugal compressor only). This shall be provided with a manual reset only.
- Time delay mechanism on the starting gear to limit short cycling regardless of malfunctioning of controls.

The cut-outs (i) to (v) mentioned above shall operate when the respective controlled variable crosses the set point to trip the compressor. Audio visual alarm shall be provided to indicate such operations. A manual reset shall be provided for them.

##### 2.1.2 Safeties mentioned above shall operate when the respective controlled variable crosses the set point to trip the compressor.

##### 2.1.3 Audio visual alarm shall also be provided to indicate such operations.



## 2.2 **Condenser**

- The safety control for a condenser shall comprise a safety pressure relief valve on the shell. This shall operate to relieve the pressure at the set point without prior leakage. For small condensers, a fusible plug may be provided to melt at a predetermined temperature.

## 2.3 **Chiller**

- An antifreeze shall be provided with water chiller, set at a few degrees above the freezing point. This shall operate, when the temperature of water in the chiller falls below the set point to trip the compressor motor. The reset provided for the safety shall be manual.
- Flooded type of chiller in addition, shall be provided with safety pressure relief valve.

## 2.4 **Refrigeration Plant**

2.4.1 In addition to the safety controls as above for the individual components of a refrigeration plant, the following safety controls shall also be provided for the plant.

- Compressor motor over current cut-out.
- Condenser water flow switch.
- Chilled water flow switch.
- Condenser air flow switch in the condenser fan discharge (in case of air-cooled condensers).
- Air flow switch in the evaporator fan discharge in case of direct expansion coils

2.4.2 The above controls, on operation, shall trip the compressor motor, and these shall be provided with manual reset arrangement.

2.4.3 The compressor motor shall also be interlocked electrically with,

- Condenser water pump in case of water cooled condenser, and condenser fan with air cooled condensers,
- Chilled water pumps in case of chilled water system and evaporator fan in case of direct expansion system, and
- Antifreeze thermostat in case of chillers.

2.4.4 Indicating lamps shall also be provided on the control panel for indicating operation of the safeties and interlocks.

## 3. **REFRIGERANT FLOW CONTROLS**

A refrigeration plant shall be provided with controls, necessary for starting, stopping and modulating the flow of refrigerant in the plant so as to satisfy the load requirements. These comprise solenoid valve, thermostatic expansion valve, float valve, compressor capacity controls etc. and other special controls if specified in a particular work.

### 3.1 **Solenoid Valve**

- For screw type compressors liquid line solenoid valve shall be provided in the liquid line of the system, ahead of the expansion valve, to allow or to stop the flow of liquid refrigerant to an evaporator, or a section of sectionalized evaporator. This shall be operated by snap-acting thermostat and it shall also be provided with a test switch to enable manual energizing.
- Discharge gas valves shall be provided in the following applications as required:

- Hot gas defrosting: normally this solenoid valve shall remain closed, but it shall open up to feed the evaporator with hot gas for defrosting when required, especially in cold storage applications.
- Solenoid valves shall be direct acting in smaller sizes and pilot operated for larger sizes, as required. The size of the valves shall be determined by the desired flow rate of refrigerant through them and the pressure drop across the same (and not by the size of the refrigerant line).

### 3.2 **Thermostatic Expansion Valve**

Thermostatic expansion valve shall be provided in DX type refrigeration plant to modulate the flow rate of liquid refrigerant entering the evaporator in response to the extent of superheat of refrigerant gas leaving the evaporator, so that only a metered flow is ensured matching the load. The number of expansion valve shall be such that the specified accuracy of temperature control of the system can be achieved and that no valve is expected to operate below 35% of its rated capacity. The sizes shall be selected suitably so as to avoid hunting. Adjustable super heat control and external equalizer port shall be provided for each valve. Each expansion valve shall be easily removable for cleaning and adjusting.

### 3.3 **Float Valve**

Float valve shall be provided in refrigerant plant with flooded type chiller for maintaining the liquid level in chiller under all conditions of load at a rate commensurate with the rate of vaporization. This can be provided either on low pressure side or on high pressure side. When provided as low side float valve, this shall be located as a part of the chiller or accumulator.

### 3.4 **Compressor Capacity Control**

The capacity control arrangement shall be in accordance with 2.2A.7 for centrifugal type compressors and 2.2B.8 for screw compressors.

## 4. **SYSTEM CONTROLS**

- The requirements for maintaining the inside design conditions as specified in the tender specifications for the work shall be met by appropriate system controls and control elements. The system shall satisfy the requirements of both full load and partial load conditions. Details of complete control elements shall be indicated by the tendered in the tender.
- Control shall be affected by 2 way diverting valve in chilled water coil. For heating using hot water coils, now control through them shall also be achieved by using 2 way valves.
- The size of 2 way diverting valves shall be selected so as to match the coil where in the flow is to be regulated. The make and size shall be indicated in the Technical particulars in the tender.
- Operation of the modulating proportional motor of 2 way diverting valve shall be controlled by proportional type thermostat.

## 5. **OPERATIONAL CONTROLS AND INTERLOCKS**

- The operation of refrigeration plant shall be either manual or automatic, as specified. The plant shall be started by an ON/OFF switch. Additionally, in the case of an automatic plant, an auto/manual switch shall also be provided.

- The automatic operation shall be effected through the monitoring of return chilled water temperature, or the room conditions, as the case may be. In multi-unit installations, one unit shall be arranged to be loaded fully before the next unit is switched on automatically. A similar operation system shall be followed in shutting off of the unit. Change over from one operating unit to another shall be possible through the status switch of the plant to be shut down by change to manual position and thus overriding its anti-cycle timer. It should be possible to introduce the changed unit by running it to speed and changing over the status switch to "auto" position.
- Pump down shut down shall be provided through low pressure (LP) safely irrespective of the status switch position, auto/manual.
- It should be possible to start the compressor motor only after the cooling tower fan motor, chilled water and condenser water pumps are operated.
- The compressor motor shall be able to be started or run, only after all the safeties as per Para 12.2 are satisfied.
- The blower motor shall be interlocked with strip heaters (where provided) such that power supply to strip heaters will become ON, only after the blower has been started and run to full (designed) speed.
- Where only the blower motor and not heaters is connected to standby generating set in any particular application, a timer shall be provided, such that the heaters may get energized, only after a period of time, after the blower is run.
- In the event of signal from high limit safety of heaters the power supply to the blower motor and the heater bank shall automatically and instantly be switched off.
- The power supply to AHU shall be cut off on receipt of a signal from the Fire Alarm System.

## 6. **REQUIREMENTS OF CONTROL ELEMENTS**

The system control elements comprise controlling elements such as thermostats, three way valves etc. as required for individual applications.

### 6.1 **Thermostats**

Thermostats shall be electric fixed differential type as indicated below, with 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 thermostat shall be such as to suit the site.

- Proportional control thermostats shall be provided for actuating the three way modulating valve at each air handling unit. Thermostat shall provide manual switching (heat-off-cool-in heating-cooling system).
- Snap-acting fixed differential type thermostat for actuating the three-way diverting valve at each fan coil unit
- Thermostat shall have temperature adjustments WARM-NORMAL-COOL settings and fan switch. Switching off must break fan circuit.
- 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.
- Safety thermostat shall be provided 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.
- Air-stat shall be provided within air handling unit containing electric heating or reheat coils to prevent heaters from energizing unless the air flow is established,

6.2 **Pressure Independent/Balanced/High-Range ability Control Valves – AHU**

Control valves for air handling units shall be 2way, globe type, pressure independent/balanced/high range ability, type of Brass/Cast Iron/S.G. Iron construction, of PN16 rating with flanged connections. The valve shall have linear stroke of minimum. The valves shall have an operating pressure rating of 150% of the pump operating head. The actuator shall be electronic, motorized, modulating type operating on 24VAC and 0-10Vdc or 4-20mA control signal. The actuator shall have provision for 0-10Vdc position feedback signal and manual operation.

6.3 **Two-Way Diverting Valves for FCUs**

This shall be provided as 2 position diverting valves in chilled/hot water lines at each fan coil unit and shall be actuated by space thermostat. Space conditions shall be maintained by allowing all of chilled/hot water to either pass through the coil or bypass the coil and mix with the chilled/hot water return. The valves shall revert to fully bypass position when fan is shut off. Pressure drop across the valve shall not exceed 0.14 kg/sq.cm. Valve shall have the facility to replace motor actuator without removing the valve body.

7. **VARIABLE SPEED DRIVE (VSD)**

7.1 **Air quantity flow control**

The VSD System shall function to supply variable air quantity in the air-conditioned area in response to the load variations including that due to variations in ambient conditions and filter cleanliness conditions, to maintain the inside designed temperature, RH and pressure conditions in conjunction with the humidifier and re-heaters. During the day hours, as per the time interval selected, the VSD System shall regulate the speed of the AHU to maintain the temperature within maximum designed temperature and positive air pressure inside the air-conditioned area. The positive air pressure shall be maintained by keeping a difference of minimum 15% in the –airflow between the supply and exhaust air. However, under any circumstances during the day hours, the air flow rate will not fall below the 60% of the rated CFM of the AHU or 15 air changes, whichever is higher. During the rest of the night hours, the Programmable timer shall give a signal to the VSD to run the AHU at a pre-determined reduced speed so as to provide only 25% of the normal CFM or the minimum CFM achievable closest to 25% but not below 25% of the normal CFM. Due to the clogging of the air filter if the inside temperature conditions are not achieved even at 100% AHU speed then the VSD will close an N.D. contacts to activate an alarm. The VSD shall have the provision to switch over to the manual mode as and when required. The system shall comprise of dedicated Variable Speed Drives (VSDs) designed for HVAC applications to accept 2 feedback signals (from temperature sensor installed in the AC area and programmable timer controller) and have 2 programmable set points (inside temperature conditions, and 60% of the normal CFM condition as stated above) using HVAC terminology, to regulate the speed of the AHU motors in response to the variations in load and filter cleanliness conditions to maintain temperature and Air flow differential in supply and exhaust conditions. In case, any additional sensor (s) including wiring etc are required to meet the system requirements the cost of that shall be deemed to be included in the cost of the VSD. The VSD control shall have:

- a) RFI (Radio frequency interference) Filters for EMC (Electro magnetic compatibility) compliance.
- b) Voltage Vector Control technology to generate advanced sinusoidal output voltage, 100% true RMS value of the fundamental voltage at rated speed and nominal torque,

cause no motor de-ration and keep motor temperature limits within permissible class B limits.

- c) Displays in user's friendly Alpha Numeric Characters for all operating parameters, programming parameters and faults.
- d) Built in energy meter
- e) Built in run time counter
- f) Local control panel (key pad)

The system shall also comprise a suitable programmable timer & PLC with required electronic components, to allow 2 feedback signals (Temperature & Minimum CFM) to be passed on to the VSD during the day hours. In the night hours only one signal from the programmable timer shall go to the VSD to run it at pre-determined reduced speed. The room space air temperature and air flow shall be sensed by a temperature and air flow transmitters, which shall generate suitable DC signal to provide feedback to the VSD, which in turn shall regulate the speed of the AHU fan to maintain the designed conditions as described above.

VSD shall be designed, with built-in PID controller, control panel (keypads & display), IP 20 enclosure for use on standard centrifugal fans. The VSDs should not cause any de-ration of the connected motors and must ensure that class B temperature levels of the connected motors are never exceeded, The display should be in alpha-numeric characters and programming facility should be in user-friendly HVAC terminology. The VSDs should be able to accept up to 2 feedback signal from temperature & air flow transmitter simultaneously and to program 2 set points in it.

The system shall also have following features incorporated

- Heat sink over temperature protection
- Under voltage protection
- Over voltage protection
- Alpha-numeric display facilities
- On indication
- Trip indication
- Selectable display of various parameters line voltage, frequency, speed, power, torque, motor temperature percentage, VSD temperature percentage, KWH.
- Raise and lower speed push button in local mode
- Frequency range variation from 0 to 50 Hz.
- Remote start and stop facility including indications thereof with necessary hardware and terminal blocks, including toggle switch etc. to over ride remote start & stop at the time of maintenance/repairs.
- Off delay facility through timer or PLC with 30 sec to 120 sec. time delay, to be connected to air flow switch.

Safeguard facility against single phasing.

Tripping of AHU blower motors in response to the fire alarm Signal from AFAS.

Inter locking of Exhaust and AHU blowers such that power supply gets fed to exhaust blower only when the supply air flow is there.

## 7.2 **Chilled water flow control**

Variable Speed Drive (VSDs) for controlling the chilled water flow rate in the secondary circuit shall be provided. Requirement and Specifications of VSD system shall be as follows:

The VSD System shall function to supply variable chilled water flow in the secondary circuit of air-conditioning system in response to the load variations including that due to variations in ambient conditions to maintain the inside designed temperature conditions. However, under any circumstances, the secondary chilled water pump speed shall not fall below the 30% of the nominal speed or any other suitable minimum speed as per the system requirement. The VSD shall have the provision to switch over to the manual mode as and when required and facility for the manual speed variation from VSD itself. The system shall comprise of dedicated Variable Speed Drives (VSDs) designed for HVAC applications to accept two feedback signals (from differential pressure transmitters installed across the two farthest, most significant AHUs of the zone to select either maximum of the two or average of the two (as selected by the user) feedback signals using HVAC terminology, to regulate the speed of the secondary chilled water pump motors in response to the load variations. In case, any additional sensor (s) including wiring etc. if required to meet the system requirements the' cost of that shall be deemed to be included in the cost of the VSD. The VSD shall have:

**The VSD system and controller shall be in such a way that the master controller can work with all other VFDs in case of problem even in master VFD.**

- RFI (Radio frequency interference) Filters for EMC (Electromagnetic compatibility) compliance.
- Voltage Vector Control technology to generate advanced sinusoidal output voltage, 100% true RMS value of the fundamental voltage at rated speed and nominal torque, cause no motor de-ration, and keep motor temperature limits within permissible class B limits.
- The VSDs shall have D.C. link reactors/ harmonic filters integrated to minimize power line Harmonics. There shall be reactors in both the positive and negative rails.
- An automatic energy optimization feature shall be provided as standard in the frequency converter. This feature shall reduce output voltage, further to quadratic V/f characteristics, when the motor is lightly loaded and minimize the motor losses.
- The VSD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% torque for upto 5seconds (for high inertia and high friction load).
- The VSD shall include Automatic Motor Adaptation (AMA) to optimize motor performance, improve start capabilities and compensate for motor cable variances. The AMA shall be carried out at motor stand still with no need for detaching the pump from motor.
- Unlimited output power circuit switching must be possible without the need for central circuit interlocking and without causing damage to the VSD.
- Auto-derating of maximum drive current shall be incorporated in VSD to allow continued operation at reduced speed in case of VSD over temperature phase loss or mains imbalance without damaging the VSD.
- Displays in user's friendly Alpha Numeric Characters for all operating parameters, programming parameters, faults, Built in energy meter.
- In run time counter.
- Local control panel (key pad)

The system shall also comprise a suitable PLC if required, with electronic components.

VSD shall be designed, with built-in PID controller, control panel (keypads & display), IP 20 enclosure for use on standard centrifugal pumps. The VSDs should not cause any de-rating of the connected motors and must ensure that class B temperature levels of the connected motors are never exceeded. The display should be in alpha-numeric characters and programming facility should be in user-friendly HVAC terminology. The VSDs shall be able to accept up to two feedback signals from differential Pressure transmitters simultaneously and to program set points in it. The system shall have following features incorporated:-

- Heat sink over temperature protection
  - Under voltage protection
  - Over voltage protection
  - Protections against input transients, loss of A.C. line phase, short circuit, ground fault, frequency converter over temperature.
  - Alpha-numeric display facilities
  - On indication
  - Trip indication
- 
- Selectable display of various parameters like output line voltage, output frequency, speed, power, motor temperature percentage, heat sink temperature, VSD temperature percentage, KWH, hours run, differential pressure.
  - Raise and lower speed push button in local mode.
  - Frequency range variation from 0 to 50 Hz.
  - Remote start and stop facility including indications thereof with necessary hardware and terminal blocks, including toggle switch etc. for over ride of remote start & stop of at the time of maintenance/repairs.
  - Safeguard facility against single phasing.

Where both building management system and air quantity flow control/ chilled water flow control through VFD are provided for same application, control panel for sequencing of VFD shall not be required.

### **CONTROL PANEL, MOTORS AND SWITCHGEARS**

#### **1. GENERAL**

- 1.1 The motor and switchgears required for various items shall generally be as per specifications given below. All electric motors shall be suitable for 3 phase, 50 Hz, 415 + 10% - 15% Volts A.C. supply.

#### **2. L.T. ELECTRIC PANEL BOARDS**

- 2.1 The main L.T. Panel board shall be extendible type on both sides, having in it all switches, starters & accessories and shall be completely factory prewired. It shall be suitable for voltage systems upto 500 volts, 3 phase, 50 Hz, 4 wire supply capable of functioning satisfactorily in temperatures of 45°C and rupturing capacity not below 31 MVA at 415 Volts.
- 2.2 The boards shall be fabricated from 2.0 mm thick, cold rolled M.S. Sheets. The front opening door panels shall be from 2 mm thick, cold rolled M.S. Sheets. Suitable stiffeners shall be used in fabricating the housing. All steel members shall first be degreased, then descaled using dilute sulphuric acid and a suitable phosphating process then the boards shall be given 2 coats of red oxide primer with powder

- coated finish in siemens grey colour. The switch board shall be dust proof and vermin proof. The panel shall generally conform to IS 8623 (full conformity not called for). It shall be flush in front and back. The panel shall have front and rear access.
- 2.3 Cable compartment of adequate size shall be provided in the main distribution board for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate support shall be provided in cable compartment to support cables. All incoming and outgoing switch terminals shall be brought out to terminal blocks in cable compartments.
  - 2.4 Items such as ammeters, switches etc. shall be located close to the corresponding switchgear and otherwise all items shall be arranged in a neat symmetrical pattern.
  - 2.5 The doors of the switch compartments and cable access shall be hinged type and that of busbars shall be fixed type.
  - 2.6 The knobs of the hinged doors shall be provided with a locking arrangement to prevent them from falling down when they are unscrewed for opening the doors.
  - 2.7 All panel doors shall have synthetic rubber gaskets with good ageing, compression and resistance characteristics.
  - 2.8 All the breakers shall be interlocked with door so that the unit cannot be closed unless the unit door is closed. The interlock shall also prevent opening the unit door unless the switch/breaker is in OFF position.
  - 2.9 Defeat arrangement shall be provided for deliberate inspection of switch/breaker without having to switch OFF the unit.
  - 2.10 All the units pertaining to a motor shall be incorporated in one cabin i.e switch, starter, CTS ammeter, current operated MPRD-2 single phasing preventor, indicating lamps etc.
  - 2.11 A danger notice plate of 200 mm x 150 mm of mild steel at least 2 mm thick vitreous enamelled white on both sides and with inscriptions in signal red colour on front side shall be provided on the panel board.
  - 2.12 Every starter/contactors etc. shall be controlled by an isolating device of adequate rating as listed later.
  - 2.13 A voltmeter and ammeter shall be provided to indicate incoming voltage and alongwith rotary phase selection switches.
  - 2.14 Ammeters shall be provided for incoming current to all motors of 10 HP (7.5 KW) and higher ratings.
    - 2.14.1 Ammeters for all the motors upto 50 HP (37.5 KW) shall be direct reading type.
    - 2.14.2 Ammeters for motors of 50 HP (37.5 KW) and above shall be operated with a selector switch.
  - 2.15 LED type indicating lamps in approved colours shall be provided for the 3 phases and for status of all controlled devices.
  - 2.16 All the switchgear shall be earthed to the earth bus.
  - 2.17 Earth shall be extended for each compartment to the door by means of a flexible, insulated copper conductor with crimped legs on either side.
    - 2.17.1 Each panel shall be provided with suitable size of earth bus at the rear of the panel and two earth terminals on either side.
    - 2.17.2 Suitable printed PVC ferrules shall be provided for all the conductors for easy identification.
  - 2.18 Etched plastic name plates shall be provided for all the incoming, outgoing switchgears, ammeter, voltmeter etc.
  - 2.19 All the control and auxiliary wiring shall be carried out with PVC insulated copper conductor of proper colour code.



- 2.20 The power wiring from the circuit/air breakers to the starters shall be carried out using colour coded, PVC insulated copper conductors crimped with lugs.
- 2.21 The out going wires of starters shall also be pvc insulated colour coded copper conductor crimped with lugs and terminated on a terminal block of proper rating.

**Important Note**

All Panel fabrication drawings shall be got approved, before the start of the fabrication work.

**3. BUS BARS**

- 3.1 The Bus Bar shall be mounted in a separate compartment in the Panel Board.
- 3.2 The Bus Bars and interconnections shall be of aluminium strips unless otherwise specified.
- 3.3 The Bus Bar shall have rectangular cross - section of (1) mm<sup>2</sup> per Amp. rating for full load current in the 3 phases as well as for neutral and should be extendable, if mounted horizontally.
- 3.4 The Bus Bars shall be insulated with heat shrink sleeves and colour coated. They should be supported on supports made of glass fibre reinforced thermosetting compound at regular intervals sufficient to withstand the force of any short circuit.

**4. CIRCUIT BREAKERS**

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

S.No.	Type	Upto 40 Amp.	63 A	80 to 200 A	Above 200 to 400 A	Above 630 A
1.	Incoming	MCB	MCCB	MCCB	MCCB	ACB
2.	Outgoing	MCB	MCB	MCCB	MCCB	ACB

**4.1 Air Circuit Breaker (ACB)**

- 4.1.1 The air Circuit Breakers shall be Draw out type conforming to I.S: 13947 (Part 2) 1993.
- 4.1.2 The ACB shall be complete with solid state overload, short circuit and earth fault protection with adjustable settings.
- 4.1.3 Each ACB shall have 4 'NO' and 4 'NC' potential free auxillary contacts, in addition to those required for its internal operating mechanisms.
- 4.1.4 There shall be suitable indicators for OPEN/CLOSE/SERVICE/TEST and Spring charged positions.
- 4.1.5 It shall be possible to close the door in Test position.
- 4.1.6 Castle Key and/or other interlocking devices shall be provided as required.

**4.2 Moulded Case Circuit Breakers (MCCB)**

- 4.2.1 The MCCB shall have TP + NL and be suitable for simultaneous manual opening and closing with rotary operating handle.
- 4.2.2 The ON/OFF/TRIP positions shall be clearly marked and easily visible to an operator and confirm to latest IS: 13947-1993.
- 4.2.3 There shall be fixed/adjustable tripping devices with inverse time characteristics for overload and short circuit protection.
- 4.2.4 Suitable Interlocking mechanism shall be provided, where required.

#### 4.3 **Miniature Circuit Breakers (MCB)**

- 4.3.1 The MCB shall have quick make/break contacts with a heat resistant housing, having high Impact strength and conform to IS 8828-1996.
- 4.3.2 The contacts shall be of silver nickel alloy.
- 4.3.3 The MCB shall permit over load for short duration, as required for Inductive loads and the breaking capacity shall not be less than 10 KV at 415 Volt A.C.
- 4.3.4 It shall be equipped with overload and short circuit protection devices and shall be suitable for DIN mounting.

#### 4.4 **Isolator Switches**

- 4.4.1 Isolator switches are to be provided for equipment located outdoors or for those located in separate enclosure, other than those Nos. having the Electric Panel.
- 4.4.2 The Isolator Switch should be of Rotary Load Break type with a weather proof sheet steel enclosure. Its rating shall be same as the outgoing device in the Electric Panel.

### 5. **CONTACTORS**

- All non inductive loads shall be provided with suitable sized magnetic contactors.
- 5.1 The contactors shall have 3/4 poles plus a minimum 2 'NO' and 2 'NC' contacts. All contacts shall be of solid silver.
  - 5.2 The No volt coil shall generally be suitable for 220 Volts + 10%, - 15% (wide band type) A.C. supply except when specified or required otherwise.

### 6. **STARTERS**

- 6.1 The type of starters to be provided for the motors shall be as follows :
  - 6.1.1 Squirrel Cage motors : upto 7.5 HP (5.6 KW) Direct on Line Type
  - 6.1.2 Squirrel Cage motors : Above 7.5 HP (5.6 KW) Automatic Star Delta Type
  - 6.1.3 Compressor motor : Above 300 HP (225 KW) Automatic Auto Transformers (where specified)
- 6.1.4 All starters shall have auxiliary contacts for interlocking different machines, connecting indicating lights, controls, alarms, etc.
- 6.1.5 All starters shall be provided with separate single phasing preventors.

#### 6.2 **Direct On-Line Starters**

- 6.2.1 These starters shall have heavy duty air break contactors of suitable rating.
- 6.2.2 These starters shall be complete with adjustable overload relays on all three phases, single phase preventing device and under voltage release. The starters should be "hand reset" type.
- 6.2.3 The "No Volt Coil" of these starters shall be 220 Volts + 10% - 15% (wide band type) whenever any controls or safety devices are connected in the starters circuits, otherwise standard 415 volts coils may be used. There shall be ON-OFF push button for each starter unless remote operation of the starter is required.

#### 6.3 **Automatic Star Delta Starters**

- 6.3.1 These starters shall have heavy duty air break contactors of suitable ratings along with an adjustable timer to automatically switch the motor connections from star to delta connections.
- 6.3.2 Each starter shall be complete with adjustable overload relays on all three phases and under voltage release. The starters should be "hand reset" type.
- 6.3.3 The "No Volt Coil" shall be of 220 Volts + 10% - 15% (wide band type) rating wherever any controls or safety device are connected in the starter circuit, otherwise

standing 415 volts coils may be used. There shall be ON-OFF push button for each starter unless remote operation of the starter is required.

#### 6.4 **Automatic Auto -Transformer Starter**

- 6.4.1 These starters will be oil immersed, each one fixed on a separate panel.
- 6.4.2 Necessary devices shall be provided for the automatic tap setting of the starter.
- 6.4.3 The starter should have "No Volt Coil" wide band type circuit of 220 volts to be connected to control circuits.
- 6.5 The Motor starter shall be in accordance with IS 1882. The starter shall be totally enclosed metal clad, dust and vermin proof construction. The starter shall be of continuous rating.
- 6.6 Contactors shall have the number of poles as required for appropriate duty. The making capacity of the starters shall be as per AC 23 of ISS.

#### 7. **PANEL ACCESSORIES**

- 7.1 All Voltmeters and Ammeters as specified shall be square of 96 mm x 96 mm, flush mounting type.
- 7.2 The Indicating Lamps shall be of LED type with Low Watt Power. The Lamps shall have translucent covers of following colours.
  - 7.2.1 Red/Yellow/Blue for phase light.
  - 7.2.2 Green/Amber for ON/OFF indication.
  - 7.2.3 Concealed door lock.

#### 8. **SUBSIDIARY PANELS (WITH SINGLE SWITCH)**

- 8.1 Subsidiary panels shall be provided for equipment located away from the plant room, such as air handling units, blower etc.
- 8.2 The construction of these panel should be similar to the main panel and shall have all related accessories, except when specified.
- 8.3 The sub panel shall be wall hung type and as compact as possible.
- 8.4 Panel fabrication drawings shall be got approved before fabrication.

#### 9. **SQUIRREL CAGE MOTORS**

- 9.1 The squirrel cage motors shall be either screen protected or totally enclosed fan cooled, depending on the application and as stated in "schedule of equipment". All motors shall conform to IS 325/1978, IS : 1231 for foot mounted motors and IS:2223 for flange mounted motors.
- 9.2 The stator windings shall be with class 'B' insulation.
- 9.3 Motors shall be provided with ball/ roller bearings. Bearings shall have ample capacity to deal with any axial thrust. Suitable grease nipple shall be provided for regreasing the bearings.
- 9.4 Motors shall be provided with a cable box for terminating the PVC insulated, PVC sheathed armoured aluminium cables.

#### 10. **INSTALLATION OF MOTOR**

- 10.1 Installation of the motor shall be in accordance with IS-900.
- 10.2 The motor along with its driven machine or equipment shall be provided with vibration isolation arrangement motors shall generally be provided with slide rails fixed to the base units nuts and bolts to facilitate belt installation and subsequent belt tension.
- 10.3 Motors shall be wired as per the detailed specifications and drawings all the motor frame shall be earthed with 2 Nos. of earthing conductors.

10.4 Motors shall be tested at works in accordance with the relevant Indian standard specifications and test certificates shall be furnished in triplicate.

Note : Rubber mats of 1100 volts capacity shall be laid in front of panel as per site requirement and no extra shall be paid.

**11. PAINTING**

All sheet steel work shall undergo a multi tank process of degreasing, pickling in acid, cold rinsing, phosphating, passivating and then sprayed with a high corrosion resistant primer. The primer shall be baked in oven. The finishing treatment shall be by application of powder coated paint of approved shade and stoved.

**DUCT WORK AND OUTLET**

**1. SCOPE**

This chapter covers the general requirements for sheet metal ductwork for air distribution with associated items such as air outlets and inlets, fresh air intake and fire dampers.

**1.1 MATERIAL**

**1.1.1 Ducts**

- 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
0 to 650	0.63	0.80
651 to 900	0.80	0.80
901 to 1250	1.00	1.00
1251 to 1500	1.25	1.50

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

### 1.1.2 Associated Items

- i. Supply/ return air outlets, F.A. grilles and accessories shall be constructed from extruded aluminium sections.
- ii. Flanges for matching duct sections, stiffening angles (braces) and supporting angles shall be of rolled steel sections, and shall be of the following sizes.

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

- iii) 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.
- iv) 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.

## 1.2 CONSTRUCTION

### 1.2.1 Ducts

- i. 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.
- ii. The interior surfaces of the ducting shall be smooth.
- iii. 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.

- iv. 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.
- v. Flanged joints shall be used at intervals not exceeding 2500 mm. Flanges shall be welded at corners first and then riveted to the duct.
- vi. 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.
- vii. Plenums for filters shall be complete with suitable access door of size 450 mm x 450 mm.
- viii. 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.

#### 1.2.2 **Air Outlet and Inlets (Supply and Return)**

- i. All air outlets and intakes shall be made of extruded aluminium sections & shall present a neat appearance and shall be rigid with mechanical joints.
- ii. Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give upto 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminium sheet. The louvers shall be of aerofoil design of extruded aluminium section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminium sheet. Louvers may be spaced 18 mm apart.
- iii. 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.
- iv. 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.
- v. Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.
- vi. Grilles and diffusers constructed of extruded aluminium sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grilles and diffusers shall

- have a rear set of adjustable blades, perpendicular to the face blades for deflection purposes.
- vii. All supply air outlets shall be fitted with a volume control device, made of extruded aluminium gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied space without removing any access panel. The volume control device for circular outlets shall be opposed blade radial /shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/wall outlets and intakes.
  - viii. All the products supplied by contractor should supplement in performance by selection curves of product ratings from the manufacturer.
  - ix. Laminar supply air diffusers shall be made of 2mm thick powder coated aluminium sheet duly insulated with 5mm thick closed cell polyethylene foam insulation having factory laminated aluminium foil and joints covered with self adhesive aluminium tape and having holes 2/3 mm dia including frame work.

### 1.2.3 Fresh Air Intakes

- i. Fresh air intake grills shall be made of extruded aluminium sections.
- ii. A flanged frame using RS sections shall be provided on front face to conceal the gap between the louvers and the adjoining wall face. Corners of frame shall be welded. The frame shall be made structurally rigid.
- iii. Louvers made from extruded aluminium section shall be in modular panel form for ease of handling. These shall be free from waves and buckles. Vertical blades shall be truly vertical and horizontal blades shall be truly horizontal. Butt joints in blades shall not be accepted.
- iv. Additional intermediate equally spaced supports and stiffeners shall be provided to prevent sagging/ vibrating of the louvers, at not more than 750mm centres where the louver's length is longer than 750mm.
- v. A bird wire screen made of 12 mm mesh in 1.6 mm steel wire held in angle or channel frame shall be fixed to the rear face of the louver frame by screens.

## 1.3 FLEXIBLE DUCTING

### 1.3.1 Application

Flexible Duct is a round, flexible light weight duct and is preliminary used for Speedy completion of project Offers a high degree of flexibility, which allows it to be easily connected to any desired position. A quick and economical means of correcting misalignment between system components. Allows ducting around obstacles where fabricated and fitted ducts would be difficult and costly to install.

### 1.3.2 Material

- i. An uninsulated flexible duct shall be made of double lamination of metalized polyester film permanently bonded to a coated spring steel wire helix. Duct shall be in tear & puncture resistant construction.
- ii. For insulated flexible duct where specified, inner core for the same should be made of double lamination of metalized polyester film permanently bonded to a coated spring steel wire helix. Fiberglass insulation of minimum 14 kg/cu.m density,

- 25 mm thickness shall be wrapped over the inner core & covered with strong outer jacket cum vapour barrier made of fibre glass reinforced metalized polyester film laminate.
- iii. Care must be taken to install all the flexible duct in fully extended position & bends made with adequate radius as per manufacturer recommended practices.

#### 1.4 **INSTALLATION OF METALLIC DUCT**

##### 1.4.1 **Ducting**

- i. The fabrication and installation shall be in a workmanlike manner. Duct work shall be rigid and straight without kinks.
- ii. All exposed ducts within the conditioned space shall have slip joints. Flanged joints shall not be used.
- iii. All joints shall be airtight.
- iv. Ducts shall be supported independently from the building structure and adequately, to keep the ducts true to shape. The support spacing shall be not more than 2 m. where ducts cannot be suspended from ceiling, wall brackets or other suitable arrangements, as approved by the Engineer-in-charge shall be adopted. Neoprene or other vibration isolation packing of minimum 6 mm thickness shall be provided between the ducts and the angle iron supports/brackets. Vertical duct work shall be suitably supported at each floor by steel structural members.
- v. Where metal ducts or sleeves terminate in woodwork, tight joints shall be made by means of closely fitting heavy flanged collars. Where ducts pass through brick or masonry openings, wooden frame work shall be provided within the openings and the crossing ducts shall be provided with heavy flanged collars on either side of the wooden frame work, so that duct crossing is made leak-proof.
- vi. Duct connections to the air-handling unit shall be made by inserting a double canvas sleeve 100 mm long. The sleeve shall be securely bonded and bolted to the duct and unit casing. Dampers shall be provided in branch duct connections for proper volume control and balancing the air quantities in the system, whether indicated in the drawings or not. Suitable links, levers and quadrants shall be provided for proper operation control and setting of the dampers. Every damper shall have an indicating device clearly showing the position of the dampers at all times
- vii. Where electrical heaters are mounted in the duct, these shall be of low temperature totally enclosed type fitted with radiation fins. A removable panel for access to the heaters shall be provided in the duct. Any hole in the duct for electrical wiring must be provided with suitable bushes to avoid leakage. 6 mm thick asbestos board lining shall be provided all around the inside of the duct for a distance of 30 cms. on either side of the electrical heaters. A manually reset thermostatic safety switch shall be provided near the duct section having heaters. In addition, the heaters must be interlocked with the connected fan motor of the AHU.

#### 1.5 **BALANCING**

Air systems shall be balanced in a manner to minimize throttling losses. The entire air distribution system shall be balanced with the help of an anemometer. The measured air quantities at fan discharge and at the various outlets shall be within  $\pm 5$  percent of those specified/quoted. For fans greater than 0.75 KW (1.0 HP), fans must then be adjusted to meet design flow conditions. Branch duct adjustments shall be permanently marked after the air balancing is completed so that these can be restored to their correct position if disturbed at any time.



## 1.6 MEASUREMENT

- i) Duct measurements (for insulated ducts) shall be taken before application of insulation.
- ii) Duct work shall be measured section wise on the basis of external surface area by multiplying the axial length from flange face to flange face for each section by the corresponding duct perimeter in the centre of that section length.
- iii) Uniformly tapering straight sections shall also be measured as in (ii) above. However, for special pieces like tees, bends etc. area computations for surface areas shall be done as per the shape of such pieces.
- iv) The quoted unit rate for external surfaces of ducts shall include all wastage allowances, flanges, gaskets for joints, vibration isolators, bracings, hangers and supports, inspection chambers/access panels, splitter dampers with quadrants and levers for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the specifications. These accessories shall not be separately measured.
- v) Grilles and diffusers (except linear diffusers) shall be measured by the cross sectional areas, perpendicular to the airflow, and excluding the flanges. Volume control dampers, where provided shall not be separately accounted for.
- vi) Linear diffusers shall be measured by linear measurements only, and not by cross-sectional areas, and shall exclude flanges for mounting of the linear diffusers. The supply air plenum for linear diffusers shall be measured as described above for ducting.
- vii) Fire dampers shall be measured by their cross sectional area perpendicular to the direction of the airflow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, fusible link/solenoid with wiring, but excluding the fire detectors, etc

## **PIPE WORK**

### 1. GENERAL

All piping work shall conform to quality standards and shall be carried out as per specifications and details given hereunder :-

Pipe sizes shown in tender documents are purely for contractor's guidance. The contractor shall be responsible for selection of sizes as per detailed engineering to be done by him. Plumbing design to be done by the Air-conditioning contractor shall conform to the following:

- i) Water velocity in pipes shall not exceed 2.5 m/sec.
- ii) Butterfly/Ball valves shall be provided at
  - a. Suction and delivery sides of pumps
  - b. Inlet and outlet of each condenser, chiller, cooling tower.
  - c. All drain connections from equipments
  - d. Inlet & outlet of every heat exchanger coil, namely for AHU's, FCU's, convector etc.
- iii) Non return valve shall be provided at the delivery of each pump. This shall be of swing type.
- iv) Balancing valve shall be provided at the outlet side of chiller, condenser, heating and cooling coils to regulate the maximum flow rate up to value preset as desired.

- v) Balancing valves shall be provided, where specified, for AHU's to regulate the maximum flow rate upto a value preset as desired. A mercury manometer shall be supplied with every 10 nos. or part thereof of balancing valves, whether or not specifically indicated in the tender specifications.
- vi) Air valves shall be provided at all high points in the piping system for venting with a size of 25 mm for pipes up to 100 mm and 40 mm for larger pipes.
- vii) Plumbing drawings showing the sizes of valves, layout and other details shall be prepared and shall be got approved from the Engineer-in-Charge before the execution of the plumbing work.

## 2. PIPES

The pipes size 150 mm and below shall be M.S. 'C' class as per IS : 1239 and pipes size above 150 mm shall be welded black steel pipe heavy class as per IS : 3589 from minimum 6.35 mm thick M.S. sheet for pipes upto 350 mm dia and for minimum 7 mm thick M.S. sheet for pipes for 400 mm dia and above.

## 3. FITTINGS

- 3.1 The dimensions of the fittings shall conform to I.S. 1239/69 Part-II unless otherwise indicated, in the specifications.
- 3.2 All bends in sizes upto and including 150 mm dia, shall be ready, made of heavy duty, wrought steel of appropriate class.
- 3.3 All bends in sizes 200 mm and larger dia, shall be fabricated from pipes of the same dia and thickness, with a minimum of 4 sections, and having a minimum centre line radius of 1.5 diameter of pipes.
- 3.4 All fittings such as branches reducers etc. In all sizes shall be fabricated from pipes of the same Dia. And thickness, and its length should be at least twice the dia of the pipe.
- 3.5 The branches may be welded straight to the main line, without making a separate fitting, where specified on drawings or required by engineer-in-charge.
- 3.6 Blank ends are to be formed with flanged joints and 6 mm thick blank between flange pair for 150 mm and over, in case where, a future extension is to be made otherwise blank end discs of 6 mm thickness are to be welded on, with additional cross stiffeners from 50 mm x 50 mm M.S. Heavy angles, for sizes upto 350 mm. All ends larger than 400 mm dia shall have dished ends.

## 4. FLANGES

- 4.1 All flanges shall be of mild steel as per I.S. 6392/71 and shall be steel slip-on-type, welded to the pipes, flange thickness shall be to suit class-II pressures.
- 4.2 Flanges may be tack welded into position, but all final welding shall be done with joints dismantled. 3 mm thick gaskets shall be used with all flanged joints. The gaskets shall be fibre reinforced rubber as approved by the Engineer-In-Charge. Special adhesive compound shall be used between flanges of steam, air and gas lines.
- 4.3 Flanges shall be used as follows :-
  - 4.3.1 Counter flanges for equipment having flanged connections.
  - 4.3.2 Flanged pairs shall be used on all such equipment, which may require to be isolated or removed for service e.g. Pumps, refrigeration machines air handling units etc.
  - 4.3.3 All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flange connections, for removal of valves from main lines for repair/replacement.

## 5. VALVES

### 5.1 BUTTERFLY VALVES

- 5.1.1 The butterfly valve shall consist of cast iron body preferably in two piece construction.
- 5.1.2 The disc shall consist of disc pivot and driving stem shall be in one piece centrally located.
- 5.1.3 The valve seat shall be synthetic material suitable for water duty. It shall be inline with the whole body.
- 5.1.4 The disc should move in slide bearings on both ends with 'o' ring to prevent leakage.
- 5.1.5 The handle should have arrangement for locking in any set position.
- 5.1.6 The valve should be suitable for 12 Kg/sq.cm working pressure.
- 5.2 All gate valves and check valves upto & including 65 mm Dia shall be of gunmetal screwed type, conforming to class 2 of I.S. 778. And shall be with I.S.I. Marking/BS 5155,API 694,ISO etc, and certification.
- 5.3 All gate valves and check valves of 80 mm dia and above shall be of cast iron flanged/wafer type conforming to class 2 of I.S.780/69 (For sizes upto 350 mm). And of I.S. 2906/69 (For sizes 350 mm and above). All such valves shall be with I.S.I. Marking/BS 5155, API 694,ISO etc, and certification.
- 5.4 All guage cocks shall be of gunmetal plug type, complete with siphon (brass chrome plated).
- 5.5 All drain valves shall be of gunmetal with a hose union connection of one hand.
- 5.6 All valves on the supply of fan coil units shall be of gunmetal ball type with integral water strainers, having (BSP) fpt inlet and flare type MPT outlet connection.
- 5.7 All valves on the return line of fan coil units shall be as in 5.6 but without integral water strainer.

## 6. BALANCING VALVES

- 6.1 The balancing valves upto 80 mm dia shall be of gunmetal screwed type confirming to B.S. 5154 or equivalent specifications.
- 6.2 The valve shall be cast gunmetal ASTM B-62 and complete with non rising spindle. PTFE disc seal cast metal hand wheel.
- 6.3 The port opening shall permit precise regulation of flow rate, by accurately measuring the pressure drop across the port.
- 6.4 The valve shall be complete with two ports for connections to a mercury manometer, to measure the pressure drop, as well as a drain port.
- 6.5 The spindle shall have a shielded screw to set the flow at the desired level.
- 6.6 This valve shall be used wherever specified.

## 7. STRAINERS

- 7.1 The strainers shall either be pot type or 'Y' type with cast iron or fabricated steel body, tested upto pressure applicable for the valves as shown on the drawings.
- 7.2 The strainers shall have a perforated bronze sheet screen with 3 mm perforation and a permanent magnet, to catch iron fillings.
- 7.3 Pot strainers shall be provided with flanged connections and 'Y' strainers shall be provided with flanged ends.
- 7.4 The strainers shall be designed to facilitate easy removal of filter screen for cleaning, without disconnection of pipe line.

## 8. JOINTING

- 8.1 All pipe lines shall be welded type.

- 8.2 Square cut plain ends will be welded for pipes upto and including 100 mm dia.
- 8.3 All pipes 125 mm dia or larger will be bevelled by 35 Deg before welding.

**9. MISCELLANEOUS**

- 9.1 Provide all pipe work as required to make the apparatus connected complete and ready for regular and safe operation. Unless otherwise noted, connect all apparatus and equipment in accordance with manufacturer's standard details, as approved by Engineer-In-Charge.
- 9.2 Unless otherwise specified, pitch the lines of piping as follows :-  
All condensation drainage, including air handling unit and fan coil unit shall be pitched in the direction of flow to ensure adequate drainage, with an adequate trap seal to prevent leakage of air due to static pressure developed by airconditioning units. Pitch, 20 mm per metre wherever possible, but not less than 10 mm per metre. Drains from other equipment shall be pitched similarly without trap seal.
- 9.3 Provide valves and capped connections for all low points in piping system, where necessary or required for draining systems. Provide isolating valves & Drain valves in all risers to permit repairs without interfering with the rest of the system.
- 9.4 During construction, temporarily close, open ends of pipes with sheet metal caps, where necessary, or required to prevent debris from entering the piping system.
- 9.5 Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion.
- 9.6 To facilitate the maintenance, repair and replacement:
  - 9.6.1 Provide shut-off valves where indicated and for individual equipment, units at inlet and outlet, to permit unit removal for repairs, without interfering with the remainder of the system. Additional shut-off valves shall be provided as required to enable all systems to be fully sectionalized. By-pass and stop valves shall be provided for all automatic control valves as specified.
  - 9.6.2 Arrange piping for maximum accessibility for maintenance and repair, locate valves for easy access and operation. No valves shall be installed with handles pointing down, unless unavoidable.
  - 9.6.3 Cut the pipes accurately according to measurements, established at building site & work into place without springing or forging.
  - 9.6.4 Pipe supports shall be adjustable for height and prime coated with rust preventive paint & finish coated with grey paint, both as approved by engineer-in-charge. The spacing of pipe supports shall not be more than that specified below :-

Nominal pipe size mm	Spacing (metres)
15	1.25
20 & 25	2.00
32,30,50 & 65	2.50
80,100 & 125	2.50
150 & Above	3.00

- 9.6.5 Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stresses on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic approved dash fasteners.
- 9.6.6 Insulated piping shall be in such a manner as not to put undue pressure on the insulation, such as providing teak wood block between pipe and support.
- 9.6.7 Where pipes are to be buried under ground, they should be coated with one coat of bituminous paint. The top of the pipes shall not be less than 75 cms. From the ground level. Where this is not practical permission of engineer-in-charge shall be obtained for burying the pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushions of not less than 15 cms. After the pipes have been laid and

top sand cushions provided, the trench shall be refilled with the excavated soil, excess soil shall be removed from the site of work by the contractor.

## 10. **HANGERS & SUPPORTS**

- 10.1 Hangers and supports shall be provided and installed for all piping and tubing wherever indicated, required or otherwise specified. Wherever necessary, additional hangers and supports shall be provided to prevent vibration or excessive deflection of piping and tubing.
- 10.2 All hangers and supports shall be made of steel or other durable and non-combustible materials, given two coat of primer red oxide and then painted with Aluminium colour paint. Wood wire or perforated strap iron shall not be used as permanent hangers or supports.
- 10.3 Hangers shall be supported from structural steel, concrete inserts & pipe racks, as specifically approved.
- 10.4 No hangers shall be secured to underside of light weight roof decking and light weight floor glass.
- 10.5 Mechanical equipment shall be suspended midway between steel joists and panel points.
- 10.6 Drilling or punching of holes in steel joist members will not be permitted.

## 11. **SLEEVES**

- 11.1 Where pipes pass through floors, walls, etc provide Galvanized steel pipe sleeves 50 mm larger than outside diameter of pipe. Where pipes are insulated, sleeves shall be large enough to ample clearance for insulation.
- 11.2 Where pipes pass through outside walls or foundations, the space between pipe and sleeve shall be caulked with lead wool and oakum.
- 11.3 The centre of pipes shall be in the centre of sleeves, and sleeves shall be flush with the finished surface.

## 12. **EXPANSION OR CONTRACTION**

- 12.1 The contractor shall provide for expansion and contraction of all piping installed by the use of swing connections and expansion loops.

## 13. **ARRANGEMENT AND ALIGNMENT OF PIPING**

- 13.1 All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the engineer-in-charge.
- 3.2 The piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceilings, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angles and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide maximum head room.
- 13.3 All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult to route, this contractor shall reroute his pipes as required to avoid interference, at the discretion of the engineer-in-charge.
- 13.4 All piping shall be carefully installed to provide for proper alignment, slope and expansion.
- 13.5 The stresses in pipe lines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle.

- 13.6 Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.
- 13.7 Small tubing gauges, controls or other equipment installed on any apparatus, shall not be coiled nor Excessive in length, but shall be installed neatly, carefully bent at all changes in direction, secured in place and properly fastened to equipment at intervals to prevent sagging.
- 13.8 The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

#### 14. **TESTING**

- 14.1 In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall the piping, equipment or appliances be subjected to pressures exceeding their test ratings.
- 14.2 The tests shall be completed and approved before any insulation is applied. Testing of segments of pipe work will be permitted, provided all open ends are first closed, by blank offs or flanges.
- 14.3 After tests have been completed the system shall be drained and flushed 3 to 4 times and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.
- 14.4 All piping shall be tested to hydraulic test pressure of at least one and half times the maximum operating pressure but not less than 10 kg/sq.cm for a period of not less than 12 hours. All leaks and defects in the joints revealed during the testing shall be rectified to the satisfaction of the engineer-in-charge, without any extra cost.
- 14.5 All the piping systems shall be tested in the presence of the engineer-in-charge or their authorized representative. Advance notice of test dates shall be given and all equipments, labour, materials required for inspection, and repairs during the test shall be provided by the contractor. A test shall be repeated till the entire systems are found to be satisfactory to the above authority. The tests shall be carried out for a part of work if required by Engineer-In-Charge in order to avoid hindrance in the work of the insulation contractor.
- 14.6 All steam and condensate pipes shall be tested and proven tight under hydrostatic pressure of 20 kg/sq.cm, unless otherwise stated, for a minimum period of 4 hours without drop in pressure.
- 14.7 Miscellaneous piping, tests with air at 10.5 kg/sq.cm for a minimum of 24 hours without drop in pressure.
- 14.8 The contractor shall make sure that proper noseless circulation is achieved through all piping systems. If due to poor bond, proper circulation is not achieved, the contractor shall bear all expenses for carrying out the rectification work including finishing of floors, walls and ceiling damaged in the process of rectifications.
- 14.9 The contractor shall provide all labours and materials to make provision for removing water and throwing it at the proper place, during the testing or/and after the testing to avoid damages to employer or other contractors 'properties. Any damages caused by the contractor to the employer or other contractors' properties, shall be borne by the contractor.

#### 15. **FLEXIBLE CONNECTIONS**

- i) The Flexible connections shall be flanged type expansion joint. Flanges shall be non-compressible and mechanically strong type and the Neoprene rubber shall be provided in between the flange ends.
- ii) The connections shall work for a temperature range of minus 10°C to 70°C.

iii) The length and working pressure of bellows shall be as follows:

Nominal Bore (mm)	Length (mm)	Test Pressure (Bars)
Upto 200	150	16
Above 200	200	16

- i) Connections shall be provided with control roads to control the excessive elongation or compression of piping systems.
- ii) It shall have torsional movement upto 3° without damage.
- iii) Bellows shall be single arch.

## 16. COPPER PIPING

- 16.1 Heavy gauge soft copper tubing, type M shall be used to make connections to equipment, wherever required or specified by engineer-in-charge.
- 16.2 Flare fittings e.g. Flare nuts, tees, elbows, reducers etc. shall all be of brass.

## 17. REFRIGERANT PIPING

- 17.1 The refrigerant circuit piping shall be heavy class M.S the fittings shall be heavy class. The pipes and fittings shall be connected by means of welded joints. The connections to gauges, controls etc. Shall be with soft copper tubing and flare fittings.
- 17.2 The refrigerant valves, required in the circuit shall be as follows.

<u>Valve Size</u>	<u>Valve Material</u>	<u>Type of Connections</u>
17.2.1 Upto 12 mm	brass/packless type	flare fittings
17.2.2 16mm & above	brass/steel packed type	brazed/welded

Note :- All valves shall be tested against leaks upto 20 kg/sq.cm.

- 17.3 The strainers for the refrigerant liquid line shall be 'Y' type with gun metal body and bronze filter screen of fine mesh. The filter screen shall be easily removable type without dismantling the strainer from the circuit.
- 17.4 The moisture indicator in the liquid line shall have leak proof glass on opposite sides to permit easy inspection of the liquid refrigerant.

## 18. DRAIN PIPING

- 18.1 The drain piping shall be medium class galvanized steel as per IS 1239/1979.
- 18.2 The fittings shall be of 'R'/UNIK make brand or equal forged with screwed connections.
- 18.3 The gate valves shall be of gun metal as described earlier.
- 18.4 Pipe crosses shall be provided at bends, to permit easy cleaning of drain line.
- 18.5 The drain line shall be provided upto the nearest drain trap and pitched towards the trap.
- 18.6 Drain lines shall be provided at all the lowest points in the system, as well as at equipments, where leakage of water is likely to occur, or to remove condensate and water from pump glands.

## 19. INSTALLATION

- The installation work shall be carried out in accordance with the detailed drawings prepared by the Air-conditioning Contractor and approved by the Engineer-in-charge.

- Air-conditioning contractor shall utilize the structural provisions for Air-conditioning services wherever provided by the Department in the building and make his own arrangements for additional changes.
- Expansion loops or joints shall be provided to take care of expansion or contraction of pipes due to temperature changes.
- Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.
- Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely, in other locations, concentric reducers may be used.
- Open ends of piping shall be blocked as soon as the pipe is installed to avoid entrance of foreign matter.
- All pipes using screwed fittings shall be accurately cut to the required size and threaded in accordance with IS: 554 and burs removed before laying.
- Piping installation shall be supported on or suspended from structure adequately. The Air conditioning contractor shall design all brackets, saddles, clamps, hangers etc. and shall be responsible for their structure integrity.
- Pipe supports, preferably floor mounted shall be of steel, adjustable for height and prime coated with zinc chromate paint and finish-coated gray. Spacing of pipe supports shall not be more than that specified below:

Nominal Pipe size (mm)	Spacing (Meters)
12 and 15	1.25
20 and 25	2.00
32, 40, 50 and 65	2.50
80, 100 and 125	2.50
150 and above	3.00

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stress on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic or rawl plugs or approved shear fasteners.

- Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation.
  - Anti vibration pads, springs or liners of resilient and non-deteriorating, material shall be provided at each support, so as to prevent transmission of vibration through the supports.
  - Pipe sleeves of diameter larger than the pipe by least 50 mm shall be provided wherever pipes pass through walls and the annular spaces shall be filled with felt and finished with retaining rings.
- i. Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe with a 12 mm thick rubber pad or any other resilient material as approved by the Engineer-in-charge.
  - ii. The space in the floor cut outs around the pipe work (after insulation work where applicable) shall be closed using cement concrete (1 :2:4 mix) or steel sheet, from the fire safety considerations, taking care to see that a small annular space is left around the pipes to prevent transmission of vibration to the structure.



- iii. Riser shall have suitable supports at the lowest point.
  - Where pipes are to be buried under ground, the top of the pipes shall be not less than 75 cms. from the ground level. Where this is not practicable, permission of the Engineer-in-charge shall be obtained for burying the pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushion of not less than 15 cms. After the pipes have been laid and top sand cushion provided, the trench shall be refilled with the excavated soil and any extra soil shall be removed from the site of work by the Air conditioning contractors.
  - All pipes and their steel supports shall be thoroughly cleaned and given one primer coat of Zinc chromate before being installed.
  - After all the water piping has been installed, pressure tested in accordance with clause 5.10, all exposed piping in the plant room shall be given two finish coats of paint, approved by the Engineer-in-Charge. Similar painting work shall be done over insulated pipe work, valves etc. The direction of flow of fluid in the pipes shall be indicated with identifying arrows.
  - 3mm gasket shall be used for flanged joints.
- iv) Cut-outs in floor slabs shall be sealed with cement concrete or steel plate after the plumbing work is done, from the fire safety point of view.

## 20. **PRESSURE TESTING**

- All piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure, but not less than 10 kg/sqcm for a period not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Engineer-in-charge.
- Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.
- System may be tested in sections and such sections shall be securely capped.
- It shall be made sure that proper noiseless circulation is achieved through all the coils and other heat exchange equipments in the system. If proper circulation is not achieved due to air-bound connections the contractor shall rectify the defective connections. He shall bear all the expenses for carrying out the above rectification including the tearing up and refinishing of floors, walls etc. as required. Insulation shall be applied to piping only after the completion of the pressure testing to the satisfaction of the Engineer-in-charge.
- Pressure gauges may be capped off during pressure testing of the installation.
- The contractor shall provide all materials, tools, equipments, Instruments, services and labor required to perform the tests and to remove water resulting from cleaning after testing.

## 21. **BALANCING**

- After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified, quoted, or as directed.
- Automatic control valves and three way diverting valves shall be set for full flow condition during balancing procedure. Water circuit shall be adjusted by balancing cocks provided for balancing. These shall be permanently marked after the balancing is completed so that they can be restored to their correct positions, if disturbed.

## 22. MEASUREMENT

Measurements of plumbing work shall be on following basis:

- Piping shall be measured along the centre line of installed pipes including all pipe fittings and accessories but excluding valves and other items for which quantities are specifically indicated in the schedule of work. No separate payment shall be made for fittings and accessories.
- The rates for piping work shall include all wastage allowances, pipe supports, hangers, nuts and check nuts, vibration isolators, suspension where specified or required and any other item as required to complete the piping installation. None of these items will be separately measured nor paid for.
- Piping measurement shall be taken before application of the insulation in the case of insulated pipe work.

## 23. PAINTING

23.1 All pipes supports, hangers, etc., shall be given two coats of red oxide primer.

23.2 All pipes, which are not to be insulated, shall then be given one coat of finish paint, of a type and colour, as per ISI code.

**Note:-** All valves should be BMS compatible.

## **INSULATION**

### 1. GENERAL

The Insulation of ducting, etc., shall be carried out as per specifications given below :

### 2. MATERIALS

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere.

#### 2.1 Duct Insulation :

2.1.1 The material for acoustic treatment of ducts shall open cell nitrile rubber.

2.1.2 The insulation for duct shall be carried out from closed cell polyethylene having a 'K' value of 0.034 W/(M.K) at mean temperature of 23<sup>o</sup> C. and a density of not less than 33 kgs/cubm. Water vapour permeability 4000 U and above. Fire rating class BI as per (DIN 4102). Approval of sample to be obtained in writing prior to execution.

### 3. DUCTING

3.1 The ducts shall be insulated with the insulation sheets as follows.

Duct insulation	-	9 mm thick
Duct acoustic lining	-	10 mm thick

## **ELECTRIC WIRING**

### 1. GENERAL

The electric wiring of motors for compressors, pumps, air handling units etc. As well as controls, heaters etc. and earthing of all equipment shall be carried out as per specifications given hereunder.

### 2. WIRING FOR MOTORS, HEATERS ETC

- 2.1 The wiring for above equipment shall be carried out in conduits or using PVC armoured cables.
- 2.2 The PVC armoured power cable for use on 415 volts system shall be 3 or 3.5 core with aluminium conductors and be of 1100 volts grade, as per IS 1554 part I-1964. The cross section of the cable shall be to suit the load or rating of the equipment. The cable shall be aluminium conductor PVC insulated single wire/strip armoured with overall PVC sheathing.
  - 2.2.1 The cables shall be laid as per IS-1255/1967, Indian Standard Code of Practice.
  - 2.2.2 The cables shall be laid, as per drawings or along a short and convenient route between switch board and the equipment, either in trenches, on wall or on hangers, supported from the slab. Cable routing shall be checked on the site to avoid interference with structure, equipment etc. Where more than one cables are running close to each other, proper spacing should be provided between them.
  - 2.2.3 The radius of bends of the cable should not be less than 12 times the radius of cable to prevent undue stress and damage at the bends, the cables should be supported with wooden cleats fixed on M.S. Supports, when running in trenches, wall or ceiling suspended hangers. When laid under ground the cables should be covered with fine soft earth and protected with cement concrete covering. Suitable G.I. Pipe shall be used wherever the cable comes out of the connected surface and clamped properly.
  - 2.2.4 Wooden bushes shall be provided at the ends of pipes through which cables are taken in walls and floors.
  - 2.2.4 All cables shall be terminated using suitable size cable glands and packing.
- 2.3 The wiring in conduits shall be 1100 volts grade.
  - 2.3.1 The conduits used shall be of high quality, all joints shall be made with sockets. The bends and elbows shall have inspection covers fixed with grease free screws. The joints shall be water tight. Approved metal saddles shall be used to secure the exposed conduits at a space of 1 meter or less. The connection of the conduit to switches etc., shall be secured by a check nut and ebonite bushes provided at the ends of conduits.
  - 2.3.2 Flush inspection covers shall be provided in case of concealed, recessed conduits. The staples for the conduits shall not be spaced more than 0.60 meters apart. Before filling up the chase with concrete the conduits should be given a coat of rust proof paint.
  - 2.3.3 The wires shall be drawn only after all the conduits have been properly fixed in position.

**3. CONTROL WIRING**

- 3.1 Control cables shall be 1100 volts grade as per IS 1554 made from copper conductor of 1.5/2.5 sq. mm PVC insulated single multi core unarmoured with an overall PVC sheathing.
- 3.2 The cables and conduits wiring shall be carried out as per details given under 2.2 and 2.3 above.

**4. EARTHING**

- 4.1 All equipment connected with electric supply shall also be provided with double earthing continuity conductors. The size of copper earthing conductors shall be :-

Size of phase wire sq.mm Aluminium	size of copper conductor tape/wire (swg)
300	25 mm x 6 mm (strip)

185	20 mm x 3 mm (strip)
150	20 mm x 3 mm (strip)
120	12 mm x 3 mm (strip)
95	4 Swg
70	4 Swg
50	6 Swg
35	8 Swg
25-6	8 Swg
4	10 Swg

Note :- GSS earthing conductors of equivalent size may be used in lieu of copper earth mentioned above.

## 5. MISCELLANEOUS

- 5.1 The final connections to the equipment shall be through flexible connections in case of conduit wiring and also where the equipment is likely to be moved back and forth, such as on slide rails.
- 5.2 An isolator switch shall be provided at any motor which is separated from the main switch panel by a wall or partition or other barrier or is more than 15 metres away from the main panel.
- 5.3 Two separate and distinct earthing conduits shall be connected from the equipment upto the main switch board panel.
- 5.4 The branch lines from the main panel to each equipment shall be separated and should not criss cross other lines.
- 5.5 The entire installation shall be tested as per electricity rules and I.S.S 732-1973 with amendments 1,2 & 3 prior to the commissioning of the plant and a suitable test report furnished by a competent and authorized person. The test report will be obtain by contractor himself at his own expenses.
- 5.6 All exposed switch board panels, conduits, hangers etc. shall be given 2 coats of suitable paint of approved colour, when all work has been completed.

## **TESTS AT SITE/WORKS**

### 1. GENERAL

The contractor must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the Architect/Consultants, in accordance with the provisions of the applicable ASHRAE standards or approved equal and furnish necessary test certificates from manufacturers at the time of delivery of requirement at side.

### 2. DUCT WORK

- 2.1 All branches and outlets shall be tested for air quantity, and the total of the air quantities shall be within plus five percent (5%) of fan capacity.
- 2.2 Fire dampers, volume dampers and splitter dampers shall be tested for proper operation.

### 3. **BALANCING AND ADJUSTMENT**

All airhandling and ventilation equipment, duct work and outlets shall be adjusted and balanced to deliver the specified air quantities as indicated, at each outlet, on the drawings and shall be recorded and submitted to the consultant. If these air quantities cannot be delivered without exceeding the speed range of the sheaves or the available horse power, the consultant shall be notified before proceeding with the balancing of air distribution system.

### 4. **ELECTRICAL EQUIPMENT**

- 4.1 All electrical equipment shall be cleaned and adjusted on site before application of power.
- 4.2 The following tests shall be carried out :
  - 4.2.1 Wire and cable continuity tests.
- 4.3 Insulation resistance tests, phase to phase and phase to earth, on all circuits and equipment, using a 500 Volts meggar. The meggar reading shall be not less than one megohm.
- 4.4 Earth resistance between conduit system and earth must not exceed half (1/2) CMH.
- 4.5 Phasing out and phase rotation tests.
- 4.6 Operating tests on all protective relays to prove their correct operation before energising the main equipment.
- 4.7 Operating tests on all starters, circuit breakers, etc.

### 5. **PERFORMANCE TESTS**

- 5.1 The installation as a whole shall be balanced and tested upon completion, and all relevant information, including the following shall be submitted to the architects.
  - 5.1.1 Air volume passing through each unit, duct, grilles, apertures.
  - 5.1.2 Differential pressure readings across each filter, fan and coil, and through each pump.
  - 5.1.3 Static pressure in each air duct.
  - 5.1.4 Electrical current readings, in amperes of full and average load running, and starting, together with name plate current of each electrical motor.
  - 5.1.5 Continuous recording over a specified period, of ambient wet and dry bulb temperatures under varying degrees of internal heat loads and use and occupation, in each zone of each part of the building.
- 5.2 Daily records should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream "on coil" of each cooling coil. Also suction temperatures and pressures for each refrigerating unit. The current and voltage drawn by each machine.
- 4.3 Any other readings shall be taken which may subsequently be specified by the architect.

### 6. **MISCELLANEOUS**

- 6.1 The above tests are mentioned herein for general guidance and information only but not by way of limitation to the provisions of conditions of contract and specification.
- 6.2 The date of commencement of all tests listed above shall be subject to the approval of the architect, and in accordance with the requirements of this specification.
- 6.3 The contractor shall supply the skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system if the architect requests such a test for determining specified or guaranteed data as given in the specification or on the drawings.

- 6.4 Any damage resulting from the tests shall be repaired And/or damaged material replaced, all the satisfaction of the architect.
- 6.5 In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed.
- 6.6 The contractor must inform the architect when such tests are to be made, giving sufficient notice, in order that the architect or his nominated representative may be present.
- 6.7 Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the architect.
- 6.8 The contractor may be required to repeat the test as required, should the ambient conditions at the time not given, in the opinion of the architect, sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

## **MODE OF MEASUREMENTS**

### **1. UNIT PRICES IN THE SCHEDULE OF QUANTITIES**

- 1.1 The item description in the schedule of quantities is in the form of a condensed resume. The unit price shall be held to include every thing necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum total of all the individual item prices shall represent the total price of the installation ready to be handed over.
- 1.2 The unit price of the various items shall include the following :
  - 1.2.1 All equipment, machinery, apparatus and materials required as well as the cost of any tests which the consultant may request in addition to the tests generally required to prove quality and performance of equipment.
  - 1.2.2 All the labour required to supply and install the complete installation in accordance with the specifications.
  - 1.2.3 Use of any tools, equipment, machinery, lifting tackle, scaffolding, ladders etc. Required by the contractor to carry out his work.
  - 1.2.4 All the necessary measures to prevent the transmission of vibration.
  - 1.2.5 The necessary material to isolate equipment foundations from the building structure, wherever necessary.
  - 1.2.6 Storage and insurance of all equipment apparatus and materials.
- 1.3 The contractor's unit price shall include all equipment, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

### **2. MEASUREMENTS OF SHEET METAL DUCTS, GRILLES/DIFFUSERS ETC.**

#### **2.1 Sheet Metal Ducts**

- 2.1.1 All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars, vanes & other fittings. Gaskets, nuts, bolts, vibration rotation pads are included in the basic duct items of the boq.
- 2.1.2 The unit of measurements shall be the finished sheet metal surface area in metres squares. No extra shall be allowed for lapse and wastages.

- 2.1.3 All the guide vanes, deflectors in duct elbows, Branches, grille collars quadrant dampers etc. Shall be measured for actual sheet metal surface and paid for at the same rate as duct of same thickness.
- 2.1.4 The unit duct price shall include all the duct hangers And supports, exposing of concrete reinforcement for supports and making good of the same as well as any materials and labour required to complete the duct frame.

## 2.2 **Grilles/Diffusers :**

- All grilles/diffusers as per tender requirements shall be treated as a lump sum item. Where extra grilles diffusers are ordered upto award of work, they should be measured as follows :
- 2.2.1 All measurements of grilles/diffusers shall be the Actual outlet size excluding the outer flanges.
  - 2.2.2 The square or rectangular grilles/diffusers shall be Measured in plain sq.m.
  - 2.2.3 All round diffusers shall be measured by their diameters in cm.
  - 2.2.4 All linear diffusers shall be measured as per actual Length in metres.

## 3. **MEASUREMENTS OF PIPING, FITTINGS, VALVES, FABRICATED ITEMS**

### 3.1 **Pipe**

- (Including water piping, steam piping, oil piping, IP gas piping, air piping, vacuum piping) etc.
- 3.1.1 All pipes shall be measured in linear metre (to the Nearest cm) along the axis of the pipes and rates shall be inclusive of all fittings e.g. Tees, bends, reducers, elbows etc. Deduction shall be made for valves in the line.
  - 3.1.2 Exposing reinforcement in wall and ceiling and floor of possible and making good the same or installing anchor fasteners and inclusive of all items as specified in specifications and schedule of quantities.
  - 3.1.3 Rates quoted shall be inclusive of providing and fixing Vibration pads and wooden pieces, wherever specified or required by the project co-ordinator.
  - 3.1.4 Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowance being made for providing the same.
  - 3.1.5 The length of the pipe for the purpose of payment will be taken through the centreline of the pipe and all fittings (e.g. Tees, bends, reducers, elbows, etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings for valves and flanges, section 3.2 below applies.

### 3.2 **Valves and Flanges**

- 3.2.1 All the extra CI & cm flanged valves shall be measured according to the nominal size in mm and shall be measured by number. Such valves shall not be counted as part of pipe length hence deduction in pipe length will be made wherever valves occur.
- 3.2.2 All gun metal (gate & globe) valves shall include two Nos. of flanges and two numbers 150 mm long ms nipples, with one side threaded matching one of the valves, and other welded to the M.S. Slip-on-flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 mm thick insertion gasket of required temp. grade and all items specified in the specifications.
- 3.2.3 The rates quoted shall be inclusive of making connections to the equipment, tanks, pumps etc. And the connection made with an installed pipe line shall be included in the rates as per the B.O.Q.

### 3.3 **Structural Supports**

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and schedule of quantities or as required a site by project co-ordinator.

### 3.4 **Copper Connections for Fan Coil Units**

3.4.1 Copper connection assembly for making connections to the fan coil units shall be measured, as part of the fan coil unit price and shall include brass flare nuts, brass straight connector, brass tees, brass reducing fittings, fixing of automatic 3 way valve, making connections and leak testing, complete assembly as per specifications and drawings. Nothing extra shall be payable on account of any variation in the length of copper pipe.

## 4. **INSULATION**

4.1 The measurement for vessels, piping, and ducts shall be made over the bare uninsulated surface area of the metal.

### 4.2 **Pipes, Ducts & Vessels**

#### 4.2.1 **Pipes**

The measurements for installation of piping shall be made in linear metres through all valves, flanges, and fittings. Pipes/bends shall be measured along the centreline radius between tangent points. If the outer radius is R1 and the inner radius is R2. The centre line radius shall be measured as  $(R1+R2)/2$ . Measurement of all valves, flanges and fittings shall be measured with the running metre of pipe line as if they are also pipe lengths. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured as part of the larger size.

#### 4.2.2 **Ducts**

The measurements for insulation of ducts shall be made in actual square metres of bare uninsulated duct surface through all dampers, flanges and fittings. In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for the dampers, flanges, fittings shall be for the surface dimension for the connecting duct, nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

#### 4.2.3 **Vessels**

The area of standard dished and flat ends of vessels shall be the square of the diameter of the uninsulated body of the shell. Areas for other shapes shall be the actual calculated area. There shall be no deduction or additions for nozzles, handles ribs, dampers, expansion joints etc. All projections on vessels or tanks shall be measured separately as pipe/duct.

### 4.3 **Accessories Insulation**

4.3.1 The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be uninsulated are in square metres.

4.3.2 In case of curved or irregular surfaces, measurements shall be taken along the curves.



4.3.3 The unit insulation price shall include all necessary adhesives, vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.

#### 4.4 **Acoustic Duct Lining**

4.4.1 In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square metres, shall be final for billing purposes.

4.4.2 The insulation/acoustic panels shall include cost of battens, supports, adhesives, vapour proofing, finished tiles/boards/sheets as well as additional labour and materials required for completing the work.

#### 4.5 **Roof and Wall Insulation & Acoustic Treatment**

4.5.1 The unit of measurement for all underdeck roof insulation, wall insulation, wall/roof acoustic panel shall be the uninsulated area of walls, roofs, to be treated, in square metres.

4.5.2 The insulation, acoustic panels shall include cost of battens, supports, adhesives, vapour proofing, finished tiles/boards/sheets as well as additional labour and materials required for completing the work.

### **VALVES & FITTINGS**

#### 1. **SCOPE**

The scope of this section comprises the supply, laying, erection, testing and commissioning of pipes required for this project as per drawings.

#### 2 **BUTTERFLY VALVES**

- a) size up to 150 mm dia (PN 16) Handle Operated
- b) size 200 mm dia and above (PN16) Gear Operated

#### 3, **TWO WAY MOTORIZED BUTTERFLY VALVE**

##### 3.1 Valve

- a. Type of valve : Butterfly Valve.
- b. Body Material : Carbon steel ASTM A 216
- c. Body seat ring (if applicable) : Gr WCB
- d. Vane : SS-316
- e. Packing : Teflon
- f. Mounting Stool : Required.
- g. Shaft : SS-316
- h. Seat : Nitrile rubber
- J Fasteners : SS-316

##### 3.2 **Actuators**

- Type : Electric
- Duty. : On/Off (Maximum 50 operations per day)
- Motor power supply : 230 V AC or 415 V 3-phase
- Travel limit switches : 2 Nos
- Torque limit switches. : 2 Nos
- Hand wheel : Required
- Speed : Approx 150 mm/min

NOTE:-

- a. Actuator must open/ close with one changeover contact. Control panel, if required, must be supplied integral with the Actuator.
- b. No gear box is envisaged, however if gear box is provided, the travel limit switches must be connected directly to the valve stem.
- c. Cover tube for the valve stem must be provided

4. **POT STRAINERS**

Strainers shall be of approved type with fabricated steel bodies designed to the test pressures specified for the valves. Strainers shall have removable stainless steel screen with 1.5 mm perforations and a permanent magnet. Strainers shall be provided with flanges as required. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe. All strainers shall be provided with equal size isolating valves and by-pass line so that the strainer may be cleaned without draining the system. Strainers shall be provided on the suction header of the pumps wherever shown in the drawings. The velocity across the filter mesh should not exceed one fifth of the velocity in the connecting pipe. The area of the filter mesh shall be five times of the area of the pipe connection.

5. **EXPANSION TANK & AIR SEPARATOR**

5.1 **EXPANSION TANK**

The chilled water system shall be provided with pre-charged steel expansion tank in the plant room as shown on the drawings. The tank should be designed to absorb the expansion forces of the chilled water system while maintaining proper system pressure under varying operating system conditions. The shell of the tank shall be constructed out of carbon steel conforming to section 8, of ASME boiler & pressure vessel code. The vessel shall be designed for maximum design pressure of 150 psig. The tank shall be painted with one shop coat of dry enamel paint. The tank shall be provided with two 1 inch tappings in the shell for safety relief and system connection. The tank shall also have suitable size drain connection. The tank shall have replaceable type, butyl – rubber bladder. The tank shall be pre-fitted with lifting rings & shall have suitable mounting arrangement. Expansion Tank shall be with pressurization unit complete with pressure gauges, transmitter, valves etc. including 2 pump sets (1 working 1 standby) whole assembly shall be from one source, pump rating shall be as per manufacturer standard and as per requirement.

5.2 **AIR SEPARATOR**

The air separator shall be constructed out of steel suitable for a maximum pressure of 150 psig at maximum Operated Temperature 350°F / 177°C. The tank shall be complete with air separation fittings, air venting arrangement, strainer with equally sized Ball type isolation valve, pressure reducing valves, isolation valves, quick fill connection, inlet & outlet flanges. The air separation efficiency shall be more than 96-98 %. The model shall be got approved from the engineer-in-charge before placement of order.

Air separator shall be insulated as per specifications given under head of “Insulation”.

## **LIST OF APPROVED `MAKES`**

<b><u>S.No.</u></b>	<b><u>Items</u></b>	<b><u>Approved Makes</u></b>
1.	Airhandling unit	Zeco/Edgetech/VTS/Systemair
2.	AHU/FCU Motor	ABB/Havells/Siemens/Marathon
3.	VFD	Siemens/Danfoss/ABB/VTS
4.	Inline fan Ostberg/Greenheck/Sphere/Caryaire/	Airflow
5.	Chilled Water Hi-Wall Unit	Edgetech/Caryaire/Midea
6.	Starters/switchgear	Siemens/Larsen & Tubro/ABB/C&S
7.	Control cables	Finolex/Skytone/Havells/Rallison/ KEI
8.	Power cables	Finolex/Skytone/Havells/Rallison/ KEI
9.	Push button starters	Siemens/ABB/L&T/Allen Bradley
10.	Auxiliary relays/contractors	Siemens/L&T/Cutler Hammer/ Jyoti/C&S
11.	Line type fuse	Siemens/English Electric/L&T/C&S
12.	Timer	Siemens/L&T/Cutler Hammer/ English Electric/C&S
13.	Terminal block	Elmex/Siemens/C&S
14.	Indicating lamps	Siemens/L&T/Control and Switch- gear/Cutler Hammer
15.	Selector switches	Siemens/L&T/Kaycee/C&S
16.	Electrical panel	RR Controls/Application/Advance/ EAP/Risha Control/kepl
<b><u>S.No.</u></b>	<b><u>Items</u></b>	<b><u>Approved Makes</u></b>
17.	Grilles/Jet Nozzle/Diffuser/Fire Dampers/ Drum Diffusers/ Back draft damper/ Motorized Damper	Servex/Caryaire/Mapro/Tristar/ Systemair

18.	Actuator assembly	Belimo/Danfoss/Siemens
19.	G.I. sheets	Tata/Sail/Jindal/Lloyd
20.	G.I. Ducting	Ductofab/Zeco/Rollastar/ MK Ducting/IQRA
21.	Sensors	Greystone/Aerosense/Omicron/ Dwyer
22.	<b><u>Pipe</u></b>	
22.1	M.S.	Tata/Jindal Hissar/Apollo tubes
22.2	G.I.	Tata/Sail/Jindal Hissar
23.	Refrigerant piping	Mandev/Indigo/Mehta Tubes/ Maxflow
24.	UPVC pipes	Supreme/Prince/Polypack
25.	Flexible pipe connection	Resistoflex/Easyflex
26.	<b><u>Valves &amp; Strainer</u></b>	
26.1	Butterfly valve	Advance/Honeywell/ SKS/ALP
26.2	Motorized Butterfly Valve	Advance/Honeywell/SKS/ALP
26.3	Balancing valve	Advance/Honeywell/SKS/ALP
26.4	Non return valve	Advance/Honeywell/SKS/ALP
26.5	Y-Strainer	Emerald/Rapidcool/SM/Sant/ALP
26.6	Pot Strainer	Rapidcool/Emerald/SM/Sant
26.7	Pressure gauge	Emerald/Anergy/Honeywell
<b><u>S.No.</u></b>	<b><u>Items</u></b>	<b><u>Approved Makes</u></b>
26.8	Thermometer	Emerald/Anergy/Honeywell
26.9	Ball Valves	Rapidcool/Emerald/CIM/Sant/ Advance/Utam&VTM
26.10	PICB valve Oventrop/Caleffi	Danfoss/Frese/
27.	<b><u>Insulation</u></b>	
27.1	Glass wool	U.P. Twiga/Owen Corning/K-wool

27.2	Nitrile rubber	Armacell/K-flex/Aerocell
27.3	Expanded polystyrene	SHI/Beardshell/Styrene Packaging
28.	PUF insulation	Lloyd/Malanpur
29.	Vibration isolator pads	Resistoflex/Kanwal
30.	Paracoat BPC	Paramount/Pidilite
31.	Cable tray	Feders Lloyd/MEM/Profab/RICO
32.	Paint	Nerolac/Asia/Berger

### **LIS T OF DRAWINGS**

<b>S.No.</b>	<b>Description</b>	<b>Floor</b>	<b>Sheet No.</b>
1.	HVAC Layout	Ground Floor	IIIT/AC/TL/AC-101

## **APPENDIX-A** **TERMINOLOGY**

- I) Air conditioning  
The process of treating air so as to control simultaneously its temperature, humidity, purity, distribution and air movement and pressure to meet the requirements of the conditioned space.
- II) Dry-Bulb Temperature  
The temperature of air as registered by an ordinary thermometer.
- III) Wet-Bulb temperature  
The temperature registered by a thermometer whose bulb is covered by a wetted wick and exposed to a current of rapidly moving air.
- IV) Dew point Temperature  
  
The temperature at which condensation of moisture begins when the air is cooled at same pressure.
- V) Humidity  
It is the amount of water vapour present in a certain volume of air.
- VI) Relative Humidity  
Ratio of the actual water vapor in the air as compared to the maximum amount of water that may be contained at its dry bulb temperature. When the air is saturated, dry bulb, wet bulb and dewpoint temperatures are all equal.
- VII) Enthalphy  
A thermal property indicating the quantity of heat in the air above an arbitrary datum in kilo joules per kg of dry air (or in Btu per pound of dry air).
- VIII) Psychrometry  
Psychrometry is the science involving thermo dynamic properties of moist air and the effect of atmospheric moisture on materials and human comfort. It also includes methods of controlling thermal properties of moist air.
- IX) Psychrometric Chart  
A Psychrometric chart graphically represents the thermodynamic properties of moist air. If two properties are known, all the other properties can be determined with the help of psychrometric chart.
- X) Evaporative air cooling  
The evaporative air-cooling application is the simultaneous removal of sensible heat and the addition of moisture to the air. The water temperature remains essentially constant at the wet-bulb temperature of the air. This is a process in which heat is not added or removed from the air.
- XI) Positive Ventilation

The supply of outside air by means of a mechanical device, such as a fan.

XII) Atmospheric Pressure

The pressure of air exerted on the surface of earth by the atmospheric column is called atmospheric pressure. At sea level, the atmospheric or barometric pressure is 760mm column of mercury (29.92 in Hg/406.8 inch water column/101.325 Kpa).

Generally atmospheric pressure is used as a datum for indicating the system pressures in

air-conditioning and accordingly, pressures are mentioned above the atmospheric pressure or below the atmospheric pressure considering the atmospheric pressure to be zero. A 'U' tube manometer will indicate zero pressure when atmospheric pressure is measured.

XIII) Indoor Air Quality (IAQ)

Indoor air quality refers to the nature of conditioned air that circulates throughout the space/ area where one works or lives, i.e. the air we breath when we are indoor. IAQ refers not only to comfort which is affected by temperature, humidity and odours but also to harmful biological contaminants and chemicals present in the conditioned space.

Bad Indoor Air Quality can be a serious health hazard. Carbon dioxide (CO<sub>2</sub>) has been recognized by ASHRAE as the surrogate ventilation index or the only measurable variable for the indoor air contaminants.

XIIIA) Buildings Related Illnesses (BRI)

BRI are attributed directly to the specific air-borne building contaminants like the outbreak of the legionnaire's disease after a convention and sensitivity pneumonitis with prolonged exposure to the indoor environment of the building.

XIV) Sick Building Syndrome (SBS)

SBS is a term, which is used to describe the presence of acute non-specific symptoms in the majority of people caused by working in buildings with an adverse indoor environment It could be a cluster of complex irritative symptoms like irritation of the eyes, blackened nose and throat, headaches, dizziness, lethargy, fatigue irritation, wheezing, sinus, congestion, skin rash, sensory discomfort from odours, nausea, etc. These symptoms are usually short-termed and experienced immediately after exposure, and may disappear when one leaves the building.

XV) Hydronic Systems

Water systems that convey heat to or from a conditioned space or process with hot or chilled water are frequently called hydronic systems. The water flows through piping that connects a chiller or the water heater to suitable terminal heat transfer units located at the space or process.

XVI) Water conditioning

Water circulating in a hydronic system may require to be treated to make it suitable for air-conditioning system due to effect on the economics of air-conditioning plant. Unconditioned water used in air-conditioning system may create problems with equipments such as scale formation, corrosion and organic growth.

XVII) Water Hardness

Hardness in water is represented by the sum of calcium and magnesium in water and may also include aluminium, iron, manganese, zinc, etc. A chemical analysis of water sample should provide number of total dissolved solids (TDS) in a water sample in parts per million (ppm) as also composition of each of the salts in parts per million.

Temporary hardness is attributed to carbonates and bi-carbonates of calcium and/or magnesium expressed in parts per million (ppm) as  $\text{CaCO}_3$ . The remainder of the hardness is known as permanent hardness, which is due to sulfates, chloride, nitrites of calcium and/or magnesium expressed in ppm as  $\text{CaCO}_3$ .

Temporary hardness is primarily responsible for scale formation, which results in poor heat transfer resulting in increased cost of energy for refrigeration and air-conditioning. Permanent hardness (non-carbonate) is not a serious a factor in water conditioning because it has a solubility which is approximately 70 times greater than the carbonate hardness. In many cases, water may contain as much as 1200 ppm of non-carbonate hardness and not deposit a calcium sulfate scale.

The treated water where hardness as ppm of  $\text{CaCO}_3$  is reduced to 50 ppm or below, is recommended for air-conditioning applications.

XVIII) Thermal Transmittance

Thermal transmission through unit area of the given building unit divided by the temperature difference between the air or some other fluid on either side of the building unit in 'steady state' conditions.

XIX) Thermal Energy Storage

Storage of 'Cold Energy' sensible, latent or combination for use in central system for air-conditioning or refrigeration is called thermal energy storage. It uses a primary source of refrigeration for cooling and storing 'Cold Energy' for reuse at peak demand or for backup as planned.

XX) Shade factor

The ratio of instantaneous heat gain through the shading device to that through a plain glass sheet of 3mm thickness.

XXI) Sensible heat factor (SHF)

Sensible heat factor is the ratio of sensible heat to total heat, where total heat is the sum of sensible and latent heat.

XXII) Supply Air

The air that has been passed through the conditioning apparatus and taken through the duct system and distributed in the conditioned space is termed as supply air.

XXIII) Return Air

The air that is collected from the conditioned space and returned to the conditioning equipment is termed as return air.

XXIV) Re-Circulated Air



The return air that has been passed through the conditioning apparatus before being re-supplied to the space is called re-circulated air.

XXV) Duct system

A continuous passageway for the transmission of air which in addition to the ducts may include duct fittings, dampers, plenums and grilles & diffusers.

XXVI) Plenum

An air compartment or chamber to which one or more ducts are connected and which forms part of an distribution system.

XXVII) Supply and Return Air grilles & Diffusers

Grilles and diffusers are the devices fixed in the air-conditioned space for distribution of conditioned supply air and return of air collected from the conditioned space for re-circulation.

XXVIII) Fire damper

A closure which consists of a normally held open damper installed in an air distribution system or in a wall or floor assembly and designed to close automatically in the event of a fire in order to maintain the integrity of the fire separation.

XXIX) Smoke damper

A smoke damper is similar to fire damper. However, it closes automatically on sensing presence of smoke in air distribution system or in conditioned space.

XXX) Fire separation wall

The wall provides complete separation of one building from another or part of a building from another part of the same building to prevent any communication of fire of any access or heat transmission to wall itself which may cause or assist in the combustion of materials of the side opposite to that portion which may be on fire.

XXXI) Refrigerant

The fluid used for heat transfer in a refrigerating system, which absorbs heat at a low temperature and low pressure of the fluid and rejects heat at a higher temperature and higher pressure of the fluid, usually involving changes of state of the fluid.

XXXII) Global Warming Potential (GWP)

Global Warming can make our planet and its climate less hospitable and more hostile to human life. It is, therefore, necessary to reduce emission of green house gases such as Co<sub>2</sub>, Sox, Nox and refrigerants. The potential of a refrigerant to contribute to Global Warming is called its GWP. Long atmospheric life time of refrigerants results in Global Warming unless the emissions are controlled.

XXXIII) Ozone Depletion Potential (ODP)

The potential of refrigerant or gasses to deplete the Ozone in the atmosphere is called ODP. The ODP values for various refrigerants are as under:-

R-11	1.000
R-12	0.820
R-22	0.034
R-123	0.012
R-134a	Nil

Due to high OPD of 1, R-22 & R-123 their use in the air conditioning and refrigeration is being phased-out.

**APPENDIX-B**  
**LIST OF RELEVANT INDIAN STANDARDS**

I.S.3615	Glossary of Terms Used in Refrigeration & Air Conditioning.
I.S.325	Three phase Induction Motors
I.S. 1822	Motor Starters of voltage Not Exceeding 1000 volts
I.S.3624	Bourden Tube Pressure and Vacuum Gauges
I.S.2372	Timber for cooling towers
I.S.7403	Code of practice for selection of standard worm and helical gear boxes
I.S.1620	Horizontal centrifugal pumps for clear, cold, fresh water
I.S.996	Single phase small A.C. and Universal motors
I.S.1239	Mild steel tubes, tubulars and other wrought steel fittings
I.S.3589	Electrically welded steel pipes for water, gas and sewage,
I.S.6392	Steel pipe flanges
I.S.778	Gun metal gate, globe and check valves for general purpose
I.S.2592	Recommendation for methods of measurement of fluid flow by means plates and nozzles
I.S. 277	Galvanised steel sheets
I.S.737	Wrought aluminium and aluminium alloy sheet and strip for general purposes.
I.S.655	Metal air ducts
I.S. 732	Code of practice for electrical wiring and fittings for building.
I.S.2516	A.C.circuit breakers
I.S.900	Code of practice for installation and maintenance of induction motors
I.S. 1248	Direct acting electrical indicating installations
I.S.2516	A.C. circuit breakers for voltages not exceeding 1000 volts
I.S.4047	Heavy duty air break switches and composite units of air break switches for voltage not exceeding 1000 volts.
I.S.2208	HRC cartridge fuse links upto 650 volts
I.S. 1554	PVC insulated (heavy duty) electric cables for working voltage upto and including (PART I) 1100 volts
I.S.8183	Specification for bonded glass wool/ mineral wool
I.S.4671	Specification for expanded polystyrene for thermal insulation purposes.
I.S.11561	Code of practice for testing of cooling towers.
I.S. 7896	Data for outside design conditions for air conditioning for summer months.
I.S.8148	Packages air conditioners
I.S.2370	Sectional cold rooms (walk-in type)
I.S.5111	Testing of refrigerant compressors
I.S.10594	Thermostatic Expansion Valve

**APPENDIX-C**  
**I.S. SAFETY CODES**

I.S.660	Safety Code for Mechanical Refrigeration
I.S.659	Safety Code for air conditioning
I.S.3016	Code of Practice for precautions in welding and cutting operations
I.S.818	Code of practice for safety and health requirements in electrical and gas welding and cutting operations.
I.S.5216	Code for safety procedure and practice in electrical works
I.S.3696	Safety code for scaffolds and ladders

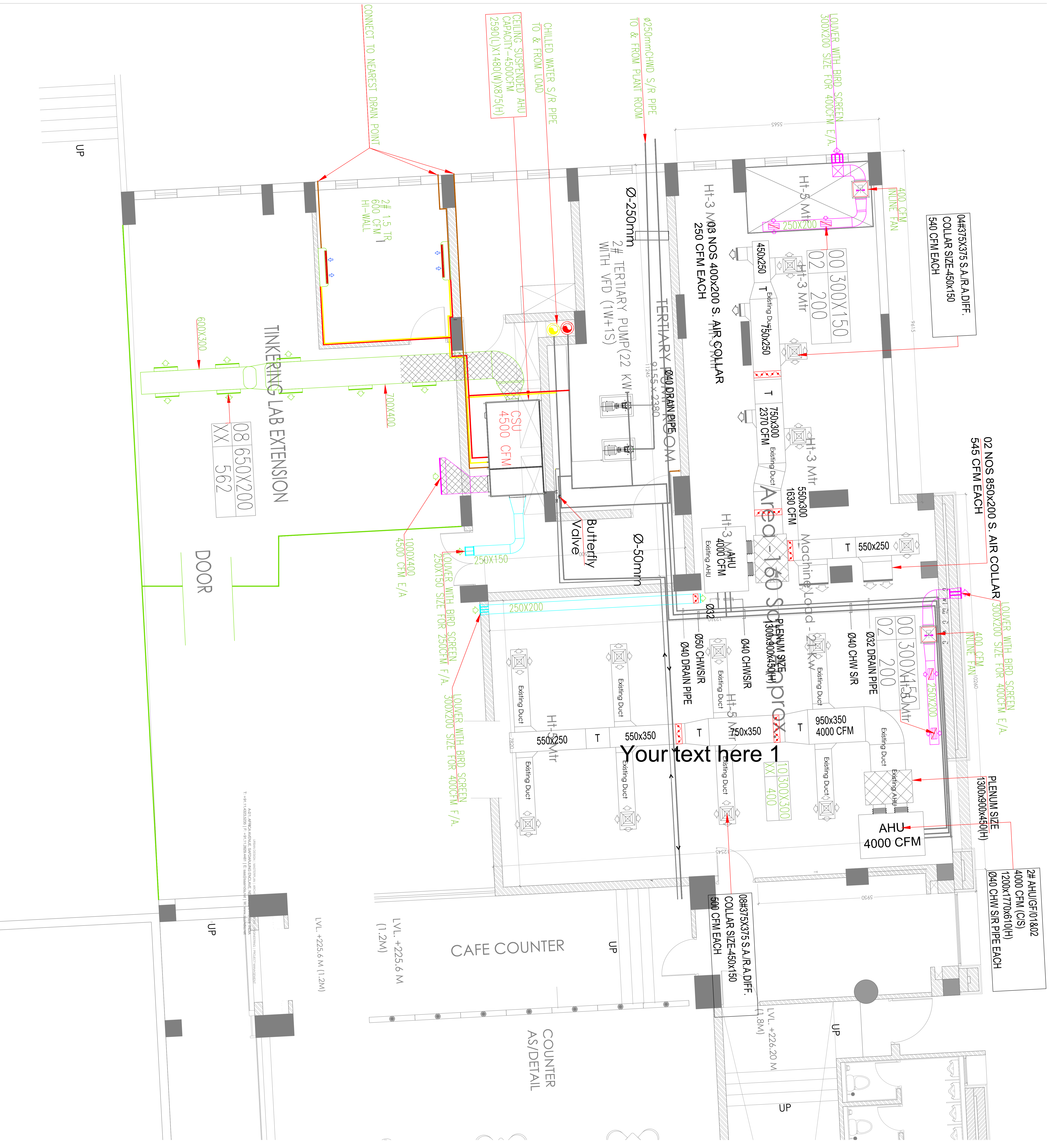
**BOQ for HVAC Work in Tinkering Lab Extension**

The prices are to be quoted in the below mentioned form and shall include the supply, installation, testing and commissioning at site of all the

S.No.	Description	Unit	Qty.	Rate	Amount
				Rs.	Rs.
<b>1</b>	<b>Ceiling Suspended Airhandling Units</b>				
	Supply, installation, testing and commissioning of ceiling mounted chilled water factory built Air handling units Double skin type with 40 mm thick panels consisting of G.I casing of thickness 0.6 mm outside layer and 0.6 mm inside layer with zinc coating and polyurethane foam (PUF) insulation having density of 42 kg/m <sup>3</sup> , complete with backward curved Plug type direct driven fan with IP - 20 VFD suitable for static pressure as detailed below, chilled water cooling coil with aluminium finned copper tubes. Filter section having 50 mm thick pre filters, MERV-13 fine filter, mixing box with VCD, TEFC, IE-3 motor suitable for 415 +10% volts, 50 Hz, 3 phase AC supply, drain connections with stainless steel drain pan (18 Ga) with PUF insulation, fire retardant canvas connection and necessary vibration isolation arrangement to avoid any vibration along with etc. complete as per specifications and drawings. AHU coils shall be AHRI /Eurovent certified. cost including with flexible duct connection, fabricated from fire- proof canvas and set of GI flanges if required.				
1.1	4500 cfm, 20 mmwg ESP, 4 row deep	No.	1		
<b>2</b>	<b>Chilled Water Hi-Wall Unit</b>				
	Supplying, installation, testing and commissioning of Hi Wall type chilled water unit wall mounted type with fan, motor, 3 row cooling coil, decorative, grill with filter, drain pump, space for valve, MCB with cabling and earthing (10 Rmt ) complete as per specifications and following capacities				
2.1	1.5 TR (With Drain Pump)	Nos.	2		
<b>3</b>	<b>Insulated Chilled water piping (Nitrile rubber insulation)</b>				
	Supplying, laying/ fixing, testing and commissioning of following nominal sizes of chilled water piping inside the building (with necessary clamps, vibration isolators and fittings but excluding valves, strainers, gauges etc.) duly insulated with following closed cell elastometric nitrile rubber of minimum 45 Kg / cu m density, thermal conductivity 0.037 W/MK or better at 20 deg mean temperature class 'O' insulation applied by suitable adhesive complete including repairing of damage to building etc. as per specifications and as required complete in all respect.				
	<b>Note:- The Pipes of sizes 150mm &amp; below shall be M.S. 'C' class as per IS : 1239 and pipes size above 150mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35mm thick M.S. Sheet for pipes upto 350 mm dia. and from minimum 7mm thick MS sheet for pipes of 400 mm dia and above.</b>				
3.1	50 mm dia. (32 mm thick insulation)	Rm	20		
3.2	25 mm dia. (19 mm thick insulation)	Rm	20		
<b>4</b>	<b>Insulated Valves</b>				
	Supplying, fixing, testing and commissioning of following valves, strainers, gauges in the chilled water plumbing duly insulated to the same specifications as the connected piping and adequately supported as per specifications.				
4.1	<b>BUTTERFLY VALVE (MANUAL)</b> with CI body SS Disc, Nitrile Rubber Seal & O-Ring PN 16 pressure rating for existing 250mm chilled water/hot water circulation as specified. <b>(Cost including of thermal insulation with Aluminium Clading, welding on existing MS pipe of 250 mm dia (For supply &amp; return line) for tapping complete as required.</b>				
4.1.1	50 mm	Nos.	2		
4.2	<b>Y - STRAINER</b> of Ductile CI Body flanged ends with stainless steel strainer for existing chilled water circulation including insulation as specified.				
4.2.1	50 mm	Nos.	1		
<b>4.3</b>	<b>PICB Valve</b>				
	Pressure independent control valve (PICV) complete with quick-fit pressure/temperature ports. Size DN 15 (from DN 15 to DN 25). Main connections 1/2" M (from 1/2" to 1 1/4") (ISO 228-1). Dezincification resistant alloy body and headwork. Control stem, piston and springs in stainless steel. Pressure regulator diaphragm, obturator and seals in EPDM. Asbestos-free fibre seals. Pre-adjustment indicator in PA6G30. Knob in PA6. Maximum working pressure 25 bar. Maximum differential pressure with actuator code 145013 (and 6565 series) installed 5 bar. Working temperature range -20–120°C. Nominal Dp control range 25–400 kPa. Accuracy ± 5 % of the setpoint. Flow rate regulation range 0,02–0,2 m <sup>3</sup> /h (0,02–0,2 m <sup>3</sup> /h, 0,08–0,4 m <sup>3</sup> /h, 0,08–0,8 m <sup>3</sup> /h, 0,12–1,2 m <sup>3</sup> /h, 0,18–1,8 m <sup>3</sup> /h, 0,3–3 m <sup>3</sup> /h and 0,37–3,7 m <sup>3</sup> /h). The adjustment position does not affect the obturator stroke. Full stroke modulation. Flow rate pre-adjustment device with at least 10 reference positions and continuous adjustment. Leakage class V according to EN60534-4. Diaphragm pressure regulator, controller wiring Complete with Modulating actuator.				
4.3.1	50 mm dia	Nos.	1		
<b>4.4</b>	<b>Ball Valves</b>				

S.No.	Description	Unit	Qty.	Rate	Amount
				Rs.	Rs.
4.4.1	25 mm with strainer	Nos.	2		
4.4.2	25 mm without strainer	Nos.	2		
4.4.3	15mm	Nos	Rate Only		
4.5	<b>2 Way ON/OFF Valve</b>				
	Pressure independent control valve (PICV) complete with quick-fit pressure/temperature ports. Size DN 15 (from DN 15 to DN 25). Main connections 1/2" M (from 1/2" to 1 1/4") (ISO 228-1). Dezincification resistant alloy body and headwork. Control stem, piston and springs in stainless steel. Pressure regulator diaphragm, obturator and seals in EPDM. Asbestos-free fibre seals. Pre-adjustment indicator in PA6G30. Knob in PA6. Maximum working pressure 25 bar. Maximum differential pressure with actuator code 145013 (and 6565 series) installed 5 bar. Working temperature range -20–120°C. Nominal Dp control range 25–400 kPa. Accuracy ± 5 % of the setpoint. Flow rate regulation range 0,02–0,2 m3/h (0,02–0,2 m3/h, 0,08–0,4 m3/h, 0,08–0,8 m3/h, 0,12–1,2 m3/h, 0,18–1,8 m3/h, 0,3–3 m3/h and 0,37–3,7 m3/h). The adjustment position does not affect the obturator stroke. Full stroke modulation. Flow rate pre-adjustment device with at least 10 reference positions and continuous adjustment. Leakage class V according to EN60534-4. Diaphragm pressure regulator, controller wiring Complete with On/Off actuator.				
4.5.1	25 mm	Nos.	2		
5	<b>Drain Piping</b>				
	Providing, fixing, testing and commissioning UPVC drain piping complete with fittings, U-trap, supports valves and insulate with 9 mm thick Nitrile rubber insulation complete as per standards, requirement and drawings.				
5.1	40 mm	Rm	20		
5.2	25 mm	Rm	20		
6	<b>Inline Fans</b>				
	Supply, installation, testing and commissioning of inline ducted fans of G.I. construction complete with centrifugal fan with motor, drive, canvass connection at inlet & outlet complete with MCB panel with cabling and earthing (with 5 Rm). Fan shall be suitable for operation on 220+6% volts, 50 Hz, 1 Phase AC power supply. All single phase inline fans shall be provided with factory filled speed regulation and as per specification and drawings.				
6.1	400 cfm, 10 mm ESP	Nos.	2		
7	<b>Ducting</b>				
	Supply, installation, balancing and commissioning of fabricated at site GSS sheet metal rectangular/round ducting complete with neoprene rubber gaskets, elbows, splitter dampers, vanes, hangers, supports etc. as per approved drawings and specifications of following sheet thickness complete as required.				
7.1	<b>G.I. Sheet Metal Ducting (Rectangular)</b>				
7.1.1	Thickness 0.63 mm sheet (24 Gauge)	Sqm	35		
7.1.2	Thickness 0.80 mm sheet (22 Gauge)	Sqm	10		
7.2	<b>G.I. Sheet Metal Ducting ( Spiral Oval with powder coating &amp; 9mm internal insulation of nitrile rubber )</b>				
	Supply, installation, balancing and commissioning of factory fabricated GSS sheet metal spiral oval ducting complete with neoprene rubber gaskets, elbows, splitter dampers, vanes, hangers, supports etc. as per approved drawings and specifications of following sheet thickness complete as required.				
7.2.1	0.63 mm (24 Gauge) (0 - 650 mm)	Sqm.	10		
7.1.2	0.80 mm (22 Gauge) (651 - 900 mm)	Sqm	15		
7.3	<b>G.I. Sheet Metal Ducting ( Spiral Oval with powder coating &amp; 10 mm internal acoustic insulation of nitrile rubber )</b>				
	Supply, installation, balancing and commissioning of factory fabricated GSS sheet metal spiral oval ducting complete with neoprene rubber gaskets, elbows, splitter dampers, vanes, hangers, supports etc. as per approved drawings and specifications of following sheet thickness complete as required.				
7.3.1	0.80 mm (22 Gauge) (651 - 900 mm)	Sqm	5		
8	<b>Duct Insulation</b>				

S.No.	Description	Unit	Qty.	Rate	Amount
				Rs.	Rs.
	Supplying and fixing of following thickness duly laminated aluminum foil of mat finish closed cell Nitrile rubber (Class "O") insulation on existing duct after applying suitable adhesive for Nitrile rubber. The joints shall be sealed with 50 mm wide and 3 mm thick self adhesive nitrile rubber tape insulation complete as per specifications and as required.				
8.1	9 mm Insulation	Sqm	15		
9	<b>Accoustic Lining</b>				
9.1	Supply and fixing of acoustic lining of supply air duct and plenum with 25 mm thick resin bonded glass wool having density of 32 kg/m <sup>3</sup> , with 25 mm X 25 mm GI section of 1.25 mm thick, at 600 mm centre to centre covered with Reinforced Plastic tissue paper and 0.5 mm thick perforated aluminum sheet fixed to inside surface of ducts with cadmium plated nuts, bolts, stick pins, CPRX compound etc. complete as required and as per specifications.	Sqm	8		
10	<b>Grilles / Diffuser</b>				
10.1	Supplying & fixing of powder coated extruded aluminium Supply Air Grills with aluminium volume control dampers as per specifications.	Sqm	1.5		
10.2	Supplying & fixing of powder coated extruded aluminium Return Air Grills with louvers but without volume control dampers complete as required.	Sqm	2		
11	<b>Fresh air Louvers</b>				
11.1	Supply and installation of Fresh air louver of aluminium powder coated with louvers, bird Screen and damper as per specifications and drawings.	Sqm	1.5		
12	<b>Volume Control Damper</b>				
12.1	Supply, installation, testing and commissioning of GI volume control duct damper complete with neoprene rubber gaskets, nuts, bolts, screws linkages, flanges etc., as per specifications.	Sqm	0.5		
13	<b>Electrical Panel Board</b>				
	Design, manufacture, supply, installation, testing and commissioning of the MV panel, front operated, cubicle construction, wall mounted type, fabricated out of 2 mm thick CRCA Sheet, Compartmentalized with hinged lockable doors, dust and vermin proof, Powder coated of approved shade after 7 tank treatment, Cable alley, inter- connections, having Switch gear and accessories mounting, internal wiring, earth terminals, Top/ Bottom cable entry, numberings etc. suitable for operation of 415 volts, 3 phase, 4 wire, 50 Hz, AC Supply with enclosure protection class IP 54, with auto manual switch and pontential free NO/NC contacts 2 way switch compitable complete as required (With provision of VFD in panel)and as specified with the following :				
13.1	1 No. 16 Amps MCB outgoing for CSAHU fan motor. (2.2 kw).	Set.	1		
14	<b>Power Cabling</b>				
	Providing & fixing of XLPE insulated armoured Aluminium / Copper cables for various equipments through walls/ceiling with appropriate clamps & fixing arrangement as per specifications and drawings.				
14.1	4C - 4 sqmm (Aluminium)	Rm	10		
15	<b>Cable Tray</b>				
	Supplying and installing following size of perforated painted with powder coating M.S. cable trays with perforation not more than 17.5%, in convenient sections, joined with connectors, suspended from the ceiling with M.S. suspenders including bolts & nuts, painting suspenders etc. as required.				
15.1	150 mm width X 50 mm depth X 1.6 mm thickness	Rm	20		
16	<b>Earthing</b>				
	Supply and laying of double earthing continuity conductors of G.I. /G.S.S between panel boards and equipments as drawings.				
16.1	Providing and fixing 6 SWG dia G.I. wire on surface or in recess for loop earthing as required.	Nos.	20		
17	Supply, installation, testing and commissioning of industrial type propeller fan for fresh and exhaust air system complete as required , as per specifications and drawings with all fixing, electrical socket,cable accessories etc as required and specified. (For Badminton -Sports Block)				
17.1	600 mm dia, 950 rpm, 5 mmwg SP.	Nos	2		
18	Supplying and drawing following sizes of FRLS PVC insulated copper conductor, single core cable in the surface/ recessed steel/ PVC conduit as required. (Actuator to Thermostat)				
18.1	3 x 1.5 sq.mm.	Mtr	15		
	<b>Total Rs.</b>				
	<b>GST @ 18%</b>				
	<b>Total Amount with GST</b>				



**GENERAL NOTES**

ALL DIMENSIONS ARE IN MM, UNLESS OTHERWISE STATED.

DO NOT SCALE DRAWING. DIMENSIONS TO BE FOLLOWED.

ALL DIMENSIONS ARE TO BE SHOWN UNLESS OTHERWISE STATED WITH APPLICABLE TOLERANCES.

ALL MATERIAL FINISHES ARE TO BE EXPRESSED AND APPROVED BY THE ARCHITECT AND THE RELEVANT CONSULTANTS.

**LEGEND**

S.NO	SYMBOL	DESCRIPTION
1.	Symbol: Green arrow	SUPPLY AIR DIFF./GRILL
2.	Symbol: Purple arrow	RETURN AIR DIFF./GRILL
3.	Symbol: Green line	SUPPLY AIR DUCT
4.	Symbol: Purple line	ACCOUSTIC LINING
5.	Symbol: Blue line	FRESH AIR DUCT
6.	Symbol: Yellow line	RETURN AIR DUCT
7.	Symbol: Orange line	CHMS
8.	Symbol: Red line	CHWR
9.	Symbol: Blue dashed line	NO OF DRY/GRILL (SUPPLY) SIZE OF DRY/GRILL
10.	Symbol: Red dashed line	NO OF DRY/GRILL (RETURN)

**GFC DRAWING**

DESIGN CELL  
 PROJECT: TINKERING LAB  
 DRAWING NO: IITD/AC/TL/AC-01

<b>STRUCTURAL</b>	Metro Consultants 110/29 1st Floor, Metro Building, Okhla Phase - III, New Delhi - 110020
<b>ELECTRICAL</b>	Metro Consultants 110/29 1st Floor, Metro Building, Okhla Phase - III, New Delhi - 110020
<b>PLUMBING &amp; FIRE</b>	Metro Consultants 110/29 1st Floor, Metro Building, Okhla Phase - III, New Delhi - 110020
<b>HVAC</b>	Metro Consultants 110/29 1st Floor, Metro Building, Okhla Phase - III, New Delhi - 110020
<b>LANDSCAPE</b>	Metro Consultants 110/29 1st Floor, Metro Building, Okhla Phase - III, New Delhi - 110020
<b>ARCHITECT</b>	Metro Consultants 110/29 1st Floor, Metro Building, Okhla Phase - III, New Delhi - 110020

**ARCHITECT**

**SAI**

**PROJECT**

DEVELOPMENT OF PHASE - II AT  
 INFORMATION TECHNOLOGY,  
 OKHLA PHASE - III, NEW DELHI - 110020

**OWNER**

INDIAN AIR FORCE  
 INFORMATION TECHNOLOGY,  
 OKHLA PHASE - III, NEW DELHI - 110020

**SCALE**

1:75@A2

**DATE ISSUED**

05-09-2020

**DRAWN BY**

ADMAN

**CHECKED BY**

ADMAN

**DWG NO.**

IITD/AC/TL/AC-01