

## INDEX

**Name of Work:**      **Construction of Cyber Security building.(SH :- Air conditioning Works)**

<b>Sl.No.</b>	<b>Description</b>	<b>Page</b>
	Index Page	<b>1</b>
	<b>PART-A</b>	<b>2</b>
1	E-Tender Notice	<b>3</b>
2.	Information and e-Tendering for Contractors	<b>4-5</b>
3.	Notice Inviting Tenders (Form CPWD-6)	<b>6-9</b>
4.	Tender (Form CPWD-7)	<b>10-15</b>
5.	Salient/Mandatory requirement for tender	<b>16</b>
6.	<b>PART-B</b>	<b>17</b>
7.	Quality Assurance of the work	<b>18</b>
8.	Additional terms & conditions	<b>19-20</b>
9.	Special condition for safety at the work site	<b>21-22</b>
10.	Special Terms & conditions	<b>23-28</b>
11.	Additional Specifications for Air-conditioning Works	<b>29-63</b>
12.	List of approved make	<b>64-66</b>

**NIT amounting to Rs. 45,99,233/- is approved.**

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

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

# ***PART-A***

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

**NIT No. 15/AC/2018/456**

**Dated : 17.07.2018**

The Superintending Engineer, IWD, IIT Kanpur, on behalf of Board of Governors of IIT Kanpur invites online item rate tender from eligible air conditioning contractors for the following air-conditioning & refrigeration work:-

Sl. No	Name of work and location	Estimated cost put to tender (In Rs.)	Earnest Money (In Rs.)	Period of Completion (in Month)	Last date & time of submission of tender	Period during which EMD, Cost of Tender Document, e-Tender Processing Fee and other Documents shall be submitted	Time & date of opening of tender
1	<b>Construction of Cyber Security building.(SH :- Air conditioning Works).</b>	45,99,233/-	91,985/-	04 Months	Upto 3.30 PM on 03.08.2018	After last date and time of sub-mission of tender and upto 3:30 PM on 06.08.2018	At 3:30 PM on 08.08.2018

The E-tender documents is available on [www.tenderwizard.com/IIT](http://www.tenderwizard.com/IIT)

(Rajeev Garg)  
Superintending Engineer

Copy to:

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

## Information and e-Tendering for Contractors

1. The intending tenderer must read the terms and conditions of FORM-6 for e-Tendering carefully. He should only submit his tender if he considers himself eligible and he is in possession of all the documents required.
2. Information and Instructions for tenderer posted on website shall form part of tender document.
3. The tender document consisting of plans, specifications, the schedule of quantities of various types of items to be executed and the set of terms and conditions of the contract to be complied with and other necessary documents can be seen and downloaded from website [www.tenderwizard.com/IIT](http://www.tenderwizard.com/IIT) or [www.iitk.ac.in](http://www.iitk.ac.in) free of cost.
4. But the tender can only be submitted after uploading the mandatory scanned documents as per list given below.
5. The intending tenderer has to fill all the details such as Banker's name, Demand Draft/Fixed Deposit Receipt /Pay Order/ Banker's Cheque/Bank Guarantee number, amount and date.

The amount of EMD can be paid by multiple Demand Draft / Pay Order / Banker's Cheque / Deposit at call receipt / Fixed Deposit Receipts along with multiple Bank Guarantee of any Scheduled Bank if EMD is also acceptable in the form of Bank Guarantee.

6. Those contractors not registered on the website mentioned above, are required to get registered beforehand. If needed they can be imparted training on online bidding process as per details available on the website.
7. The intending tenderer must have valid class-III digital signature to submit the tender.
8. On opening date, the contractor can login and see the tender opening process. After opening of tenders he will receive the competitor tender sheets.
9. Contractor can upload documents in the form of JPG format and PDF format.
10. Contractor must ensure to quote rate of each item. The column meant for quoting rate in figures appears in pink colour and the moment rate is entered, it turns sky blue.

In addition to this, while selecting any of the cells a warning appears that if any cell is left blank the same shall be treated as "0".

Therefore, if any cell is left blank and no rate is quoted by the tenderer, rate of such item shall be treated as "0" (ZERO).

**List of Documents to be scanned and uploaded within the period of tender submission:**

- *Copy of Registration with the Department if any or specialized agencies.*
- *Required experience / completion certificates of similar nature of works.  
The works certificates submitted by the bidder clearly indicate that:*
  1. *The completion certificate cost of the air-conditioning & refrigeration works*
  2. *Actual date of completion of the air-conditioning work.*
- *Copy of EPF & ESI No.*
- *Details of turn over during the last three years.*
- *Copy of bank solvency certificate*
- *E.M.D.*
- *Copy of GST Registration*

## FORM -6 FOR e-Tendering

The Executive Engineer, IWD, I.I.T., Kanpur on behalf of Board of Governors of IIT Kanpur invites online item rate tenders for the following works from eligible Air conditioning contractors:

**“Construction of Cyber Security building.(SH :- Air conditioning Works)..”**

The work is estimated to cost **Rs. 45,99,233/-** This estimate, however, is given merely as a rough guide.

1.1 The authority competent to approve NIT for the combined cost and belonging to the major discipline will consolidate NITs for calling the tenders. He will also nominate Division which will deal with all matters relating to the invitation of tenders.

### 2. Criteria of eligibility

- Copy of Registration with the Department if any or specialized agencies of air-conditioning & refrigeration works.
  - The Tenderer should have completed satisfactorily at least \*3 similar works each of value 40% of the estimated cost or \*2 similar works of 50% of the estimated cost or \*1 similar work of 80% of estimated cost during the last 7(seven) years. (at least one work of them should be in Central Govt. /Central Autonomous bodies/ Central PSU/State PSU /State Govt.). *Similar work means "Supply, installation ,testing and commissioning of Air handling units, chilled water piping and associated works etc."*. The details of average annual financial turnover on air-conditioning works should be at least 100% of the estimated cost during the last 3 consecutive financial years, list of works completed of the requisite magnitude along with the attested copies of certificates of satisfactory completion”.
  - Having ESI & EPF registration No. of government authorities.
  - Having a bank solvency certificate not less of 40% of estimated cost.
  - Having GST registration.
3. Agreement shall be drawn with the successful tenderers on prescribed Form No. CPWD 7 (or other Standard Form as mentioned) which is available as a Govt. of India Publication and also available on website [www.iitk.ac.in](http://www.iitk.ac.in) Tenderers shall quote his rates as per various terms and conditions of the said form which will form part of the agreement.
4. The time allowed for carrying out the work will be **4 Months** from the date of start as defined in schedule ‘F’ or from the first date of handing over of the site, whichever is later, in accordance with the phasing, if any, indicated in the tender documents.
5. The site for the work is available.\*
6. The tender document consisting of plans, specifications, the schedule of quantities of various types of items to be executed and the set of terms and conditions of the contract to be complied with and other necessary documents except Standard General Conditions of Contract Form can be seen on website [www.tenderwizard.com/IIT](http://www.tenderwizard.com/IIT), <https://eprocure.gov.in/cppp/latestactivetenders> or [www.iitk.ac.in](http://www.iitk.ac.in) other necessary documents also can be seen in the office of the EE , IWD Electrical and Air conditioning Division, IIT, Kanpur between hours of 9:30 AM to 5:30 PM from **19.07.2018 to 03.08.2018** free of cost.

7. After submission of the tender the contractor can re-submit revised tender any number of times but before last time and date of submission of tender as notified.
8. While submitting the revised tender, contractor can revise the rate of one or more item(s) any number of times (he need not re-enter rate of all the items) but before last time and date of submission of tender as notified.
9. When tenders are invited in three stage system and if it is desired to submit revised financial tender then it shall be mandatory to submit revised financial tender. If not submitted then the tender submitted earlier shall become invalid.
10. Earnest Money can be paid in the form of Treasury Challan or Demand Draft or Pay order or Banker`s Cheque or Deposit at Call Receipt or Fixed Deposit Receipt (drawn in favour of **Director, IIT, Kanpur** along with Bank Guarantee of any Scheduled Bank wherever applicable.  
A part of earnest money is acceptable in the form of bank guarantee also. In such case, 50% of earnest money or Rs. 20 lac, whichever is less, will have to be deposited in shape prescribed above, and balance in shape of Bank Guarantee of any scheduled bank.
- (i) **Cost of Tender Document – Rs. 590/-** (Including GST) drawn in favour of the Director IIT, Kanpur through e-payment
  - (ii) **e-Tender Processing Fee – Rs. 5427/-** (including GST) drawn in favour of "**ITI Limited**" payable at Delhi through e-payment
- Treasury Challan or Demand Draft or Pay Order or Banker`s Cheque or Deposit at Call Receipt or FDR or Bank Guarantee against EMD, Cost of Tender Document and Cost of Tender Processing Fee shall be placed in single sealed envelope superscripted as “Earnest Money, Cost of Tender Document and Cost of Tender Processing Fee” with name of work and due date of opening of the tender also mentioned thereon.
- Copy of Enlistment Order and certificate of work experience wherever applicable and other documents if required and specified in this bid document shall be scanned and uploaded to the e-Tendering website within the period of tender submission and certified copy of each shall be deposited in a separate envelop marked as “Other Documents”.
- Both the envelopes shall be placed in another envelope with due mention of Name of work, date & time of opening of tenders and to be submitted in the office of Superintending Engineer after last date & time of submission of tender and up to 03:30 PM **on 06.08.2018**. The documents submitted shall be opened at 4.00 PM on **06.08.2018**.
- Online tender documents submitted by intending tenderers shall be opened only of those tenderers, whose Earnest Money Deposit, Cost of Tender Document and e-Tender Processing Fee and other documents placed in the envelope are found in order.
- The tender submitted shall be opened at 03:30 PM on **08.08.2018**.
11. The tender submitted shall become invalid and cost of tender & e-Tender processing fee shall not be refunded if:
- (i) The tenderers is found ineligible.
  - (ii) The tenderers does not upload all the documents as stipulated in the tender document.
  - (iii) If any discrepancy is noticed between the documents as uploaded at the time of submission of tender and hard copies as submitted physically in the office of tender opening authority.
12. The contractor whose tender is accepted will be required to furnish performance guarantee of 5% (Five Percent) of the tendered amount within the period specified in Schedule F. This guarantee shall be in the form of cash (in case guarantee amount is less than ` 10000/- ) or Deposit at Call receipt of any scheduled bank/Banker`s cheque of any scheduled

bank/Demand Draft of any scheduled bank/Pay order of any Scheduled Bank of any scheduled bank (in case guarantee amount is less than ` 1,00,000/-) or Government Securities or Fixed Deposit Receipts or Guarantee Bonds of any Scheduled Bank or the State Bank of India in accordance with the prescribed form. **In case the contractor fails to deposit the said performance guarantee within the period as indicated in Schedule 'F', including the extended period if any, the Earnest Money deposited by the contractor shall be forfeited automatically without any notice to the contractor.**

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



19. The tender for the works shall remain open for acceptance for a period of **ninety (90) days** from the date of opening of tenders if any tenderer withdraws his tender before the said period or issue of letter of acceptance, whichever is earlier, or makes any modifications in the terms and conditions of the tender which are not acceptable to the department, then the Government shall, without prejudice to any other right or remedy, be at liberty to forfeit 50% of the said earnest money as aforesaid. Further the tenderers shall not be allowed to participate in the retendering process of the work.
20. This Notice Inviting Tender shall form a part of the contract document. The successful tenderers/contractor, on acceptance of his tender by the Accepting Authority shall within 15 days from the stipulated date of start of the work, sign the contract consisting of:-
- a) The Notice Inviting Tender, all the documents including additional conditions, specifications and drawings, if any, forming part of the tender as uploaded at the time of invitation of tender and the rates quoted online at the time of submission of tender and acceptance thereof together with any correspondence leading thereto.
  - b) Standard C.P.W.D. Form 7 or other Standard C.P.W.D. Form as applicable.
- 20.1.1 The tender document will include following three components:
- Part A:-**  
CPWD-6, CPWD-7 including schedule A to F for the major component of the work, Standard General Conditions of Contract for CPWD 2014 as amended/modified up to **03.08.2018**.
- Part B:-**  
General/specific conditions, specifications and schedule of quantities applicable to major component of the work.
- Part C:-**  
Schedule A to F for minor component of the work. (SE/EE in charge of major component shall also be competent authority under clause 2 and clause 5 as mentioned in schedule A to F for major components), General/specific conditions, specifications and schedule of quantities applicable to minor component(s) of the work.
- 20.1.2 The tenderers must associate himself, with agencies of the appropriate class eligible to tender for each of the minor component individually.
- 20.1.3 The eligible tenderers shall quote rates for all items of major component as well as for all items of minor components of work.
- 20.1.4 Entire work under the scope of composite tender including major and all minor components shall be executed under one agreement.
- 20.1.5 Security Deposit will be worked out separately for each component corresponding to the estimated cost of the respective component of works. The Earnest Money will become part of the security deposit of the major components of work.
21. The EPF & ESI contribution paid to the contract workers shall be reimbursed on actual basis.

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

**ITEM RATE TENDER AND CONTRACT FOR WORK**

- (A) **Tender for the work of:** | **Construction of Cyber Security building.(SH :- Air conditioning Works).**

**TENDER**

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

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

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

A sum of **Rs. 91,985/-** is hereby forwarded in Cash/Receipt Treasury Challan/Deposit at call Receipt of a Scheduled Bank/Fixed deposit receipt of scheduled bank/demand draft of a scheduled bank/bank guarantee issued by scheduled bank as earnest money. If I/we, fail to furnish the prescribed performance guarantee or fail to commence the work within prescribed period I/we agree that the said Board of Governors, IIT, Kanpur or his successors in office shall without prejudice to any other right or remedy be at liberty to forfeit the said earnest money absolutely. Further, if I/we fail of commence work as specified, I/we agree that Board of Governors, IIT, Kanpur or his successors in office shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the said earnest money and the performance guarantee absolutely, otherwise the said earnest money shall be retained by him towards security deposit to execute all the works referred to in the tender documents upon the terms and conditions contained or referred to therein and to carry out such deviations as may be ordered, up to maximum of the percentage mentioned in Schedule 'F' and those in excess of that limit at the rates to be determined in accordance with the provision contained in Clause 12.2 and 12.3 of the tender form.

Further, I/We agree that in case of forfeiture of earnest money or both Earnest Money & Performance Guarantee as aforesaid, I/We shall be debarred for participation in the re-tendering process of the work.

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

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

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

Witness: \*\*

Address: \*\*

Occupation: \*\*

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

## ACCEPTANCE

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

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

- a) \_\_\_\_\_
- b) \_\_\_\_\_
- c) \_\_\_\_\_

For & on behalf of the Board of Governors, IIT,  
Kanpur

Dated \_\_\_\_\_

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

Operative schedules shall be supplied separately to each intending tenderer)

**SCHEDULE 'A'**

Schedule of Quantities:

**SCHEDULE 'B'**

Schedule of materials to be issued to the contractor:

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

**SCHEDULE 'C'**

Schedule of Tools and Plants to be hired to the contractor

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

**SCHEDULE 'D'**

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

**SCHEDULE 'E'**

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

**SCHEDULE 'F'**

Reference to General Conditions of contract.

<b>Name of Work:</b>	<b>Construction of Cyber Security building.(SH :- Air conditioning Works)</b>		
<b>Estimated cost of the work:</b>	Air-conditioning Items of Work		<b>45,99,233/-</b>
<b>Earnest money</b>			<b>91985/-</b>
<b>Performance Guarantee</b>	5% of the tendered value of the work		
<b>Security Deposit</b>	5% of the tendered value of the work		
<b>General rules and direction :</b>			

**Definitions:**

2(v) **Engineer-in-Charge**

	For Air-conditioning & Refrigeration/Electrical items of work	<b>Executive Engineer, Institute Works Department IIT, Kanpur Superintending Engineer, Institute Works Department IIT, Kanpur</b>	
2(vi)	Accepting Authority		
2(vii)	Percentage on cost of materials and labour to cover all overheads and profits	15%	
2(viii)	<b>Standard Schedule of Rates:</b> Electrical Items of Work:	D.S.R. 2016 with up to date correction slips	
2(ix)	Department:	Central Public Works Department	
2(x)	Standard CPWD contract Form:	GCC 2014, CPWD <b>form-7</b> as modified & corrected up to <b>03.08.2018</b> (Whether correction vide latest circulars are incorporated or not in this document).	
<b>Clause 1</b>	i) Time allowed for submission of Performance Guarantee from the date of issue of letter of acceptance	15 Days	
	ii) Maximum allowable extension beyond the period as provided in i) above	7 Days	
<b>Clause 2</b>	Authority for fixing Compensation under Clause 2	<b>Superintending Engineer, Institute Works Department IIT, Kanpur. Or successor thereof</b>	
<b>Clause 2 A</b>	Whether Clause 2A shall be applicable	No	
<b>Clause 5</b>	i) Number of days from the date of issue of letter of acceptance for reckoning date of start	22 Days	
	ii) Time allowed for execution of work	<b>4 Months</b>	
<b>Authority to decide</b>	<b>Extension of time</b>	<b>Superintending Engineer, Institute Works Department IIT, Kanpur</b>	
<b>Clause 6/ 6A</b>		<b>Only clause 6 applicable.</b>	
<b>Clause 7</b>	Gross work to be done together with net payment/Adjustment of advances for material collected, if any, since the last such payment for being eligible to interim payment	<b>Not applicable</b>	
<b>Clause 10A</b>	Material to be provided by the contractor.	<b>Applicable</b>	
<b>Clause 10B (ii), (iii)</b>	Whether clause 10-B (ii) and 10-B (iii) shall be applicable.	<b>Not Applicable</b>	
<b>Clause 10 C</b>	Component of labour expressed as percentage of value of work	---	

<b>Clause 10 CA</b>	Materials covered under this clause.	Nearest material( <b>other than cement, reinforcement bars and structural steel</b> ) for which All India Whole sale price Index is to be followed.	Base price of all the materials covered under clause 10 CA
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<b>Clause 10 CC</b>	1. Cement ( <b>PPC</b> ) 2. Steel Increase/Decrease in Price of materials/wages	<b>Nil</b> <b>Nil</b>	<b>NIL</b> <b>Nil</b> <b>Not Applicable</b>
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**Clause 11 Specification to be followed for execution of work:**

**For electrical works CPWD specifications 2005 internal and 2014 external electrical works**

**For Air conditioning & Refrigeration item of works** CPWD Specifications 2004 HVAC for Air-conditioning & refrigeration works with up to date correction slips.(Hereinafter called CPWD specifications also)

**Clause 12**

12.2 & 12.3	Deviation limit beyond which clause 12.2 & 12.3 shall apply for building work	---
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**Clause 16 Competent Authority for Deciding reduced rates:**

For electrical/civil/Air-conditioning& refrigeration items of work	<b>Superintending Engineer, Institute Works Department IIT, Kanpur</b>
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<b>Clause 18</b>	List of mandatory machinery, tools & plants to be deployed by the contractor at site.	<b>Ladders, Multimeter, drill machine, crimping tools, spanner set, blower, Gas Charging line with equipment, welding torch etc</b>
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<b>Clause 36 (i)</b>	<b>Requirement of technical Representative(s)</b>
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For supervision of air-conditioning/refrigeration & civil as well as electrical items of work, technical representatives of the respective disciplines will be required to be deployed.

# SALIENT/MANDATORY REQUIREMENTS FOR THE TENDER

**Name of Work:** **Construction of Cyber Security building.(SH :- Air conditioning Works).**

- 1 The tenderer is advised to read and examine the tender documents for the work and the set of drawings available with Engineer-in-charge. He should inspect and examine the site and its surroundings by himself before submitting his tender.
- 2 Separate schedule of quantity is included in this tender for air conditioning & refrigeration items of work. If the tenderer wants to offer any unconditional rebates on their rates, the same should also be offered in the respective components of schedule separately. The contractor shall quote the item rates in figures and words accurately so that there is no discrepancy in rates written in figures and words.
- 3 Time allowed for the execution of work is **04 Months.**
- 4 The contractor(s) shall submit a detailed program of execution in accordance with the master programme/milestone within ten days from the date of issue of award letter.
- 5 Contractor has to arrange and install field laboratory during the currency of work and nothing extra will be paid on this account.
- 6 Quality of the project is of utmost importance. This shall be adhered to in accordance with the provisions of CPWD specifications and guidelines given in the relevant paras.
- 7 Contractor has to deploy required Plant and machinery on the project. In case the contractor fails to deploy the plant and machinery whenever required and as per the direction of the Engineer-in-charge, he (Engineer-in-charge) shall be at a liberty to get the same deployed at the risk and cost of the contractor.
- 8 The contractor shall comply with the provisions of the Apprentices Act 1961, and the rules and orders issued there under from time to time. If he fails to do so, his failure will be a breach of the contract and the Superintending Engineer/Executive Engineer may in his discretion, without prejudice to any other right or remedy available in law, cancel the contract. The contractor shall also be liable for any pecuniary liability arising on account of any violation by him of the provisions of the said Act.
- 9 Temporary Electric connection shall be issued as per request and the water charges shall be recovered as per rule.



# ***PART-B***

## **QUALITY ASSURANCE OF THE WORK**

### **Sampling of Materials:**

1. The contractor shall procure all the materials at least in advance so that there is sufficient time to testing and approving of the materials and clearance of the same before use in work.
2. All materials brought by the contractor for use in the work shall be got checked from the Engineer-in-Charge or his authorized representative of the work on receipt of the same at site before use.
3. The contractor shall be fully responsible for the safe custody of the materials issued to him even if the materials are in double lock and key system.

## ADDITIONAL TERMS AND CONDITIONS

- 1 Unless otherwise provided in the Schedule of Quantities/Specifications, the rates tendered by the contractor shall be all inclusive and shall apply to all heights, lifts, leads and depths of the work and nothing extra shall be payable to him on account of the same. Extra payment for centering/shuttering, if required to be done for heights greater than 3.5 m shall however be admissible at the rates arrived at in accordance with clause 12 of the agreement, if not already specified.
- 2 Other agencies doing works related with this project may also simultaneously execute their works and the contractor shall afford necessary facilities for the same. The contractor shall leave such necessary holes, openings etc. for laying/burying in the work, pipes cables, conduits, clamps, boxes and hooks for fan clamps etc. as may be required for the other agencies. Nothing extra over the Agreement rates shall be paid for doing these.
- 3 Some restrictions may be imposed by the security staff etc. on the working and for movement of labour, materials etc. The contractor shall be bound to follow all such restrictions/instructions and nothing extra shall be payable on account of the same.
- 4.1 The contractor shall fully comply with all legal orders and directions of the Public or local authorities or municipality and abide by their rules and regulations and pay all fees and charges for which he may be liable in this regard. Nothing extra shall be paid/reimbursed for the same.
- 4.2 The building work shall be carried out in the manner complying in all respects with the requirements of the relevant bylaws and regulations of the local body under the jurisdiction of which the work is to be executed or as directed by the Engineer-in-charge and nothing extra shall be paid on this account.
- 5 If as per local Municipal regulations, huts for labour are not to be erected at the site of work; the contractor shall be required to provide such accommodation at a place as is acceptable to the local body and nothing extra shall be paid on this account.
- 6 The structural and architectural drawings shall at all times be properly co-related before executing any work. However, in case of any discrepancy in the item given in the schedule of quantities appended with the tender and Architectural drawings relating to the relevant item, the former shall prevail unless otherwise given in writing by the Engineer-in-charge.
- 7.1 For the purpose of recording measurements and preparing running account bills, the abbreviated nomenclature indicated in the publications Abbreviated Nomenclature of Items of DSR 2012 shall be accepted. The abbreviated nomenclature shall be taken to cover all the materials and operations as per the complete nomenclature of the relevant items in the agreement and relevant specifications.
- 7.2 In case of items for which abbreviated nomenclature is not available in the aforesaid publication and also in case of extra and substituted items for which abbreviated nomenclature are not provided for in the agreement, full nomenclature of item shall be reproduced in the measurement books and bill forms for running account bills.
- 7.3 For the final bill, however, full nomenclature of all the items shall be adopted in preparing abstract in the measurement books and in the bill forms.

8. The contractor shall take instructions from the Engineer-in-charge for stacking of materials. No excavated earth or building materials etc. shall be stacked/collected in areas where other buildings, roads, services, compound walls etc. are to be constructed.
- 9 Any trenching and digging for laying sewer lines/water lines/cables etc. shall be commenced by the contractor only when all men, machinery's and materials have been arranged and closing of the trench(s) thereafter shall be ensured within the least possible time.
- 10 It shall be ensured by the contractor that no electric live wire is left exposed or unattended to avoid any accidents in this regard.
- 11 In case the supply of timber/steel frames/shutters for doors, windows etc. is made by some other agency, the contractor shall make necessary arrangements for their safe custody on the direction of the Engineer-in-charge till the same are fixed in position by him & nothing extra shall be paid on this account.
- 12 The contractor shall maintain in perfect condition, all portions executed till completion of the entire work allotted to him. Where however phased delivery of work is contemplated these provisions shall apply separately to each phase.
- 13 The entire royalty at the prevalent rates shall have to be paid by the contractor on all the boulders, metals, shingle sand etc. collected by him for execution of the work, directly to the Revenue authority or authorized agents of the State Government concerned or the Central Government, as the case may be.
- 14.1 The contractor shall bear all incidental charges for cartage, storage and safe custody of materials issued by the departments and shall construct suitable go downs, yards at the site of work for storing all materials as to be safe against damage by sun, rain, dampness, fire, theft etc. at his own cost and also employ necessary watch and ward establishment for the purpose, at his own cost. Materials to be charged directly to work and stipulated for issue free of cost shall also be issued to the contractor as soon as those are received at site or at the stipulated place of issue. The provision of this para shall apply equally and fully to those as well.
- 14.2 All materials obtained from the Institute Works Department store or otherwise on receipt shall be got checked by the Engineer-in-charge of the work or his representations before use.
- 14.3 Registers for the materials to be issued by the department shall be maintained as required by the Engineer-in-charge and these shall be signed by the contractor or his authorized agent and representative of Engineer-in-charge on each day of transactions.

## **SPECIAL CONDITION FOR SAFETY AT THE WORK SITE**

The contractor will identify one of the supervisors for taking care of implementation of Safety systems.

The Contractor should follow the following General Guidelines governing the safety rules as laid down under:

1. Smoking is strictly prohibited at workplace.
2. Nobody is allowed to work without wearing safety helmet. Chinstrap of safety helmet shall be always on. Drivers, helpers and operators are no exception.
3. No one is allowed to work at or more than three meters height without wearing safety belt and anchoring the lanyard of safety belt to firm support preferably at shoulder level.
4. No one is allowed to work without adequate foot protection.
5. Usage of eye protection equipment shall be ensured when workmen are engaged for grinding, chipping, welding and gas-cutting. For other jobs as and when site safety co-coordinator insists eye protection has to be provided.
6. All safety appliances like Safety shoes, Safety gloves, Safety helmet, Safety belt, Safety goggles etc. shall be arranged before starting the job.
7. All excavated pits shall be barricaded & barricading to be maintained till the backfilling is done. Safe approach to be ensured into every excavation.
8. Adequate illumination at workplace shall be ensured before starting the job at night.
9. All the dangerous moving parts of the portable / fixed machinery being used shall be adequately guarded.
10. Ladders being used at site shall be adequately secured at bottom and top. Ladders shall not be used as work platforms.
11. Material shall not be thrown from the height. If required, the area shall be barricaded and one person shall be posted outside the barricading for preventing the tre-passers from entering the area.
12. Other than electricians no one is allowed to carry out electrical connections, repairs on electrical equipment or other jobs related thereto.
13. All electrical connections shall be made using 3 or 5 core cables, having a earth wire.
14. Inserting of bare wires for tapping the power from electrical sockets is completely prohibited.
15. A tools and tackles inspection register must be maintained and updated regularly.

16. Debris, scrap and other materials to be cleared from time to time from the workplace and at the time of closing of work everyday.
17. All the unsafe conditions, unsafe acts identified by contractors, reported by site supervisors and / or safety personnel to be corrected on priority basis.
18. No children shall be allowed to enter the workplace.
19. All the lifting tools and tackles shall be stored properly when not in use.
20. Clamps shall be used on Return cables to ensure proper earthing for welding works.
21. Return cables shall be used for earthing.
22. All the pressure gauges used in gas cutting apparatus shall be in good working condition.
23. Proper eye washing facilities shall be made in areas where chemicals are handled.
24. Connectors and hose clamps are used for making welding hose connections.
25. All underground cables for supplying construction power shall be routed using conduit pipes.
26. Spill trays shall be used to contain the oil spills while transferring / storing them.
27. Tapping of power by cutting electric cables in between must be avoided. Proper junction boxes must be used.

**(Rajeev Garg)**  
Superintending Engineer

## **SPECIAL TERMS & CONDITIONS**

1. In the Contract (as hereinafter defined) the following definitions words and expressions shall have the meaning hereby assigned to them except where the context otherwise required.
  - i) Institute shall mean the Indian Institute of Technology (IIT), Kanpur
  - ii) The President shall mean the Board of Governor, IIT Kanpur.
  - iii) The Engineers In-charge, who shall administer the work shall mean the Executive Engineer for electrical and Air-conditioning works.
  - iv) Government or Govt. of India shall mean the Indian Institute of Technology represented by its Director.
  - v) The term Director General of Works shall mean the Chairman, Building & Works Committee of the Institute.
  - vi) Accepting authority shall mean the Director, IIT Kanpur or his authorized representative.
  - vii) Superintending Engineer shall mean the Superintending Engineer of the Institute, who as overall In-charge and head of the Institute Works Department, shall direct the contract.
  - viii) Site Engineers shall mean the Assistant Engineer & Jr. Engineer (AC/Electrical) for Electrical & Air-conditioning works, appointed by the Institute Works Department.

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

- i) Site Engineers :

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

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

- a) Failure of the Site Engineer (s) to disapprove any work or materials shall not prejudice the power of the Engineer In-charge / Architect to subsequently disapprove such work or materials and to order the pulling down, removal or breaking up thereof.
- b) If the contractor is dissatisfied by reason of any decision of the Site Engineer (s), he shall be entitled to refer the matter to the Engineer-in-charge / Architect, who shall thereupon confirm reverse or vary such decision.

- ii) The scope of contract comprises the construction, completion and maintenance of the works for (12) months after the completion and the provision of all labour, materials, construction of plant equipment and transpiration, temporary works and everything, whether of temporary or permanent nature required in and for such construction, completion and maintenance so far as the necessity for providing the same is specified in or reasonably be inferred from the contract. The contractors shall make his own arrangements for the store storage of materials, accommodation for his staff etc. and no claim for the temporary accommodation from the contractor shall be entertained.

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

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

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

### 3. **Contract Document:**

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



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

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

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

- 3.3 The successful tenderer shall be required to enter into an agreement with the Institute. The Bill of Quantities & rates filled by the successful tenderer in, the General Condition of the Contract for CPWD works 2010, CPWD specifications for Civil, Electrical & Air-conditioning works, the special conditions, additional specifications, negotiation letter and the award letter etc. shall form part of the agreement to be signed by the successful tenderer. The cost of stamp paper and stamp duty, required for the agreement, shall be borne by the contractor.

#### 4. **Contract Agreement:**

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

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

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

9. Water and electricity required for electrical & air-conditioning works shall be supplied free of charge.
10. Stamps duty on the security money shall also be the born by contractor as per prevailing notification of U.P Govt.
11. Income tax shall be deducted as per prevalent law.
12. **Conditions for Electrical and Air-conditioning Works:-**
  - 13.1 All chase cuttings in the wall, for recessed conduits & boxes and drilling the holes shall be done with power operated machines only. No chase shall be allowed to be cut manually with the use of hammer & chisel.
  - 13.2 All cuttings in cement plaster and brick shall be made good by using cement mortar 1:3 (1 part cement, 3 part coarse sand)
  - 13.3 The cut surfaces shall be repaired by an experienced mason only so as to match the repaired plaster with the original.
  - 13.4 All such repaired surfaces shall be cured for 3 to 4 days to keep the surfaces wet, using water spray machine (hand/motor operated) and avoid unnecessary flooding of the area.
13. **Payment shall be regulated as under**
  - a.) 75% of the tendered rate on receipt of materials at site.
  - b.) 15% of the tendered rate on installation and connection.
  - c.) 10% of the tendered rate on testing and commissioning.
14. **Drawings/Data required prior to commencement of electrical/air-conditioning works:-**
  - 16.1 Following drawings shall be furnished by the contractor for the approval of the Engineer-In-charge before execution of the work.
    - i.) G.A and schematic drawings of VFD Drive schematic with RTD sensor, motor connections and protection circuits & MV switchgear/distribution /Plant/AHU/ FCU/Fire Alarm panel showing material and size of sheet steel/bus bars / inter connections and make and ratings of switchgear i/c details of protection, metering, indicating and inter lock etc.
    - ii.) Technical particulars/specifications of the VFD drive make Danfoss F102 or equivalent model from approved makes.
17. **Completion drawings:**

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

  - i. As built G.A and schematic drawings of VFD Drive schematic with RTD sensor, motor connections and protection circuits & MV switchgear/distribution /Plant/AHU/ FCU/Fire Alarm panel showing material and size of sheet steel/bus bars / inter connections and make and ratings of switchgear i/c details of protection, metering, indicating and inter lock etc.
  - ii) Technical literature, test certificates, and operation and maintenance manuals for window/split/tower ac units & their compressors required.

18. **Works Inspection and Testing of Equipment:**

- a.) Prior to dispatch of equipment the Institute reserves the right to inspect the same at the manufacturer's works and the contractor shall provide and secure every reasonable access and facility at the manufacturers works for inspection, for witness of all acceptance and routine tests as per relevant Indian Standards. Contractor shall give a reasonable notice of about 15 days for the purpose of test, and witness of all major equipments.
- b.) Pre-commissioning test: All routine tests shall be carried out on the electrical & air-conditioning equipment. Protective & measuring devices should be checked for calibration of window/split/tower ac units should be checked for air quantities and temperature. All grills/diffusers should be checked for balanced air quantities.

19. **Rates:** The work shall be treated as on works contract basis and the rates tendered shall be for complete item of work and all charges for items contingent to the work, such as packing, forwarding, insurance, freight and delivery at site for the materials to be supplied by the contractor, watch and ward of all materials at the site, labour related expenses as per relevant labour laws, testing of materials/ samples etc. excluding Goods & Service tax (GST)

20. **Taxes & Duties:**

20.1 *Being an indivisible works contract, no other tax is payable other than GST. The GST shall be as applicable to IIT Kanpur as per Government rules.*

21. The earnest money of the unsuccessful tenderers shall be refunded on written request, within 1(one) month of the award of work. The earnest money of the successful tenderer shall however be adjusted towards the security deposit.

22. The tender document & drawings in respect of the work can be seen in the o/o Sr. Electrical Engineer

23. The tender document contains \_\_\_\_\_ pages. No page of the tender document shall be removed, mutilated, detached, or cancelled.

24. Rates for finished works shall be given for each items separately, both in words & figures. In the event of non compliance the tender shall be deemed incomplete and liable for rejection.

25. All entries by the tenderer should be made in one ink and one hand writing only. Tenders should be filled in legible hand writing and should not contain erasures, corrections and overwriting as far as possible. However if it becomes necessary, each correction etc. should be properly attested under dated signature.

26. The work shall be executed on the basis of the following CPWD specifications:

i) **Electrical & HVAC Works :**

- General specifications for Electrical Works Part-1 (Internal) 2005 with up to date corrections.
- General specifications for electrical works (external) 1994 with upto date corrections.
- General specifications for electrical works Part-VII (DG set) 2006 with upto date corrections.
- General specifications for electrical works Part-IV Sub-station- 2007 with upto date corrections.

- General specifications of HVAC works 2004 with upto date corrections.
27. For the purpose of clause 12 of the General conditions of contract the following schedule of rates shall be applicable.
    - i) Electrical Works: Electrical Works, air-conditioning & refrigeration works: Based upon prevailing market rates
  28. The special conditions listed above shall take precedence over all above provisions of the contract. The General Condition of contract for CPWD works shall be generally followed including the clause 21 i.e. work shall not be sublet.
  29. The contractor shall have to execute the work in such place and condition where other agencies will also be engaged for other works such as site grading, filling and leveling, interiors, landscape, and electrical and mechanical engineering works, etc. No claim shall be entertained due to work being executed in the above circumstances.
  30. No contractor, to whom the provisions of the BOCW Act apply, shall be allowed to commence work on the campus unless he has produced the 'Registration Certificate' issued by the office of Dy. CLC (Central).
  31. The contractor shall engage only such workers who are registered as beneficiaries with U.P. BOCW Welfare Board and in case of engagement of new workers; he shall ensure the submission of applications for registration of such workmen within appropriate time.
  32. A certificate for administrative convenience shall be obtained from the contractor covered under BOCW Act whether he has engaged 10 or more workmen while working in the Institute and only thereafter, Cess @1% from the bills raised by him shall be deducted at source for all running works. Cess, so deducted shall be deposited with the BOCW Welfare Board.
  33. As per clause 36 (I) of GCC: It should be noted that license wire man shall only be allowed for the wiring work.

## **Section 1 Additional Specification for Air-conditioning & Refrigeration Works**

### **1. General**

1.1 The motor and switchgears required for various items shall generally be as per specifications given below. All electric motors/compressor shall be suitable for 3 phase/1-phase, 50 Hz, 415  $\pm 10\%$ /215 $\pm 10\%$  Volts A.C. supply.

### **1.2 Painting**

All sheet steel work shall undergo a multi tank process of degreasing, pickling in acid, cold rinsing, phosphate, 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.

## **Section 2**

## **DUCT WORK AND OUTLETS**

### **1. General**

- 1.1 The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, and exhaust system ready for operation as per drawings.
- 1.2 Except as otherwise specified all duct work and related items shall be in accordance with these specifications.
- 1.3 Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

### **2. Duct Materials**

- 2.1 The ducts shall be fabricated from galvanized steel sheets class VIII conforming to ISS:277-1962 (revised) or aluminium sheets conforming to ISS:737-1955 (wherever aluminium ducts are specified).
- 2.2 All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with amendment-I (1971 edition)

The thickness of the sheet shall be as follows :-

	Size of Duct	Sheet Thickness	Type of Joints	Bracing if any
2.2.1	Upto 750 mm	0.63 mm 24 Ga	G.I. Flange	
2.2.2	751 mm to 1000 mm	0.80 mm 22 Ga	25x25x3 mm Angle iron frame with 8 mm dia nuts & bolts	25x25x3 mm at the rate of 1.2 M from joints
2.2.3	1001 mm to 1500 mm	0.80 mm 22 Ga	40x40x5 mm Angle iron frame with 8 mm dia nuts & bolts	40x40x5 mm at the rate of 1.2 M from joints
2.2.4	1501 mm to 2250 mm	1.00 mm 20 Ga.	50x50x5 mm Angle iron frame with 10 mm dia nuts & bolts at 125 mm centre.	40x40x3 mm at the rate of 1.2 M to be Braced Diagonally
2.2.5	2251 mm and above	1.25 mm 18 Ga.	50x50x6 mm Angle iron frame with 10 mm dia nuts & bolts at 125 mm centre.	40x40x3 mm at the rate of 1.6 M from joints

- 2.3 The gauges, joints and bracings for sheet metal duct work shall further conform to the provisions as shown on the drawings.
- 2.4 Ducts larger than 600 MM shall be cross broken, duct sections upto 1200 MM length may be used with bracing angles omitted.

- 2.5 Changes in section of duct work shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer-In-Charge.
- 2.6 All ducts shall be supported from the ceiling/slab by means of M.S. Rods of 9 MM (3/8")DIA with M.S. Angle at the bottom. The rods shall be anchored to R.C. Slab using metallic expansion fasteners.

### 3. **Installations**

- 3.1 During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer-In-Charge.
- 3.2 Great care should be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.
- 3.3 All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.
- The ducts shall be re-inforced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.
- 3.4 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.
- 3.5 The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge. The contractor shall verify all measurements at site and shall notify the Engineer-In-Charge of any difficulty in carrying out his work before fabrication.
- 3.6 Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be self adhesive installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.
- 3.7 Flanges bracings and supports are to be black, mild steel and are to be painted with rust proof primer on all surfaces before erection. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.
- 3.8 Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.
- 3.9 Joints requiring bolting or rivetting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.
- 3.10 Fire retarding flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-In-Charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle

fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.

- 3.11 The flexible joints are to be not less than 75 MM and not more than 250 MM between faces.
- 3.12 The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.
- 3.13 Duct passing through brick or masonry, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

#### 4. **Dampers**

- 4.1 At the junction of each branch duct with main duct and split of main duct, volume dampers must be provided. Dampers shall be two gauges heavier than the gauge of the large duct and shall be rigid in construction.
- 4.2 The volume dampers shall be of an approved type, lever operated and completed with locking devices which will permit the dampers to be adjusted and locked in any positions and clearly indicating the damper position.
- 4.3 The dampers shall be of splitter, butterfly or louver type. The damper blade shall not be less than 1.25 MM (18) Gauge, reinforced with 25 MM angles 3 MM thick along any unsupported side longer than 250 MM. Angles shall not interfere with the operation of dampers, nor cause any turbulence.
- 4.4 Automatic and manual volume opposed blade dampers shall be completed with frames and bronze bearings as per drawings. Dampers and frames shall be constructed of 1.6 MM steel sheets and blades shall not be over 225 MM wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 MM thickness with fine mesh.
- 4.5 Wherever require for system balancing, a volume balancing opposed blade damper with quadrant and thumb screw lock shall be provided.
- 4.6 After completion of the duct work, dampers are to be adjusted and set to deliver air flow as specified on the drawings.

#### 5. **Fire Dampers**

- 5.1 Automatic fire dampers shall be provided wherever shown on the drawings. The damper shall be multi blade louvre type. The blades should remain in the air stream in open position and shall be constructed with minimum 1.8 MM thick galvanised sheets. The frame shall be of 1.6 MM thickness. Other materials shall include locking device, motorised actuator, control panel to trip AHU motor etc.
- 5.2 The fire dampers shall be capable of operating automatically on receiving signal from a fire alarm panel. All control wiring shall be provided between fire damper and electric panel.

#### 6. **Access panel**

- 6.1 A hinged and gasketed access panel measuring at least 450 MM x 450 MM shall be provided on duct work before each reheat coil and at each control device that may be located inside the duct work.



## 7. **Miscellaneous**

- 7.1 All duct work joints are to be true right angle and with all sharp edges removed.
- 7.2 Sponge rubber gaskets also to be provided behind the flange of all grilles.
- 7.3 Each chute from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.
- 7.4 Diverting vanes must be provided at the bends exceeding 600 MM and at branches connected into the main duct without a neck.
- 7.5 Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Engineer-In-Charge.
- 7.6 The ducts should be routed directly with a minimum of directional change.
- 7.7 The duct work shall be provided with additional supports/hangers, wherever required or as directed by the Engineer-In-Charge, at no extra cost.
- 7.8 All angle iron flanges to be welded electrically and holes to be drilled.
- 7.9 All the angle iron flanges to be connected to the GSS ducts by rivets at 100 MM centres.
- 7.10 All the flanged joints, to have a sponge rubber packing stuck to the flanges with suitable adhesive.
- 7.11 The G.S.S. ducts should be lapped 6 MM across the flanges.
- 7.12 The ducts should be supported by approved type supports at a distance not exceeding 2.0 Metres.

## 8. **Standard Grilles**

- 8.1 The supply and return air grilles shall be fabricated from extruded aluminium sections. The supply air grilles shall have single/double louvers. The front horizontal louvers shall be of extruded section, fixed/adjustable type. The rear vertical louvers where required shall be of aluminium extruded sections and adjustable type. The return air grille shall have single horizontal extruded section fixed louvers. The grilles may or may not be with an outer frame.
- 8.2 The damper blades shall also be of extruded aluminium sections. The grill flange shall be fabricated out of aluminium extruded section. Grilles longer than 450 MM shall have intermediate supports for the horizontal louvers.

## 9. **Diffusers**

- 9.1 The ceiling type square diffusers shall be of aluminum extruded sections with flush or step down face, as specified with fixed pattern and neck.
- 9.2 All supply diffusers shall be provided with extruded aluminium dampers, with arrangement for adjustment from the bottom.
- 9.3 The slot diffusers shall be of aluminium extruded sections with diffusion plate and sliding damper.

10. **Linear Diffusers/Grilles**

- 10.1 The linear diffusers/grilles shall be fabricated from Aluminium extruded sections.
- 10.2 The diffusion blades shall be extruded, flush mounted type with single or double direction air flow.
- 10.3 The frame shall be of aluminum extruded section and shall hold the louvers tightly in fixed position.
- 10.4 The dampers as described under grilles shall be provided wherever specified.

11. **Exhaust Grilles**

- 11.1 The exhaust grilles shall be fabricated from aluminum extruded sections.
- 11.2 The exhaust grilles shall be horizontal fixed bar grilles with 15<sup>0</sup> blade inclination.

12. **Sensor Terminal**

- 12.1 Sensor mounting terminal with cap shall be provided for taking temperature, pressure or other measurement in ducts or AHUs.
- 12.2 The terminal shall be fabricated from gun metal stock, duly threaded with check nut, nut and washers.

13. **Painting and Vision Barrier**

- 13.1 All grilles, and diffusers shall be powder coated, before installation, in approved colour.
- 13.2 All ducts immediately behind the grilles/diffusers etc. are to be given two coats of black paint in matt finish.
- 13.3 The return air and dummy portion of all linear grilles shall be provided with a vision barrier made of 24 gauge galvanised sheets. The vision barrier shall be fixed to the false ceiling frame with self tapping screws and shall be given two coats of black paint in matt finish. Care shall be taken to ensure that the return air path is not obstructed.

14. **Testing**

- 14.1 After completion, all duct system shall be tested for air leakage.
- 14.2 The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final tabulation of air quantity through each outlet shall be submitted to the Engineer-In-Charge for approval.

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## **Section 3**

## **PIPE WORK**

### **1. General**

All piping work shall conform to quality standards and shall be carried out as per specifications and details given hereunder & shall follow the applicable on relevant Indian standards.

### **2. Pipes**

- 2.1 All pipes upto 150 MM shall be M.S. E.R.W tube (black steel) heavy class as per I.S. 1239-79, Part-I with amendment-I of January '81.

### **2.2 Pre-Insulated Pipes**

Pre insulated pipes, as called for in schedule of quantities shall be sourced from the factory in length of minimum 6m. Metered dose of Polyurethane foam shall be injected in annular space between pipe OD and outer jacket to achieve average density of 36 Kg/m<sup>3</sup>. After expanding, homogenous foam shall be formed between the cavity with no air gaps. Suitability of temperature range shall be from (-) 20<sup>0</sup>C to 120<sup>0</sup> C.

Outer jacket shall be of HDPE as indicated in schedule of quantities.

### **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 readymade 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 Butt 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 insertion of rubber gasket between flange pair for 150 mm and over, in case where, a future extension is to be made otherwise blank end discs of 6 mm thickness are to be welded on, with additional cross stiffeners from 50 mm x 50 mm M.S. Heavy angles, for sizes upto 350 MM dia. 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 as per BS10.
- 4.2 Flanges may be tack welded into position, but all final welding shall be done with joints dismounted. 3 mm thick gaskets shall be used with all flanged joints. The gaskets shall be fibre re-inforced 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 line 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 All valves 200mm Dia. and above shall be gear operated.
- 5.1.7 The valve should be suitable for 12 Kg/cm<sup>2</sup> working pressure.

### 6. **Ball Valves**

- 6.1 All Valves 40 mm Dia. and below shall be of Gun Metal Ball type Valves with (FPT) female threads conforming to class 2 of IS 778 and mating flanges fitting.
- 6.2 All Ball valves shall be ISI Marked.

### 7. **Balancing Valves**

- 7.1 The balancing valves upto 80 mm Dia. shall be of gunmetal screwed type conforming to BS 5154 or equivalent specifications.
- 7.2 The valve shall be cast gunmetal ASTM B-62 and complete with non rising spindle. PTFE disc seal cast metal hand wheel.
- 7.3 The port opening shall permit precise regulation of flow rate, by accurately measuring the pressure drop across the port.
- 7.4 The valve shall be completed with two ports for connections to a mercury manometer, to measure the pressure drop, as well as a drain port.
- 7.5 The spindle shall have a shielded screw to set the flow at the desired level.
- 7.6 This valve shall be used wherever specified.

### 8. **Dual Plate Check Valves**

- 8.1 The body of the check valve shall be made from a single piece casting in cylindrical shape.
- 8.2 There shall be two plate, which shall be hinged in the centre of the circle. Both plates shall be have springs attached to them for assisting in closing action of the valve.
- 8.3 There shall be properly/designed metal to metal seal between the plates and the outer body, to ensure non leaking sealing.
- 8.4 The valve design shall confirm to API 594 or equivalent specifications.

### 9. **Automatic/Dynamic Balancing Valve.**

- 9.1 Automatic Dynamic Balancing Valve shall be of forged brass (upto 40mm dia.) grey iron (above 40mm dia.) construction of 1350K Pa pressure and 120°C temperature rating. The valves shall have precision calibrated, stainless steel carriage to achieve the desired/pre-fixed flow rates irrespective of the pressure fluctuations in the water lines within a range of 10-210 K. Pa. The flow rate within a tolerance of  $\pm 5\%$  will be achieved by automatic adjustment of the open orifice area in response to the pressure differential changes. The end connection upto 80mm dia. should be threaded and for above 80mm dia. it should be flanged.

## 10. **Strainers**

- 10.1 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.
- 10.2 The strainers shall have a perforated bronze sheet screen with 3 mm perforation and with a permanent magnet, to catch iron fillings.
- 10.3 Pot strainers shall be provided with flanged connections and 'Y' strainers shall be provided with flanged ends.
- 10.4 The strainers shall be designed to facilitate easy removal of filter screen for cleaning, without disconnection of pipe line.

11. **Other Valves**

- 11.1 All gauge cocks shall be of gunmetal plug type, complete with siphon (brass chrome plated).
- 11.2 All drain valves shall be of gunmetal with a hose union connection on one hand.

12. **'V' Form Thermometers (Industrial Type)**

- 12.1 The body shall be of aluminium alloy with anodized gold colored surface. The casing shall be adjustable side ways for reading from the front. The glass capillary shall be triangular in shape with the blue mercury filled in glass. Scale of reading shall be of the range 0°C to 50°C/32°F to 120°F.
- 12.2 Thermometer shall be suitable for 12 mm connections with long stem, so that thermometer is removable without damaging the insulation. M.S. socket to be welded on pipes shall be provided with thermometer.

13. **Jointing**

- 13.1 All pipe lines shall be welded type.
- 13.2 Square cut plain ends will be welded for pipes upto and including 100 MM Dia.
- 13.3 All pipes 125 MM Dia. or larger will be bevelled by 35 DEG. before welding.

14. **Pipe Supports/Hangers**

- 14.1 Pipe supports shall be provided and installed for all piping 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.
- 14.2 All vertical pipe support shall be made of 10mm M.S. Rods and the horizontal support shall be of M.S. angles of 50x50x4 mm thick.
- 14.3 Pipe supports shall be adjustable for height and prime coated with rust preventive paint & finish coated with black paint using approved grade of paint.

The spacing of pipe supports shall not be more than that specified below :-

<b><u>Nominal pipe size MM</u></b>	<b><u>Spacing (Metres)</u></b>		
15	...	...	1.25
20 & 25	...	...	2.00
32,30,50 & 65	...	...	2.50
80,100 & 125	...	...	2.50
150 & Above	...	...	3.00

- 14.4 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 wall and ceiling by means of approved metallic dash fasteners.
- 14.5 Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation, cause condensation. The pipe supports or Saddles shall be of PUF, factory fabricated to suit pipe sizes.
- 14.6 Hangers shall be supported from structural steel, concrete inserts & pipe racks, as specifically approved.
- 14.7 No hangers shall be secured to underside of light weight roof decking and light weight floor glass.
- 14.8 Mechanical equipment shall be suspended midway between steel joints and panel points.
- 14.9 Drilling or punching of holes in steel joint members will not be permitted.
- 14.10 Contractor shall make shop drawing for fixing of support for approval.

15. **Miscellaneous**

- 15.1 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.

- 15.2 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.
- 15.3 During construction, temporarily close, open ends of pipes with sheet metal caps, where necessary, or required to prevent debris from entering the piping system.
- 15.4 Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion.
- 15.5 To facilitate the maintenance, repair and replacement:
  - 15.5.1 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.
  - 15.5.2 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.
  - 15.5.3 Cut the pipes accurately according to measurements, established at building site & work into place without springing or forging.
  - 15.5.4 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 CM. 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 CM. 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.

## 16. **Sleeves**

- 16.1 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.
- 16.2 Where pipes pass through outside walls or foundations, the space between pipe and sleeve shall be filled with rock wool covered with GI sheet.
- 16.3 The centre of pipes shall be in the centre of sleeves, and sleeves shall be flushed with the finished surface.

## 17. **Arrangement and alignment of piping**

- 17.1 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.
- 17.2 The piping shall be installed in a uniform manner, parallel 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.
- 17.3 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.
- 17.4 All piping shall be carefully installed to provide for proper alignment, slope and expansion.
- 17.5 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.
- 17.6 Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.
- 17.7 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.

17.8 The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

18. **Testing**

18.1 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.

18.2 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.

18.3 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.

18.4 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/cm<sup>2</sup> 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.

18.5 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.

18.6 Miscellaneous piping, tests with air at 10.5 kg/cm<sup>2</sup> for a minimum of 24 hours without drop in pressure.

18.7 The contractor shall make sure that proper noiseless 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.

18.8 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.

19. **Drain Piping**

19.1 The drain piping shall be medium class galvanized steel as per IS 1239/1979.

19.2 The fittings shall be of 'R' brand or "Unik" or equal forged with screwed connections.

19.3 The gate valves shall be of gun metal duly ISI marked on each valve.

19.4 Pipe crosses shall be provided at bends, to permit easy cleaning of drain line.

19.5 The drain line shall be provided upto the nearest drain trap and pitched towards the trap.

19.6 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.

20. **Painting**

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

20.2 All pipes, which are not to be insulated, shall then be given two coat of finish paint, of a type and colour, as approved by the Engineer-In-Charge.

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## **Section 4**

## **INSULATION**

### **1. General**

The Insulation of water piping, air handling units, ducting, chillers & refrigerant piping 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. The detailed specifications of the materials are listed under respective sub heads.

2.1	Pipe Insulation	:	Rigid Polyurethane Foam (PUF)
2.2	Drain Pipe Insulation	:	Polyethylene Foam (Kinney Foam)
2.3	Duct Insulation	:	Resin Bonded glass wool
2.4	Acoustic Treatment	:	Resin Bonded glass wool
2.5	Equipment Insulation	:	Expanded Polystyrene (SE) (EP).
2.6	Refrigerant Pipe	:	Nitrile rubber insulation

### **3. Pipe Insulation**

- 3.1 The insulation for chilled water and drain piping, chillers, pump etc. shall be carried out from rigid polyurethane foam having a 'K' value of 0.018 W/mK. at mean temperature of 10°C and a density of 27.2 to 39.9 kgs/cubm. The material shall be factory faced on one side with aluminium foil on the outside, reinforced with kraft paper and fused to the insulation material. The aluminium foil shall be extended by a minimum of 50 mm on one side of the pipe section along the length to seal all longitudinal joints. The aluminium foil facing shall be replaced with Kraft Paper facing wherever the pipe is to be covered with Tar felt.
- 3.1.2 The thickness of the insulation for chilled water pipes shall be 30 MM.
- 3.1.3 Preformed pipe sections shall be used for pipes upto and including 350 mm dia.
- 3.1.4 Pipes above 350 mm dia. shall be insulated with insulation slabs cut in mitred sections.

### **3.2 Drain Pipe Insulation**

- 3.2.1 The material for insulation of drain pipes shall be sheets of Polyethelene foam having a 'K' valve of 0.027 W/mK at a mean temperature of 10°C and a minimum density of 26 Kg./cubm.
- 3.2.2 The thickness of insulation shall be 2 layer of 6 mm thickness..

### **3.3 Duct Insulation**

- 3.3.1 The materials for duct insulation shall be resin bonded fibre glass, as described earlier but conforming to I.S. 8183 of 1976. The density of insulation shall not be less than 24 kg/cubm and material shall be in the form of blankets/rolls of uniform thickness. The 'K' value at 10° C. Shall not be less than 0.031 W/mK. It shall be factory faced with aluminium foil on one side reinforced with kraft paper and fused to the insulation material.
- 3.3.2 The thickness of duct insulation shall be as follows :
- |    |                             |   |             |
|----|-----------------------------|---|-------------|
| a. | Duct in conditioned space   | - | 25 mm thick |
| b. | Duct in unconditioned space | - | 50 mm thick |

### **3.4 Acoustic Treatment**

- 3.4.1 The material for acoustic treatment of ducts, rooms, roofs etc. shall be resin bonded fibre glass, as described earlier, conforming to I.S. 8183 of 1976. The density of fibre glass shall be 32 kg/cub.m and the material shall be in the form of boards of uniform density. The 'k'



value at 10°C shall not be less than 0.03 W/mK. Facing shall be provided with 0.5 mm perforated aluminium sheet held with G.I. Nuts bolts or nailed to the batten work as required.

3.4.2 The thickness of insulation shall be as follow unless otherwise specified elsewhere :

- a. Duct Acoustic : 25 MM
- b. Room Acoustic : 50 MM

### 3.5 **Equipment Insulation**

3.5.1 The materials for equipment insulation shall be slabs of expanded Polystyrenes (Self extinguishing grade) having a 'K' Value of 0.035 W/mK at 10°C and a density not less than 20 Kg./Cum.

3.5.2 The complete shell of the chiller as well as its two heads, shall be factory insulated.

3.5.3 The insulation on chilled water pumps and expansion tank shall be of expanded polystyrene having a 'K' value of 0.035 W/mK at a mean temperature of 10°C and a density not less than 20 Kg/Cubm. The thickness of the insulation will be as given below :

- i) Expansion tank - 50 mm
- ii) Chilled water pumps - 50 mm

### 3.6 **CPRX Compound**

3.6.1 The cold compound adhesive being supplied shall be CPRX Type.

### 3.7 **Tar Felt**

3.7.1 The Tar felt used for water proofing shall conform to IS: 1322 Type 3 Grade-I.

## 4. **Installation**

### 4.1 **Chilled Water Piping (PUF)**

4.1.1 The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.

4.1.2 The pipes shall be given a coat of red oxide primer.

4.1.3 Two coats of CPRX Compound shall be applied on the cleaned pipe surface.

4.1.4 The preformed sections of insulation shall be fixed tightly to the surface taking care to seal all joints.

4.1.5 All joints along the circumference of the pipe sections shall be sealed with 50 mm wide aluminium faced adhesive tape.

4.1.6 All longitudinal joints shall be further sealed with 50 mm wide aluminium faced adhesive tape.

4.1.7 Insulation on pipes and valves in the AHU room shall be covered with 0.5 mm aluminium sheet cladding.

### 4.2 **Drain Piping**

4.2.1 The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.

4.2.2 Coat the pipe with one layer of red oxide primer.

4.2.3 Then two layer of 6mm thick insulation shall be wrapped on the pipe.

4.2.4 Then it shall be tied with 1 mm thick G.I. wires.

### 4.3 **Ducting**

4.3.1 Clean the surface with a wire brush and make it free from rust and oil.

4.3.2 Apply two coats of CPRX compound on the cleaned surface.

4.3.3 Wrap the duct with insulation blankets of the thickness mentioned in item 3.3.2 above and covered with 0.63 mm/19 mm wire mesh netting on the outside.

4.3.4 The joints shall be sealed with aluminium tape before covering with wire netting.

4.3.5 The Ducts in areas exposed to the weather shall be additionally covered with one layer of tar felt B.H. The tar felt shall be stuck with Hot Bitumen.

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

4.4.1 The duct surface shall first be cleaned from inside.

4.4.2 Then 25 mm square section made of 18 Ga (1.2 mm) thick G.I. sheet should be fixed on both ends of the duct piece.

4.4.3 The insulation slabs should be fixed between these sections of ducts using adhesive compound and **stick pins**.

4.4.4 The insulation shall then be covered with RP tissue, sealing all joint so that no fibre is visible.

4.4.5 The insulation shall then be covered with 0.5 mm perforated aluminium sheets.

4.4.6 The sheet of insulation shall be secured to the duct by means of stick pins as mentioned above.

#### 4.5 **Equipment**

4.5.1 The surface shall first be cleaned with wire brush.

4.5.2 Then two layers of hot bitumen shall be applied.

4.5.3 The insulation shall then be fixed in one layer and sealing them with hot bitumen.

4.5.4 The insulation shall then be covered with 0.63 mm/ 19 mm mesh wire netting which shall be fixed to the insulation with brass 'U' nails.

4.5.5 The final finish shall be 0.50 mm aluminium cladding.

#### 4.6 **Room Acoustic**

4.6.1 Fix 40 mm x 50 mm G.I. channels at 0.5 metre interval longitudinally then fix cross battens at 1.0 metre centre using suitable gutties, and brass screws.

4.6.2 Fill each rectangle with 50 mm glass wool and covered with RP tissue.

4.6.3 Tie with 24 gauge G.I. Wires at 300 mm intervals.

4.6.4 Then cover with 22 gauge (0.80 mm) perforated Aluminium sheet having 3 mm perforations at 6 mm centres. Overlap all joints and provide beading of 25 mm by 2 mm flats.

4.6.5 All corners joints shall be covered with 25 x 25 x 2 mm thick aluminium angles.

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## **Section 5**

## **ELECTRIC CABLING**

### **1. General**

The electric cable connections of motors and earthing of all equipments shall be carried out, as per specifications, given hereunder.

### **2. Cabling**

- 2.1 The cabling of various equipment shall be carried using PVC Insulated and 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 660/1100 volts grade, as per IS 1554 (Part I) 1964. The cross section of the cable shall be to suit the load and rating of the equipment. The cables shall be of aluminium conductor, PVC insulated, 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 in the ducts/pipes/trays etc. along a short and convenient route between switch board and the equipment, (either in trenches, on wall or on hangers, supported from the slab). Cable routing shall be checked at the site of work to avoid interference with structure, equipment etc. Where more than one 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 overall dia. of cable in order to prevent undue stress and damage at the bends, the cables should be supported with wooden cleats on M.S. Supports, when laid in trenches, or wall/ceiling suspended hangers. When laid underground the cables should be covered with fine soft earth and protected with 2nd Class bricks. Suitable G.I. Pipe shall be used wherever cables are laid under the roads etc.
  - 2.2.4 Wooden bushes shall be provided at the ends of pipes through which cables are connected through.

### **3. Surface Wiring**

- 3.1 The surface wiring shall be cased in conduits which shall be of 1100 volts grade and conform to IS 9587-1987 (revised to date)
  - 3.1.1 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 conduits to switches etc., shall be secured by check nuts and ebonite bushes provided at the ends of conduits.
  - 3.1.2 The M.S. conduits shall be heavy duty and rigid type-ISI marked/conforming to IS specifications. The wall thickness shall not be less than 2 mm. For conduits above 32 mm dia. Metallic conduits of 19 mm dia. and below shall not be used. Conduit accessories (Boxes etc.) shall conform to IS-5133-1968 and IS-2667-64 (amended-revised to date). Conduit pipes shall be jointed, wherever necessary by means of screwed couples and screwed accessories only. In Long distance straight, run of conduits inspection type couplers at suitable intervals shall be provided.
  - 3.1.3 Threads on conduit pipes shall be between 13 mm to 19 mm long.
  - 3.1.4 The wiring shall be carried-out as per IS 732-1989 (Amended and revised to date).
- 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.
- 3.3 The wires shall be drawn only after all the conduits have been properly fixed in position. Fish wires (steel wire : 16 SWG) shall be laid in conduits for drawing of wires subsequently.

4. **Control Cabling/wiring**

- 4.1 Control cables shall be 1100 volts grade, as per IS 1554, made from copper conductor of 1.5 Sq mm PVC insulated single Core, strip armoured with an overall PVC sheathing.
- 4.2 The cables and conduits wiring shall be carried out as per details given under 2.2 and 2.3 above.

5. **Earthing**

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

<b>Size of phase wire sq.mm Aluminium</b>	<b>Size of G.I. conductor Tape/Wire (Swg)</b>
185	25 mm x 6 mm (strip)
150	25 mm x 6 mm (strip)
120	25 mm x 6 mm (strip)
95	4 Swg
70	4 Swg
50	6 Swg
35	6 Swg
25-6	6 Swg
4	6 Swg

Note :- Aluminium earthing conductors of equivalent Size may be used in lieu of GSS conductors mentioned above.

6. **Miscellaneous**

- 6.1 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.
- 6.2 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.
- 6.3 Two separate and distinct earthing conductors shall be Connected from the equipment upto the main switch board panel.
- 6.4 The branch lines from the main panel to each equipment shall be separated and should not criss cross other lines.
- 6.5 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.
- 6.6 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.

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## **Section 6**      **TESTING AND COMMISSIONING**

### **1. General**

- 1.1 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, in accordance with the provisions of the applicable ASHRAE standards or approved equal in addition to furnish necessary test certificates from manufacturers.
- 1.2 The system shall then be commissioned, tested and balanced to fulfil the intent and purpose for which it is designed.
- 1.3 In addition continuous Run Tests shall be carried out during peak weather condition.

### **2. Compressors Condensers/Chillers/Evaporators/Pumps etc.**

- 2.1 Hydraulic test for various components and assembled equipments at 1.5 times design pressure or double the operating pressure, whichever is higher.
- 2.2 Pneumatic leak test after assemblies at design pressure
- 2.3 Static and dynamic balancing on electronic precision machine for rotating parts, links, impellor/ crank shaft assemblies etc.
- 2.4 Testing of oil passages in compressor at 1.5 times pump discharge pressure.
- 2.5 Pressure drop test for condenser, chiller and evaporator.
- 2.6 For compressor assembly, electronic leak, air running test, pneumatic test with dry nitrogen and leak test in water.

### **3. Air Handling Units**

#### **3.1 Blowers**

- 3.1.1 Dynamic/static balancing of impellers.
- 3.1.2 Performance test as per applicable codes.

#### **3.2 Coils**

- 3.2.1 Pneumatic test.

#### **3.3 Filters**

- 3.3.1 Test of filter elements as per B.S. 2831 B.S. 1701 as applicable. This is to ascertain filtration efficiency by weight at inlet and outlet.
- 3.3.2 Manufacturer's test certificates also to be produced for the assembled A.H.U. Final dimensional check will be done. Inspection may be done during assembly of components for quality of workmanship, painting etc.

#### **3.3 Piping**

Materials check for specifications and size.

#### **3.4 Valves**

Hydraulic./pneumatic test certificates.

#### **3.5 Motors**

Manufacturer's test certificate as per motor data sheet.

3.6 **Instruments and Controls**

Visual examination.

3.7 **Special Note**

Vendor to note that above procedure is to be followed in addition to the specifications attached with the tender.

4. **Associated Works at Site.**

- 4.1 All electrical items will be subjected to inspection at any stage during manufacturing activity. Routine electrical test as per relevant codes. Inspection of manufacturer's test certificates.
- 4.2 Inspection of raw materials to be used for fabrication and assembly and inspection of manufacturer's certificates.
- 4.3 Inspection of welding including welders qualification as desired by inspection engineers. Inspection of fabricated items.
- 4.4 Pressure testing of pipe fittings used for the refrigerant and water and other services.
- 4.5 Pressure testing, leak testing of complete piping network for chilled water. (Condenser water and refrigerant/services).
- 4.6 Checking of electrical circuits (power & controls) and checking functioning of controls of refrigerant systems and other circuits of air conditioning plant.
- 4.7 Checking of calibration of controls and instrumentation
- 4.8. Checking of assemblies or electrical control panel, instruments panels, local panels (dimensional and functional) annunciator panels etc.
- 4.9 Inspection of complete electrical installation at site.
- 4.10 Performance testing of complete A.C. Plant as per specifications.

5. **Vendor Responsibility**

- 5.1 The above inspection procedure is given for general guidance and information of vendors. The inspection of purchaser/consultant is strictly not limited to these.
- 5.2 The inspection engineer of purchaser/consultant will have full right, to have detailed inspection at any stage right from placement of order to completion of project, as and when desired by inspection engineer.
- 5.3 Co-ordination of inspection agency of purchaser/consultant with his factory/subvendor's factory/erection site will be the sole responsibility of successful vendor, subsequent to placement of order for complete air conditioning plant, covered under these technical specifications.

6. **Piping System**

- 6.1 In general pressure tests shall be applied to piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subjected to pressure exceeding their test ratings.
- 6.2 Tests shall be completed and approved before any insulation is applied.

6.3 After tests have been completed, the system shall be drained and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fittings, and debris.

#### 6.4 **Water Piping**

All water piping shall be tested and proven tight under Hydrostatic pressure of 11 Kg/Cm<sup>2</sup> (150 PSI) or 1.5 times the design pressure which ever is more unless stated otherwise in the specifications. The prescribed pressure shall be maintained for eight hours. In case leaks are detected, the pressure test will be repeated, after the repair of the leaks.

#### 7. **Duct Work**

7.1 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.

7.2 Fire dampers, volume dampers and splitter dampers shall be tested for proper operation.

#### 8. **Electrical Equipment**

8.1 All electrical equipment shall be cleaned and adjusted on site before application of power.

8.2 The following tests shall be carried out:

8.2.1 Cables and Wires continuity tests.

8.2.2 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 megaohm.

8.2.3 Earth resistance between conduit system and earth must not exceed half (1/2) CMH.

8.2.4 Phasing out and phase rotation tests.

8.2.5 Operating tests on all protective relays to prove their correct operation before energising the main equipment.

8.2.6 Operating tests on all starters, circuit breakers etc.

#### 9. **Plant Audit & Certification work**

9.1 The work of plant audit & certification shall be done by an approved outside agency.

9.2 The whole system balancing shall be tested with microprocessor based Hi-tech instruments with an accuracy of  $\pm 0.5\%$ .

9.3 The instrument shall be capable of storing data and then down loading into a PC. The agency shall provide a minimum but not limited to the following instruments.

9.3.1 Microprocessor based velocity calculation meter to measure DB and WB temperature, RH and dew point.

9.3.2 Velocicalc meter to measure air volume and air velocity.

9.3.3 Pitot tube.

9.3.4 Electronic Rotary Vane Anemometer.

9.3.5 Accubalance Flow Measuring Hood.

9.4 The outside agency shall analyse all the data and shall be responsible for the capacity and performance audit and certification of the plant.

9.5 The successful Bidder shall be responsible to provide necessary sockets and connections for fixing of the Testing Instruments, probes etc.

## 10. **Commissioning of the System**

The system shall be commissioned by adopting the following procedure.

10.1 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.

10.1.1 Air volume passing through each unit, duct, grilles, apertures.

10.1.2 Static pressure in each air duct.

10.1.3 Water flow passing through each condenser, chiller, AHU etc.

10.1.4 Differential pressure readings across each filter, fan and coil, and through each pump.

10.1.5 Electrical current readings, in amperes of full and average load running and starting, together with name plate current of each electrical motor.

10.1.6 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.

10.2 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.

10.3 Any other readings shall be taken which may subsequently be specified by the architect.

## 11. **Air Balancing**

11.1 All air handling/ ventilation equipments, duct work and outlets shall be adjusted and balanced to deliver the specified air quantities, at each inlet and outlet as indicated on the drawings.

11.2 If these air quantities cannot be delivered without exceeding the speed range of the pulley or the available horse power, the architect shall be notified, before proceeding with the balancing of air distribution system.

11.3 A proper record shall be maintained as per Test Proforma given elsewhere.

## 12. **Water Balancing**

12.1 The output of water pumps shall be checked using the balancing valves, provided on the pumps, for this purpose, to ensure the output and pressures match the specified requirement.



12.2 Then flow to Condensers/Chillers, Air handling units etc. shall be individually adjusted and balanced to match the flow rate as given in specifications/ drawings to meet the requirement.

12.3 The balancing valves, provided on the equipments, shall be used for adjustment.

13. **Miscellaneous**

13.1 The above tests and procedures are mentioned herein, for general guidance and information only, but not by way of limitation to the provisions of conditions of contract and specification.

13.2 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.

13.3 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.

13.4 Any damage resulting from the tests shall be repaired and/or damaged material replaced, to the satisfaction of the architect without any extra cost.

13.5 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 recommenced after the adjustment or repairs have been completed.

13.6 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.

13.7 Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the architect.

13.8 The contractor may be required to repeat the test as required, should the Ambient conditions at the time, do not give, 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.

## Section 7

### **DOUBLE SKIN AIR HANDLING UNITS**

#### **Scope**

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

#### **Type**

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

#### **Capacity**

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

#### **Housing/Casing**

The housing/casing of the air-handling unit shall be of double skin construction. The housing shall be so constructed that it can be delivered at site in total/semi knock down conditions depending upon the locations. The casing strength of the assembled Air Handling Unit shall be designed to meet BS EN 1886, Class 2A and the casing air leakage of the assembled Air Handling Unit shall be designed to meet BS EN 1886, Class B.

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

Double skin panels (each not exceeding 750mm wide) shall be made out of 24 gauge pre painted galvanized steel sheet on outside and 24 gauge plain galvanized sheet inside with 48 mm thick injected CFC free PU foam insulation in between. These panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Suitable doors with pressure die cast aluminium hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on steel channel frame work. Each component section of the Air Handling Unit shall have matching cross- sectional dimensions of the same construction showing a neat exterior along the length of the unit and a clean interior appearance to ensure even air flow through each plant item.

Drain pan shall be constructed out of 18 gauge stainless steel with necessary slope to facilitate rapid removal of condensate water. Drain pan shall be factory insulated with minimum 9mm thick closed cell elastomeric insulation as required. Necessary supports will be provided to slide the coil in the drain pan. Outlet shall be provided from the drain pan in a manner that access panel can be opened without disconnecting the drain pipe connection.

### **Motor and Drive**

Fan motors shall be high efficiency IE-02 suitable for operation on 415 + 10% volts, 50 cycles, 3 phase, squirrel cage, totally enclosed fan cooled with IP-55 protection and class F insulation and class B temperature rise. Motors shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM & 2800 RPM for fans below 3500 Cfm. Drive to fan shall be provided through belt-drive arrangement. Belts shall be of the oil-resistant type. Efficiency of motors shall be 85 % or more. As an option belt guards shall be provided with a painted metal sheet belt guard that totally encloses the drive, the guard shall be rigidly attached to the fan base support structure. The motor shall be suitable for VFD controlling.

### **Fan**

The fan shall be forward curved floor standing double inlet double width type. The wheel and housing shall be fabricated in galvanized steel construction as per manufacturer standard. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame/spider and self lubricated sealed eccentric type ball bearings. The impeller and fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 1800 FPM. Fan housing with motor shall be mounted on a common steel base mounted inside the air handling housing on anti-vibration spring mounts or rubber mounts. The fan outlet shall be connected to casing with the help of fire retardant canvass.

### **Cooling /Heating Coils**

Chilled/Hot water coils shall have 12.5 mm to 16 mm dia tubes of wall thickness not less than 24 G with aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 500 FPM. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21Kg/Sqcm air pressure under water. Tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 fins per inch (4 to 5 fins per cm.)

### **Filters**

Each unit shall be provided with a factory assembled filter section containing cleanable type pre-filters of synthetic media having anodized aluminium channels. The media shall be supported with HDP mesh on one side and aluminium mesh on other side. Filter face velocity shall not exceed 500 FPM. Filters shall fit so as to prevent by-pass. Holding frames shall be provided for installing a number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels. Filters shall be of 90% efficiency down to 10 micron.

### **Heater Section**

Each Air Handling units shall be provided with heater section for monsoon reheat & winter heating as required. The section shall include all control such as heating thermostat, control wiring etc. The unit shall also incorporate necessary safety features as mentioned under strip heaters. The heater terminals shall be extended in order to check parameters without opening the AHU door/panels. The capacity of the heater strip

to be provided by the manufacturer at the time of drawing approval by Engineer In Charge.

Supply and install (or paint) on the exterior of the unit in a prominent position adjacent to the heater bank a notice, which shall read.

### **Fire**

This unit contains electric heating elements and is fire resistant. In the event of fire, disconnect the power by the main isolating switch.

(Characters to be in white, 15mm high for the word "FIRE" and 5mm high for the rest on a red background)

### **Accessories**

Each air handling unit shall be provided with manual air vent at highest point in the cooling/heating coil and drain plug at the bottom of the coil. Besides, the following accessories may be required at air handling units, the detailed specifications are given in individual sections, and quantities separately described in the schedule of quantities.

Motorized self balancing pressure independent valves located in chilled / hot water lines connecting to the coil. This valve shall be operated by the cooling/ heating thermostat and shall control the flow of chilled/hot water.

Insulated butterfly valves/balancing valves, Y-strainer, unions and condensate drain piping upto sump or floor drain in air handling unit rooms as described in section "Piping".

Dial type thermometer in the thermometer wells and pressure gauge (with cocks) within gauge ports in chilled/ hot water supply and return lines as per the section "Automatic Controls and Instruments".

### **Performance Data**

Air handling units shall be selected for the lowest operating noise level. Technical submittal of air handling units shall be prepared for Consultants approval prior to procurement as mentioned under clause 7 under Special Conditions. Fan performance rating and power consumption characteristics shall be submitted and verified at the time of testing and commissioning of the entire installation.

### **Testing**

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

## **Section 8**

## **FAN COIL UNITS**

### **1. General**

The fan coil units shall be complete in all respects and shall generally comply with the specifications as given hereunder.

### **2. Fan Coil Units**

2.1 The coil units shall be of seamless copper tube not less than 0.5 mm thick walls and min. 9 MM OD tube dia. The coil shall have continuous aluminium sheet fins with die formed collars for mounting. The finned coil, fan section with motor, drain pans, air filters, filter box, fan speed regulator and other controls.

### **2.2 Cooling Coil**

The coil shall be of seamless copper tubes not less than 9 mm O.D. 0.40 mm thick. The coil have continuous aluminium plate 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 coil circuit should be sized for adequate water velocity but not exceeding 1.8 M/s (6 F.P.S) the fins shall be uniformly bonded to the tubes by hydraulic expansion of the tubes.

The coils shall be tested against leaks at a hydraulic pressure of 10 kg/sq.cm. This pressure shall be maintained for a period of 2 hours. No drop should be observed indicating any leaks.

### **2.3 Fan Section**

2.3.1 This shall consist of (2) two light weight aluminium impellers of forward curved type, both statically and dynamically balanced, along with properly designed G.I. sheet casings of 18 gauge.

2.3.2 The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running at (3) three speeds.

2.3.3 A. G.I. Plenum of 18 gauge shall connect the fan outlets to the coil.

### **2.4 Drain pans**

2.4.1 The drain pan shall be of double skin construction made of 1.6 mm (16 GA.) G.I. Sheet, covering the whole of coil section and extended on one side for accommodating coil connection, valve etc and complete with a 25 mm drain connection. The drain pan shall be insulated with 25 mm expanded polystyrene and covered with second G.I. tray.

### **2.5 Air Filter**

The filter shall be cleanable type 12 mm thick, of wire mesh to be mounted, behind the pan in a filter box made of G.I. Sheet of 18 gauge.

### **3. Speed Control**

A sturdy switch shall be provided with the unit complete with wiring, for off and with minimum (3) three speed control, of the fan.

### **4. Painting**

The fan coil units shall be powder coated in suitable colour.

5. **Automatic Controls (Wherever Required)**

5.1 Each unit shall have a room type thermostat and a 2 way motorised water valve. The valve shall be fixed at a convenient location. The thermostat shall be mounted along with the speed control switch on a common plate. The plate shall clearly indicate the fan positions. The controls should be as per specifications under 'controls'.(price separately)

5.2 The water valves on inlet line shall be of gun metal ball type with integral water strainers, having BSP(FPT) inlet and flare type mpt outlet connection. The valve on return line shall be as above, but without the water strainer.

6. **Water Connections**

The water lines shall be finally connected to the coil of the fan coil unit, by at least 300 mm long, type I seamless solid drawn copper tubing with flare fittings and connections.

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**Section 8**

**FILTERS**

1. **General**

1.1 The various types of Filters to be used in the Different Systems, to achieve the required degree of air purification shall conform to the following specifications.

2. **Standard Filters**

2.1 The standard filters shall have an efficiency of 90 % down to 10 Microns.

2.2 The frames of the filter shall be of G.I. of suitable rigidity.

2.3 The filtering media shall be 5 ply pleated synthetic media, closely packed to give the required efficiency.

3. **Miscellaneous**

Suitable packing shall be provided in the frames of all filters, to prevent any leakage of air through the gaps, between the filter joints. All such joints shall be properly sealed against any leakage of unfiltered air.

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## **Section 9**

### **VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEM**

#### **1 GENERAL REQUIREMENTS**

- 1.1 *This specification covers complete variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD.*
- 1.2 *The frequency converter shall not be a general purpose product, but a dedicated HVAC engineered product.*
- 1.3 *The VFD and its options shall be factory mounted and tested as a single unit under full load before dispatch.*
- 1.4 *The VFD shall be tested to UL 508C. The appropriate UL label shall be applied.*
- 1.5 *The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.*
- 1.6 *The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.*

#### **2 TECHNICAL REQUIREMENTS**

- 2.1 *The VFD 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.*

*When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.*

- 2.2 *The VFD 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.*

*When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.*

- 2.3 *The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.*
- 2.4 *The VFD shall have a dual 5% impedance DC link reactor (harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.*

- 2.5 VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
- IEEE519, 1992 recommendations shall be used for the basis of calculation of total harmonic distortion (THD) at the point of common coupling (PCC). On request VFD manufacturer shall provide THD figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, short circuit current, short circuit impedance etc to allow this calculation to be made.*
- 2.6 All VFDs shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 61800-3 : 2004, Category C1 with 50m motor cable (unrestricted distribution). The suppliers of VFDs shall include additional EMC filters if required to meet compliance to this requirement.
- 2.7 The VFD's full load output current rating shall meet or exceed the normal rated currents of standard IEC induction motors. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.
- 8.2.8 The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.
- 8.2.9 A programmable automatic energy optimization selection feature shall be provided as standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.
- 8.2.10 The VFD must be able to produce full torque at low speed to operate direct driven fans.
- 8.2.11 Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.
- 8.2.12 An Automatic Motor Adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.
- 8.2.13 Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.
- 8.2.14 VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.
- 8.2.15 The VFD shall allow up to at least 100 meters of SWA (Single Wire Armour) cable to be used between the FC and the motor and allow the use of MICS (Mineral Insulated Copper Sheath) cable in the motor circuit for fire locations.



### 8.3 PROTECTIVE FEATURES

- 8.3.1 *A minimum of Class 20 I2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.*
- 8.3.2 *Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.*
- 8.3.3 *Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.*
- 8.3.4 *Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.*
- 8.3.5 *VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.*
- 8.3.6 *If the temperature of the VFD's heat sink rises to 80 °C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.*
- 8.3.7 *In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.*
- 8.3.8 *The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.*
- 8.3.9 *Protect from output switching : The VFD shall be fully protected from switching a contactor / isolator at the output without causing tripping e.g.: for switching on/off the isolators of the AHU / ventilation fans / pumps near the motor with VFD in ON mode.*
- 8.3.10 *The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.*
- 8.3.11 *When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.*

### 8.4 INTERFACE FEATURES

- 8.4.1 *Hand, Off and Auto keys shall be provided on the control panel to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.*

- 8.4.2 *There shall be an “Info” key on the keypad. The Info key shall include “on-line” context sensitive assistance for programming and troubleshooting.*
- 8.4.3 *The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.*
- 8.4.4 *Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.*
- 8.4.5 *All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.*
- 8.4.6 *To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD’s keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.*
- 8.4.7 *Display shall be programmable to communicate in multiple languages including English, Chinese, Korean, Japanese, Thai and Indonesian.*
- 8.4.8 *A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.*
- 8.4.9 *A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.*
- 8.4.10 *A three-feedback PID controller to control the speed of the VFD shall be standard.*
- 8.4.11 *This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or minimum deviating signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.*
- 8.4.12 *The VFD shall be able to apply individual scaling to each feedback signal.*
- 8.4.13 *For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.*
- 8.4.14 *The VFD’s PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.*
- 8.4.15 *The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.*
- 8.4.16 *Floating point control interface shall be provided to increase/decrease speed in response to contact closures.*

- 8.4.17 *Five simultaneous meter displays shall be available. They shall be selectable from (at a minimum), frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, feedback signals in their own units, among others.*
- 8.4.18 *Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.*
- 8.4.19 *A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.*
- 8.4.20 *VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F). Examples can be room temperature in 0C , return air temperature in 0C , supply air temperature in 0C, CO2 concentration in ppm, pressure in bar, differential pressure in PSI etc.*
- 8.4.21 *VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.*
- 8.4.22 *Standard Control and Monitoring Inputs and Outputs*
- 8.4.22.1 *Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.*
- 8.4.22.2 *Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.*
- 8.4.22.3 *Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.*
- 8.4.22.4 *Each relay shall have an adjustable on delay / off delay time.*
- 8.4.22.5 *Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.*
- 8.4.22.6 *Each shall be independently selectable to be used with either an analog voltage or current signal.*
- 8.4.22.7 *The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.*
- 8.4.22.8 *A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.*
- 8.4.22.9 *The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,*

- 4.22.10 One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.
- 4.22.11 It shall be possible to read the status of all analog and digital inputs of the VFD through serial bus communications.
- 4.22.12 It shall be possible to command all digital and analog output through the serial communication bus.
- 4.23 Optional Control and Monitoring Inputs and Outputs
- 4.23.1 It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.
- 4.23.2 These modules shall use rigid connectors to plug into VFD's control card.
- 4.23.3 The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.
- 4.23.4 Modules may include such items as:
- 4.23.5 Additional digital outputs, including relay outputs
- 4.23.6 Additional digital inputs
- 4.23.7 Additional analog outputs
- 4.23.8 Additional analog inputs, including Ni or Pt temperature sensor inputs
- 4.23.9 It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.
- 4.24 Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Firemode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.
- 4.25 A real-time clock shall be an integral part of the VFD.
- 4.25.1 It shall be possible to use this to display the current date and time on the VFD's display.
- 4.25.2 Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. It shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.
- 4.25.3 All VFD faults shall be time stamped to aid troubleshooting.
- 4.25.4 It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

4.25.5 *The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.*

4.25.6 *The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.*

4.25.6.1 *The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:*

4.25.6.2 *Comparators for comparing VFD analog values to programmed trigger values*

4.25.6.3 *Logic operators to combine up to three logic expressions using Boolean algebra*

4.25.6.4 *Delay timers*

4.25.6.5 *A 20-step programmable structure*

4.26 *The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.*

## 5 SERIAL COMMUNICATIONS

5.1 *The VFD shall include a standard EIA-485 communications port, Modbus & Bacnet and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:*

*Metasys N2  
Modbus RTU  
Bacnet*

5.2 *VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.*

5.3 *The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.*

## 6 ADJUSTMENTS

6.1 *The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.*

6.2 *Four independent setups shall be provided.*

6.3 *Four preset speeds per setup shall be provided for a total of 16.*

6.4 *Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.*

*Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.*

*If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.*

*The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.*

*An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.*

*Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.*

## **7 OPTIONAL FEATURES**

*7.1 All optional features shall be built and mounted by VFD manufacturer as an inbuilt factory solution. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.*

## **8 SERVICE CONDITIONS**

*8.1 Ambient temperature at full speed, full load operation with continuous drive rated output current:*

*8.2 -10 to 45°C for ratings upto 90 kW without derating*

*8.2 -10 to 40°C for ratings 110 kW and higher without derating*

*8.3 Relative Humidity : 0 to 95%, non-condensing.*

*8.4 Elevation : Up to 3,300 feet without derating.*

*8.5 AC line voltage variation : + 10% of nominal with full output.*

*8.6 VFD Enclosure protection : IP 55, integral, with no additional cabinets.*

*8.7 Side Clearances : No side clearance shall be required for cooling.*

*8.8 All power and control wiring shall be done from the bottom.*

*8.9 All VFDs shall be plenum rated.*

## **8.10 QUALITY ASSURANCE**

*8.10.1 To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.*

8.10.2 All optional features shall be functionally tested at the factory for proper operation.

#### 8.11 RESISTANCE TEMPERATURE DEVICE(RTD)

The device should be mineral Insulated. Available in all sheath diameters.  
Mineral Insulation enables flexibility and durability .Class 'A' Tolerance as per IEC-751.  
It should come with enclosures in all Categories

RTD should be simplex type having element of pt 10 with a temperature range of 0 to 60 C.  
Also it should have 2 wire configuration with a sheath diameter of 10 mm.

Following process connection should be used :-

03B 1/8" BSP (M)  
03N 1/8" NPT (M)  
06B 1/4" BSP (M)  
06N 1/4" NPT (M)  
06BT 1/4" BSPT (M)  
10B 3/8" BSP (M)  
10BT 3/8" BSPT (M)  
10N 3/8" NPT (M)  
15N 1/2" NPT (M)  
15B 1/2" BSP (M)  
15BT 1/2" BSPT (M)  
M12 M 12 X 1 (M)  
M16 M 16 X 1.5 (M)  
M20 M 20 X 1.5 (M)

The head extension should be adjustable type with single wire entry.

## LIST OF APPROVED MAKES

S.No	DETAILS OF EQUIPMENT AND MATERIALS	MANUFACTURER'S NAME
1.	Air handling unit	Carryaire/ Suvidha/ Zeco/Edgetech/Wave
a)	Blower	Nicotra/Comferi/ Kruger
b)	Cooling coil	Coil Co. / Blue Star / Wave/Zeco/Edgetech
c)	Hepa Filter	Thermadyne /Anfilco/ Dyna Air Filtration/
2.	Fan Coil Units	Blue Star / Caryaire / Hitech Engineering /Zeco/Edgetech/Media
3.	GI Sheets	Bhushan / TATA/ Jindal
4.	Duct (factory fabricated)	Rola Star / Techno Fabriduct/Zeco/Ductofab
5.	Pipes (MS & GI)	Tata /Jindal (Hissar)/QST
6.	Gate Valve/ SS Ball Valve	Leader /CIM/ Zoloto / Sant/Honeywell
7	Butterfly valve	Audco / Advance / Deepak/ C&R/Honeywell
8.	Check Valve (Non return valve)	Audco / SKS / Advance/ Deepak/ Zolto/Honeywell
9.	Balancing valve	Advance /C&R /Audco/Deepak/Honeywell
10.	Water strainers (Y-strainer/pot strainer)	Emerald/Sant/D.S. Engineering / Maharaja Casting
11.	Proportional thermostat	Siemens /Honeywell/Johnson
12.	3 Way Motorized/ Mixing / Diverting valves	Siemens /Honeywell/Johnson/Anergy/ Rapid Control
13.	Pressure gauges for water line/Refrigerant	Emerald / Fiebeg/ H. Guru
14.	Thermometers	Emerald/ Japsin
15.	V-Belts	Fenner India/ Dunlop
16.	Fibre glass wool	UP Twiga /Owens Corning.
17.	Nitrile Rubber / closed cells expanded	Thermafex / Armafex/ Eurobatex /Paramount polyethylene foam
18.	Fire retardent flexible duct connection	Air flow / Navaire/Continental/Mahajan
19	Gasket for ducts	Prima Kool / Nuprine
20.	Anchor Fasteners	Hilti / Fischer
21.	Extruded Aluminium grilles & diffusers	Caryaire/ Ravi Star/ Air Flow



Fresh air louvers/Dampers

22.	Fire damper	Ravi Star/Air Flow/ Mapro
23.	Duct attenuator	Caryaire / Ravi Star/ Continental/Mahajan
24.	Vibration isolators	Resistolex/Gerb / Base/ Dunlop
25.	Motors	Siemens/Crompton/Kirloskar/ABB
26.	Fuse switch unit/switch fuse unit/HRC fuse	Larsen Toubro / Siemens / Schneider (MG)/Havells
27.	Contactors, Timers, O/L relays/Motor starters	Larsen Toubro/ Siemens / Schneider
28.	Control cables	CCI/ Fort Gloster/ Universal/ Incab/ Havells
29.	Cable glands	Dowells/ Comet/ Peeco
30.	Electrical Panel	Milestone Switchgear Pvt. Ltd/ Neptune Systems Pvt. Ltd. / Tricolite Elect. Industries/ESSAAR
31.	Indication lamps and Push Buttons	L&T/ BCH/ Siemens
32.	Ammeters and voltmeters	AEI/L&T/ Rishab / IMP
33.	CTs	AEI/L&T/ Rishab / IMP
34.	MCB	Legrand (MDS)/L & T/ Schnieder
35.	MCCB	L & T/Siemens / Schneider / Legrand (MDS)
36.	XLPE / PVC power cables	CCI/Gloster/Universal/ Havells
37.	Digital LCD energy meter	Enercon / Havells / IMP
38.	Selector Switch	Kaycee/Salzer
39.	Cable Trays	Steel Ways/Slotco
40.	Stick Pins	Primaseal/Airflow
41.	Humidistat	Honeywell/Danfoss/Penn.
42.	Condenser/ Chiller	Bluestar/ Voltas/Hitachi/ Trane
43.	Polyurethane Foam (PUF)	Malanpur/ Lloyd /Best Opuf
44.	Thermocole	Pioneer
45.	Chemical Reagent	Antiscalant/ Descalant / Antifungal Hibird / amacid/ Maic
46.	Centrifugal pump / Monobloc Pump	Kirlosker/ Batliboi / KSB / Beacon/Grundfoss

47.	Water Softening Plant	Ion Exchange Ltd. / Milton Royal.
48.	Pressure switch	Indfoss / Honewell
49.	Bronze ball valve	Emerald/ Zolto / Leader/ Sant
50.	Bronze ball valve with Y strainer	Emerald / Rapid control/ BAP
51.	VFD with sensors	ABB/DANFOSS/ ANERGY
52.	Cooling Tower	Paharpur/Mihir/ Flow air-tech Pvt.Ltd.
53.	Cooling Tower PVC Fills	Paharpur/Mihir
54.	Aluminium cable lugs	Alcon (Heay gauge) / Jainson
55.	Suction guide	Anergy instrument Pvt.Ltd./Johnson
56.	Water cooled screw chilling unit	TRANE/CARRIER/Mcquay/Kirlosker/Blue star
57.	Window/Split Air-conditioner/Hi-wall split AC	Voltas/Hitachi / Carrier/LG/Panasonic/Blue star/Voltas
58.	Dosing pump	M/s Ion Exchange (I) Ltd/ Milton Royal
59.	Chemical reagent	Eco friendly bio clean pond clarifier/ Volga.
60.	Sand filter	M/s Ion Exchange (I) Ltd / Pentair.
61.	Compressor	Voltas/ Kirlosker/Emmerson/Tecumsheh/Bohn/Danfoss
62.	Cold room/Deep freezer	Danfoss/Blue Star/Bohn
63.	Air-cooled ductable split/ceiling mounted Cassette type air-conditioning unit/	Blue Star/Voltas/LG/Hitachi/Carrier
64.	PVC water tank	Syntex/ Polycon
65.	Water Cooler	Blue Star/Usha/Sidwal
66.	Tower AC units	Blue Star/Voltas/LG/Hitachi
67.	DC inverter VRF system	Daikin/Toshiba/Voltas/Bluestar/ LG/Samsung/Mitsubishi Electric/Hitachi
68.	Hi wall type chilled water FCU	Cruise/Carrier/Zeco/Hitech
69.	Wet scrubber	Zeco/Edgetech/ZAIR
70.	Air washer (Evaporative cooling unit)	Carryaire/Suvidha/Zeco/Zair/Edgetech