



TENDER DOCUMENT FOR  
HEATING VENTILATION & AIR CONDITIONING  
(HVAC)SYSTEM

GIA-008  
Version : 03  
Date30/08/13

**INVITATION TO TENDER**

**FOR**

**HEATING VENTILATION**

**AND**

**AIR CONDITIONING SYSTEM**

**OF**

**PHARMA FORMULATION FACILITY**

**AT**

**JAIPUR**

Tender fees-5000/-



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## 1.0 SITE DATA

1. OWNERS / PURCHASERS : **M/s. RAJASTHAN DRUGS & PHARMACEUTICALS LTD.**
2. PROJECT TITLE : FORMULATION PLANT
3. PROJECT SITE : JAIPUR
4. NEAREST RAILWAY STATION: JAIPUR
5. NEAREST AIRPORT : SANGANER, JAIPUR
6. CONDITIONS :
- TEMPERATURE
- SU : DB –110°F / WB- 75°F/RH 20%
- MO : DB –95°F / WB- 78°F/RH 48%
- WI : DB – 46°F / WB- 41°F/RH 65%



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## **2.0 TENDER FORM**

**M/s. RAJASTHAN DRUGS & PHARMACEUTICALS LTD  
JAIPUR**

**Subject: AIR HANDLING AND VENTILATION SYSTEMS**

Dear Sirs,

I / We the undersigned have carefully gone through and clearly understood the Tender Drawings and Tender Document comprising of the Tender Form, Notice to Contractors, Condition of Contract, Specifications and Schedule of probable Quantities prepared by you.

I / We hereby undertake to execute and complete the whole work at the respective rates at which I/ We have quoted for. I/We have quoted for all the items of the probable Bill of Quantities and at which rates the total value of the work specified amount to **Rs.** \_\_\_\_\_.

I / We further agree to complete the work included in the said Schedule of Quantities within \_\_\_\_\_ months from the date of Letter of Intent along with advance issued to commence the same.

I / We agree not to employ any Sub- Contractors or procure items other than those that may be approved by you.

I/ We agree to pay all Government (State and Central) Taxes and Duties, Insurance and any other statutory dues that may be prevailing and payable from time to time, on such items for which the same are leviable and rates quoted by me/ us are inclusive of the same.

DATE: .....

NAME OF THE COMPANY

AUTHORISED SIGNATORY  
NAME AND SEAL OF THE COMPANY.



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### **3.0 NOTICE INVITING TENDERS**

Sealed Items Rate Tenders in two bids system are invited in the prescribed form by **M/s. RAJASTHAN DRUGS & PHARMACEUTICALS LTD** for the work detailed below. Contractors, who have experience in carrying out Air Conditioning & Ventilation system work for Pharma Factories shall be given preference .

Name of Work	Estimated Value of Work( in Lacs of Rs.)	Earnest Money ( in Lacs Rs.)	Time of completion	Tender Cost
Air conditioning and ventilation system	350 lacs	3.5 lacs	Six months	5000/-

The tender documents,instructions to Tenders,Bill of quantities,Conditions of Contract , Technical Specifications can be collected from the office of **M/s. RAJASTHAN DRUGS & PHARMACEUTICALS LTD, JAIPUR** , on the payment of the cost of tender documents (Five Thousand )  
In cash or demand draft drawn in favour of the company payable at Jaipur.

The tenderer is required to deposit Rs.3.5 lacs as earnest money along with the tender in shape of bank draft drawn in favour of M/s. **RAJASTHAN DRUGS & PHARMACEUTICALS LTD**, Payable at Jaipur ( Branch of any public sector bank ) The earnest money will be refunded to the unsuccessful tenderers without any interest /Bank Commission /Collection charges subject to the relevant provisions in the tender Document.



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Dear Sirs,

**M/s. RAJASTHAN DRUGS & PHARMACEUTICALS LTD** propose to set up a new facility for manufacture of various pharmaceutical formulations. to meet current GMP standards of International Regulatory Authorities like WHO-GMP/GLP. The facility is located at: JAIPUR

The completed bid (Technical & Financial) in all respects with all its accompaniments shall be enclosed in two different sealed envelopes and hand delivered or sent by courier at the following address on or before 07.10.13 Upto 3.00 pm.

Only the Technical Bid shall be opened on 07.10.13 at 4.00 pm  
Bidders who qualify in the technical bid shall be intimated the date and time of opening the financial Bid. The representatives of bidders may remain present at the time of opening of tenders.

The tender documents should be filled in English and all the entries must be made by hand and written in ink.

Initials of tenderer must attest all erasures and alteration made while filling the tender. Overwriting of figures is not permitted.

The tenderer must obtain for himself on his own responsibility and at his own expense all the information which may be necessary for the purpose of filling this tender and for entering into a contract for execution of the same and must examine the drawings and inspect the site of the work and acquaint himself with all the local conditions and matters pertaining thereto.

In case where the same item of work is mentioned at one or more places in the Schedule of Quantities, the lowest of the rates quoted by the contractor for the item shall be taken for the payment of this item.

The quantities contained in the Schedule are only approximate. The work as actually carried out and measured from time to time will be considered for payments subject to the terms and conditions of the contract.

**Time being the essence of this Contract; the work should be completed in Six Months** from the date of the letter of the intent issued to the contractor to commence the work. The successful contractor will have to submit a bar chart for various items of work to be done so that the work gets completed within the stipulated time.



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If the successful contractor fails to complete the work by the scheduled date of completion or within any sanctioned extension, liquidated damages at the rate of 0.5% per cent of the contract value per week of delay subject to a maximum of 5% of the total contract value shall be recovered from the contractors' bills.

The client do not bind themselves to accept the lowest bid and reserve to themselves the right to accept or reject any or all tender either in whole or in part without assigning any reason for doing so. **The contract may be awarded either in part or full at the sole discretion of the client.**

The offer should be valid for 60 days from the due date of submission.

Factory Manager



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## **4.0 INSTRUCTIONS TO TENDERERS**

### **01. TENDERER TO BE CONVERSANT WITH THE DOCUMENTS**

The tenderer is expected to read all the documents hereof and be conversant with the contents and when tenders are signed it will be understood and inferred that all the documents have been read and understood. Any difficulty experienced in interpreting the documents may be communicated to the employer in writing, and, should any written clarification be required it will be made available by them to all tenderers. No extra cost will be entertained because of the tenderers mistakes, ignorance or misinterpretation of drawings and other documents.

### **02. ADDENDA**

Addenda may be issued prior to the date set for submission of tenders to clarify the documents or to effect modifications in the HVAC contract terms or design of the project.

### **03. VISIT TO SITE**

The tenderers should visit the site and satisfy themselves as to the accessibility thereof, the local conditions, the construction and occupation of the building, the full extent and nature of the operations, the conditions affecting the supply of labour, carriage, carting, unloading, storage and safe custody of materials, scaffolding, tackle and tools, supply of light, power and water for the execution of the HVAC Contract generally. Claims on grounds of want of knowledge in such respects or otherwise shall not be entertained.

### **04. DRAWINGS**

Unless expressly stated, drawings prepared shall not be binding as to detail.

All drawings accompanying this specification are to explain each other and are to be considered as a whole. Any HVAC work(s) indicated on the drawings and not specifically mentioned in the specifications and vice-versa are deemed to be included.

The tenderer will, before tendering, carefully examine all drawings and specification forming part of tender and should any technical or other





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discrepancy appear, he will immediately inform the employer to obtain his ruling.

The tenderer shall carefully check the size of the plant rooms, and confirm that his equipment, piping, ducting, wiring, etc. can be installed in the space allocated for the same.

**05. WORKING DRAWINGS**

The tenderer is to include for the preparation of all working drawings (shop drawings), which will be required for the proper execution of the works. All working drawings shall be submitted to the client for approval before executing the work.

**06. FINAL AS INSTALLED DRAWINGS**

After completion of the installation, the HVAC Contractor is to provide tracings and five copies each of drawings showing runs and locations of all the plant, equipment, controls, piping, ducting, electric wiring, etc. giving all necessary details of the works as actually installed. He has to submit all drawings in CD also.

**07. INCLUSIONS AND INCIDENTALS**

The HVAC Contractor will include for providing materials and incidentals, which may be inferred from drawings and / or specifications, in order to ensure a complete and perfect installation although, same may not be expressly indicated or mentioned.

**8. ELIGIBILITY CRITERIA**

- (a) Bidder should have minimum three years experience in executing similar jobs in the Pharma formulation unit.
- (b) Bidder should have executed minimum Two crore (single project) of Heating Air Conditioning and Ventilation in the Pharma formulation Unit.

**9. DOCUMENTS TO BE SUBMITTED ALONG WITH THE TECHNICAL Bid**

- a) Demand draft of Rs.3.5 Lacs as earnest money. Earnest Money Interest free deposit of Rs.3.5 Lacs through D.D in favor of RDPL payable at Jaipur.
- b) Last three years balance sheet, income tax returns of last three years ,Bank solvency certificate of at least Rs. One Crore .Bio Data of Proprietors, partness or Directors and Key persons of the firm.



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- c) Number of projects executed during the last three years ,Monetary value of each project ,address of the companies or firms where these projects have been executed ,name and contact telephone nos. of the dealing persons there of .
- d) List of the technical manpower to be deployed for this project along with their qualification and experience.
- e) List of the perform testing equipment's available.
- f) Proof of satisfactory completion of various projects completed during the last three years.
- g) Projects in hand and anticipated projects during the current year.
- h) Section -10 information to be provided by the tenderer along with the tender.
- i) If any technical deviation is there the bidder can enclose a deviation sheet. (Deviation format as per Part-II)

**ALL THESE DOCUMENTS MUST BE SUBMITTED ALONG WITH TECHNICAL BID. NON SUBMISSION OF ANY OF THE ABOVE DOCUMENTS MAY LEAD TO REJECTION OF THE TENDER.**

## **10. DOCUMENTS TO BE SUBMITTED ALONG WITH FINANCIAL BID**

- (A) Tender form as per the format given in section 2.
- (B) Bill of quantities with rates (BOQ)
- (C) Payment terms

## **11. SPECIFICATIONS**

**15**

The HVAC Contractor shall execute the works with materials in accordance with the specifications or if not specified, in accordance with the latest Indian /International Standards. All materials which, in the opinion of the employer are unsound and/ or do not meet with the above conditions shall be immediately dismantled and/ or removed from site by the Contractor and shall be replaced by the appropriate approved materials without claim or extra payment to the Contractor.

The specifications are to be read in conjunction with the latest relevant Indian / International Standards & Specifications. Where differences or contradictions appear to arise between the Indian & International specifications these differences or contradictions shall be referred to the employer.



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## 12. TRAINING OF EMPLOYER'S STAFF

The HVAC Contractor shall make suitable arrangements at his own cost to train the operational and maintenance staff of the Employer during the installation and maintenance periods according to the conditions of the HVAC Contract.

## 13. INSPECTION

The Employer reserves the right to arrange inspection of all the items prior to their shipment through an inspector appointed by him. The inspection charges will be borne by the Employer unless otherwise stated. The tenderer need not, unless otherwise stated, make any provision for the Inspector's fee in his tender. The Employer shall, however, not pay anything extra to the HVAC Contractor or his suppliers for any expense in connection with the inspection.

## 14. PRICES

The Tenderer shall give a firm price for the supply of all materials (free delivery at site) and the cost of fabrication, installation, testing etc. to complete the works in working order in all respects.

The HVAC Contractor shall be responsible, without additional charge to the Employer, for a maintenance period of 12 calendar months from the date of issue of completion certificate by the employer. The HVAC Contractor shall during the maintenance period, service the complete plant at the time of start-up and shut down at the beginning and end of each operational season and at least once a month according to the schedule approved by the Employer. The HVAC Contractor shall also be responsible for rendering any special services during the maintenance period.

The Tenderer shall give a firm price for the supply of all materials (free delivery at site), construction and other cost for demolition & dismantling works wherever required, etc. indicated in the BOQ to complete the works in all respects.

## 15 PAYMENTS

The running payments in respect of the cost of the materials and labour charges shall be made to the HVAC Contractor according to the progress of the works and based on the certificate of the Site Engineer. Such certificates shall be based on the item break-up of the tender and of the percentages thereof.



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## 16. Taxes and Duties

The bidder has to quote for the price inclusive of all taxes and duties  
Applicable as on date including local & central sales tax (against C form)  
Excise duty, any applicable import duty, Service tax, etc. Company will  
Furnish you necessary C forms as per CST Act. However the breakup of such  
taxes & duty shall have to be furnished.

## 17. INSURANCE AND INDEMINIFICATION

Bidders shall take adequate comprehensive insurance to cover all HVAC  
Equipment's, materials, installation, personnel's, etc., till the completion of the  
project and indemnify RDPL against any damage ,loss, claims, or liabilities,3rd  
party damages, etc., that may arise due to any cause whatsoever till the entire  
HVAC system on completion is taken over by the company. Cost of Insurance Is to  
be inclusive in your order value. Thus the bidder will hold RDPL free from any  
liability in this regard and also shall keep RDPL harmless and indemnified.

## 18. ACCEPTANCE

Promptly after receiving of all tenders, the Employer will undertake a detailed  
study and appraisal of the tenders submitted. The Employer does not bind himself  
to award the HVAC Contract to the lowest or to any tenderer but will take into  
careful consideration the tenderer's price and such other factors as are deemed to  
be applicable for awarding the contract.

## 19. RIGHTS

The Employer reserves the right to re-call the tender or, reject any or all tenders  
and to waive any formalities in the tenders received (such as deviation in the use  
and presentation of the specified tender documents and forms), if it appears to be  
in his best interest to do so.

The tender documents and drawings are the exclusive property of the issuing  
authority and are subject to be recalled and shall not be used, lent, copied or  
reproduced by anybody without their written permission.

## 20. EQUIPMENT AND MATERIAL

The HVAC Contractor shall give written guarantee that all the equipment and  
material supplied under the HVAC Contract shall be brand new from the  
manufacturer and that, the materials and workmanship will be of best class. It will



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further be guaranteed that these shall be installed in first class manner, that it will be complete for operation and nothing shall be omitted by way of labour and material required to make it so, even though not specifically shown or mentioned in the specifications or in the drawings.

The HVAC Contractor shall execute the works with the materials in accordance with the specifications. All materials, which in the opinion of the employer are not sound or do not meet with the above conditions, shall be immediately dismantled and/or removed from site by the HVAC Contractor and replaced by appropriate approved materials without claim of any extra payment.



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## **5.0 HVAC-CONTRACT CONDITIONS**

### **01. EXTENT OF HVAC CONTRACT**

The HVAC Contract comprises the design, manufacture, supply, fabrication, installation, completion, testing, commissioning, validation, documentation and maintenance of complete HVAC works including supply of all materials, plant and equipment as per requirements of design contained in the HVAC Contract, drawings, specifications and documents.

Except in so far as the HVAC Contract otherwise provides, the provision of all labor, materials, plant and machinery, temporary works and everything whether of a temporary, permanent or incidental nature required in and for such construction, completion and maintenance so far as the necessity be inferred from the HVAC Contract.

The selection of the HVAC Contractor shall be subject to following conditions & provisions:

That the Contractors will keep harmless and indemnify the Employer from and against any negligence by the Contractor, his workmen and servants and from and against any misuse by him or them of any constructional plant or temporary works provided by the Employer either directly or through any other agency for the purposes of this Contract.

### **02. HVAC CONTRACT DOCUMENTS**

The HVAC Contract shall be read, construed and interpreted in English language and shall operate in conformity with the laws of India and within the jurisdiction of the courts at Jaipur.

Several documents forming the HVAC Contract shall be taken as self explanatory, but in case of ambiguities or discrepancies, the same shall be explained and interpreted by the employer who shall thereupon issue to the Contractor, instructions directing the manner, in which the HVAC works are to be carried out.

One set of the HVAC Design Drawings and two sets of the approved HVAC shop drawings shall be kept by the HVAC Contractor on the site and the same shall at all reasonable times be available for inspection and use by the



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Employer/Employer's Representative and by any other person authorised by the Employer.

The HVAC Contractor shall prepare at his own expense any shop drawing/s which will be required for the proper execution of the works.

None of the documents herein before mentioned shall be used by either of the parties hereto for any purpose other than this HVAC Contract and neither shall divulge or use, except for the purpose of this HVAC Contract, any information in the schedule of prices and rates.

The HVAC Contractor shall retain in his office all necessary drawings; data and calculations for the HVAC work in a methodical manner and shall produce them whenever required by the Employer.

### **03. GENERAL OBLIGATIONS**

The HVAC Contractor shall be deemed to have satisfied himself before tendering as to the correctness and sufficiency of his tender and the rates and prices shall cover all his obligations under the HVAC Contract and all matters and things necessary for proper completion and maintenance of the HVAC works.

The Contractor shall execute, complete and maintain the HVAC works in strict accordance with the HVAC Contract to the satisfaction of the Employer and the whole of the materials, plants, equipment and labor and other things that shall be provided by the HVAC Contractor pursuant to the HVAC Contract and the mode, manner and speed of execution and maintenance shall be to the satisfaction of the Employer.

The HVAC Contractor shall comply and adhere strictly to the Employer instructions and directions on any matter (whether mentioned in the HVAC Contract or not) concerning the HVAC works. The HVAC Contractor shall take instructions and directions from the Site Engineer.

### **04. PROGRAMME OF WORKS**

The HVAC Contractor shall, within Ten days after the acceptance of his tender, submit in writing, for approval of the Employer, a program of works coordinated with the construction program, in the form of a bar chart showing the order of procedure and method in which he proposes to carry out the HVAC works. He shall also submit, for the information of the Employer full particulars of the



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organization and staff by which he proposes to direct and administer his performance of the HVAC Contract.

The program, which, the HVAC Contractor is required to furnish, shall be such as to allow the completion of the whole project by the completion date.

The program shall cover the full period of works from the date of the acceptance of the tender to the completion of installation, testing, and validation and handing over of the complete plant in working order. The program shall cover the sequence of work for all items showing separately in each case the time allowed for manufacturing, shipment, fabrication, delivery to site, installation, testing, commissioning and starting up.

The program submitted by the HVAC Contractor may be amended if any part of it is not to the satisfaction of the Employer and it shall not be carried into effect until it has been approved (in an amended form, if necessary) by Employer.

If the Employer under the provision of this clause requires the HVAC Contractor to amend his program of works, the HVAC Contractor shall not thereby be entitled to any adjustment in the HVAC Contract price or to any extension of time.

The submission to or approval by the Employer of such program or the furnishing of such particulars or information shall not relieve the HVAC Contractor of any of his duties or responsibilities under the HVAC Contract.

#### **05. DELAYS AND EXTENSION OF TIME**

If in the opinion of the Employer the works are delayed or are expected to be delayed because of any of the following reasons, the completion period may be extended by such period as may be mutually agreed upon:

- a) Force majeure
- b) By reason of any exceptionally inclement weather (if acceptable to the Employer)
- c) By reason of proceedings taken or threatened by or dispute with adjoining or neighboring owners or public authorities arising otherwise, through the Contractor's own default.
- d) By the work's or delays of other contractors or tradesman engaged or nominated by the Employer and not referred to in the Schedule of Quantities and / or specifications.





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- e) By reason of civil commotion, local combination of workmen or strike or lockout affecting any of the works / trades.
- f) By reason of Employer instructions.

If and whenever it becomes reasonably apparent to the Contractor that the progress of work is being, or is likely to be delayed, due to reasons not attributable to them, they shall forthwith give written notice to the Owner explaining the circumstances including the cause or causes of such delay. Where the cause or causes of delay refers to any agency other than the Contractor, a copy of such notice shall be sent to them also.

#### **06. PENALTY / DAMAGES FOR DELAY**

If the HVAC Contractor fails to complete the works within the schedule agreed upon, or within such extensions that may be granted to him pursuant to Clause 05 above, then the Employer will be at liberty to deduct from the Contractor's bills, by way of penalty a sum equivalent to 1/2 % of the value of the contract for each week's delay subject to a maximum of 5% of the value of the contract. The Employer may without prejudice to any other method of recovery deduct the amount of such damages from moneys in his hands due to or which may become due to the HVAC Contractor from his obligation to complete the works or from any other of his obligation and liabilities under the HVAC Contract.

#### **07. HVAC CONTRACTOR' S SUPERINTENDENCE**

The HVAC Contractor shall give or provide all necessary superintendence for the proper fulfilling of the HVAC Contractor's obligations under the HVAC Contract.

A competent and duly authorized representative of the HVAC Contractor and who shall have full authority to act for and bind the HVAC Contractor, is to be constantly at the site of works and shall give his whole time to the superintendence of the HVAC works.

The representative of HVAC contractor shall receive on behalf of the HVAC Contractor directions and instructions from the Employer.

The HVAC Contractor shall provide and employ on the site for the purpose or in connection with the HVAC Contract, only such Engineers, Supervisors, Technical Assistants as are skilled and experienced in their respective callings and are competent to give proper supervision to the work they are required to supervise, and, such skilled, semi – skilled and



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un-skilled labor as are necessary for the proper and timely performance of the HVAC Contract.

The Employer shall be at liberty to object to and require the HVAC Contractor to remove forthwith from the site any persons employed by the HVAC Contractor or any Sub – Contractor who in the opinion of the Employer misconducts himself or is incompetent or negligent in the proper performance of his duties or whose employment is otherwise considered by the Employer to be undesirable. Such person shall not be again employed for the purpose of or in connection with the HVAC Contract without the written permission of the Employer. Any person so removed shall be replaced immediately by a competent substitute approved by the Employer.

#### **08. WATCH & CARE OF WORKS**

Except as otherwise specifically provided in the HVAC Contract the HVAC Contractor shall make all arrangements for the security and protection of persons and property or for the safety or convenience of persons as is necessary or as required by the Employer.

From the commencement to the completion of the works, the HVAC Contractor shall take full responsibility for the care of all temporary works, materials, constructional plant and other things on the site. In case any damage, loss or injury shall happen to the works or any such materials or constructional plant or other things from any cause whatsoever (save and except the expected risks like out – break of war or act of invasion), he shall at his own cost, replace, repair and make good the same. It is to be ensured that at completion, the works shall be in good condition and in conformity in every respect with the requirements of the HVAC Contract.

The HVAC Contractor shall indemnify and keep indemnified the Employer against all losses and claims for injuries or damage to any person or any property of Employer whatsoever which may arise out of or in consequence of the performance of the HVAC Contract and against all claims, demands, proceedings, damages, costs, charges and expenses, whatsoever in respect of or in relation thereto.

#### **09. COMPLIANCE WITH STATUTES, REGULATIONS, ETC.**

HVAC Contractor shall conform in all respects to the provisions of all requirements, local laws, regulations or orders or other laws for the time being in force including all regulations and bylaws of local or other duly constituted authority which may be applicable during the pendency of the contract and the



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rules and regulations of all public bodies and companies whose property or rights are affected or may be affected in any way by the HVAC works or any temporary works and shall give all notices and pay all fees, charges, rates and taxes (collectively referred herein as fees) required to be given or paid thereby and shall keep the Employer indemnified against all penalties and liabilities of any kind and in any form.

**10. SUPPLY OF PLANT, MATERIALS AND LABOUR**

Except where otherwise specified the HVAC Contractor shall at his own expense and risk, supply and provide all the constructional plant, temporary works, scaffolding materials both for temporary and for permanent work, labor (including the supervision thereof), transport to and from the site and in and about the site and other things of every kind required for the purpose of or in connection with the HVAC Contract.

**11. CO – ORDINATION WITH OTHER CONTRACTORS**

The HVAC Contractor shall arrange and administer the HVAC Contract and the program of work incorporating the program of building construction and other services.

The HVAC Contractor shall acquaint himself fully with the requirements of the program of building construction and the requirements of the Employers and any other contractors in carrying out the works in the Building. It would be necessary due to the nature of the HVAC installation to arrange a proper sequence of operations with respect to the work of the other trades. It shall be responsibility of the HVAC Contractor to schedule his work so as to complete the HVAC installation within the required time and without delaying the completion of the entire project.

The decision of the Employer shall be final and binding on the HVAC Contractor in case of dispute or difference of opinion arising between various contractors in relation to the responsibilities and scope of work required under mutual co-ordinations.

**12. OPPORTUNITIES FOR OTHER CONTRACTORS**

The HVAC Contractor shall in accordance with the requirements of the Site Engineer afford all reasonable opportunities for carrying out their work, to any other contractors employed by the Employer and their workmen and to the workmen of the Employer.



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### **13. INTERFERENCE WITH TRAFFIC AND ADJOINING PROGRAMME**

All operations necessary for the execution of the HVAC works and for the construction of any temporary works shall be in compliance with the requirements. The works shall be carried on so as not to interfere unnecessarily or improperly with public convenience or the access to use and occupation of public or private roads and footpaths or to or of properties whether in the possession of the Employer or of any other person and the HVAC Contractor shall make harmless and indemnify the Employer in respect of all claims, demands, proceedings, damages, costs, charges and expenses whatsoever arising out of or in relation to any such interference.

### **14. WORKS NOT INCLUDED AND FACILITIES PROVIDED BY OTHERS**

The Employer will not be under any obligation to provide equipment, stores, office, etc. to the HVAC Contractor for the HVAC works installation.

However, he shall at his own discretion arrange open space at site for HVAC Contractor to have his office, stores and workshop constructed by himself. The Employer shall also arrange the following facilities or works to him for proper execution of HVAC works.

#### **GENERAL**

The Employer will provide at his cost temporary water and electrical points within a reasonable distance from the HVAC Contractors place of Work. The HVAC Contractor shall arrange his own distribution of facilities for lighting, power for tools and welding equipment and water for testing from these points. The Employer will provide temporary lighting for safety and security only.

The HVAC Contractor will be responsible for the provision and erection of all scaffolding, etc. required by him during the course of the HVAC works. However, the erected scaffolding, if not in use of any other contractor the same can be used by the HVAC Contractor with the written permission of the relevant contractor/ employer.

The HVAC Contractor will be responsible for the removal and transport of all his rubbish, wrappings, waste and unused materials, etc. every day to a place to be designated by the Employer.

The HVAC Contractor will be responsible for those safety regulations,



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Which, are directly under his control. The HVAC Contractor will be held responsible for his own safety regulations. Limited First Aid facilities may be provided on site by the Employer and can be made available to the HVAC Contractor at cost.

Any damage caused by the HVAC Contractor to works of other trades, shall be the sole responsibility of the HVAC Contractor. He shall take full precautions to prevent such happenings.

**15. LABOUR LAWS.**

The HVAC Contractor shall, in relation to the works executed under this contract, strictly comply with the provisions of all current labor laws and statutory amendments or additions thereof and any regulation or orders made there under affecting the works. Liabilities towards labor i.e. PF ESI, and other liability under any labour and any other law shall be of the contractor.

**16. CERTIFICATE OF COMPLETION**

No certificate of completion shall be given nor shall the work be considered to be complete until the HVAC Contractor shall have removed from the premises on which the work has been executed, all scaffolding, surplus materials and rubbish and cleaned off the dirt, from those parts of the building where the work has been executed or of which he may have had possession for the execution thereof, nor until the work shall have been measured and recorded by Employer and checked by the Employer which measurement shall be binding and conclusive for the HVAC Contractor. If the HVAC Contractor shall fail to comply with the requirements of this clause as to removal of scaffolding etc. and cleaning off the dirt on or before the date of completion of works, the Employer may at the expense of the HVAC Contractor remove and dispose off such scaffolding, etc. and clean off such dirt as aforesaid and the HVAC Contractor shall forthwith pay to the Employer the amount of all expenses so incurred and the said amount shall be adjusted from the amount due to the HVAC Contractor from the Employer and the HVAC Contractor shall have no claim in respect of such scaffolding and surplus materials as aforesaid.

**17. VARIATIONS**

The HVAC Contractor shall not make any variation in the works except in accordance with a written variation order.



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The Employer may make any variation of the form, quality or any part thereof as he may think necessary and for that purposes, by a written variation order, may order the HVAC Contractor to do and the HVAC Contractor shall do any of the following :-

Increase or decrease the quantity of any HVAC works included in the HVAC Contract.

Omit any such HVAC works.

Change the levels lines position and dimensions of any part of the HVAC Works.

Change the character or quality or kind of any such HVAC works.

Execute additional or substituted work of any kind necessary for the completion of the HVAC Works.

No variation order shall in any way vitiate or invalidate the HVAC Contract but shall be taken into account in ascertaining the HVAC Contract price.

For the removal of doubt, it is declared that any increase or decrease of the estimate quantities set out in the schedule of prices ascertained by measurement is not a variation within the meaning of this clause.

The Employer shall determine what adjustment (if any) in the HVAC Contract price shall be made in respect of work done or omitted pursuant to a variation order. All such work shall be valued at the rates and prices set out in the schedules of prices and item rates if in the opinion of the employer the same shall be applicable. If the schedule of prices and item rates do not contain any rate or price applicable to such work, then suitable rates and prices based upon the rates and prices contained in the schedules of prices and item rates and based on prevailing market rates shall be agreed between the Employer and HVAC Contractor.

## **18. MEASUREMENT**

The quantities set out in the schedule of prices are estimated quantities only and they shall not be taken as the actual and correct quantities or work to be executed by the HVAC Contractor in fulfillment of the obligation under the HVAC Contractor.

The Employer's representative shall except as otherwise stated, ascertain and determine by actual site measurements the value of works in



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accordance with the HVAC Contract. He shall, when he requires any work to be measured, give notice to the HVAC Contractor who shall forthwith attend or send a qualified representative to assist the Employer's Representative in making such measurement and shall furnish all particulars required by either of them. Should the HVAC Contractor not attend or neglect or omit to send such representative then the measurement made by the Employer's Representative or approved by him shall be taken to be correct measurement of the works.

## **19. MAINTENANCE AND DEFECTS**

The expression "period of maintenance" shall mean the period of maintenance named specified elsewhere in this tender calculated from the date of completion of the HVAC works certified by the Employer.

During the period of Maintenance the HVAC Contractor shall execute all such work of repairs, amendment, re-constructions, rectification's, making good of defects, imperfections, shrinkage or other faults as may be required of the HVAC Contractor in writing by the Employer's Representative during the period of maintenance or within thirty days after its expiration.

All such works shall be carried out by the HVAC Contractor at his own expense, if, in the opinion of the employer, it is to the use of materials or workmanship not in accordance with the HVAC Contract or due to neglect or failure on the part of the HVAC Contractor to comply with any obligation expressed or implied on the HVAC Contractor's part under the contract. If in the opinion of the employer such necessity shall be due to any other cause, the value of such work shall be ascertained and paid for by the Employer as if it were additional work.

The HVAC Contractor shall be responsible during the period of maintenance for removing without undue delay any defects or fault, which may develop under the conditions provided for in the HVAC Contract and under proper use and arising from faulty materials or design or workmanship. If it becomes necessary, for the HVAC Contractor to replace or remove any defective part of the plant or equipment under this clause the provisions thereof shall apply to the parts so renewed or replaced. If the HVAC Contractor, when called upon to do so, fails to remedy such defects within a reasonable time, the Employer is empowered to instruct other parties to carry out the work at the expense of the HVAC Contractor.



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Such action by the Employer will not prejudice any other right, which, the Employer may have against the HVAC Contractor in respect of such defects.

In the event of any defect occurring or being discovered in the HVAC works during the period of maintenance and due to faulty materials or workmanship supplied by the HVAC Contractor the period of maintenance shall continue until the cause of the defect has been discovered and remedied to the satisfaction of the Employer.

**20. STATEMENT, CERTIFICATES AND PAYMENTS**

The HVAC Contractor shall submit to the employer after the end of each month a statement showing the estimated contract value of the HVAC works executed in the form of progress report, upto the end of the month and the HVAC Contractor will be paid monthly, the amount due to him subject to deduction of previous payments and retention percentage named in the Contract.

All interim payments against monthly certificate shall be regarded as payments on account until the final payment and not as payment for work actually done and completed and shall not include the requiring of bad, unsound and imperfect or unskilled works to be removed and taken away and reconstructed or recreated or be considered as an admission of the due performance of the HVAC Contract or any part thereof in any respect or the accruing of any claim nor shall it conclude, determine or affect in any way the powers of the Employer under the HVAC Contract as to the final settlement and adjustment of the accounts.

No claim from the HVAC Contractor on account of fluctuations in the market rates will be entertained during the currency of this HVAC Contract for any item of HVAC works executed under this HVAC Contract.

The HVAC Contractor shall submit the final bill within one month of the completion of the works unless otherwise allowed. In case of failure to submit the final bill within the above period, the HVAC works will be measured by the Employer at the expense of the HVAC Contractor and the measurement so taken will be binding on the HVAC Contractor.

**21. PERFORMANCE BANK GUARANTEE**

The HVAC contractor shall submit a performance bank guarantee issued by a PSU Bank in favour of company for a value equivalent to 10% of the





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aggregate value of contract before the date of completion of the entire works as per contract awarded, to enable the company to have smooth and trouble free operation and running of the whole of HVAC systems installations as agreed upon to its entire satisfaction with validity for atleast one year from the date of certification of commissioning of the system.

## 22. PROPOSED TERMS OF PAYMENT

We have considered DIVISIBLE CONTRACT for execution of the project. This means company will place two separate orders to the successful bidder. One for the supply of the items (Specified in schedule A of Bill of Quantities ) & the second order for the site fabrication & erection (Specified in Schedule B) of Bill of Quantities

HVAC contractor should specify his terms of payment. The terms of payment shall be finalized at the time of negotiation.

### Payment Terms for the supply items mentioned in schedule A:

- a) 10% (Ten percent) of contract value of supply items on submission of drawings on pro rata basis of the area covered in the drawings with respect to the total area in the contract. Along with submission DQ documents and bank guarantee for 10% value.
- b) 50% (Fifty percent) of value of the material received at the site on pro-rata delivery of items. (Not being higher than 50% of contract value)
- c) 20% (Twenty percent) of contract value against installation of the equipment at site on pro rata basis after submission of IQ & OQ documents.
- d) 10% (Ten percent) of contract value against successful commissioning, testing & validation by you; taking over of the entire HVAC system by us; submission of validation / qualification documents and AS- built drawings on pro rata basis after submission of PQ documents.
- e) 10% (Ten percent) of contract value against submission of Performance Bank Guarantee by you from a public sector bank for the like amount valid till the guarantee period (One Year from the date of approval / certification of commissioning of the system). Alternatively, 10% of Gross payment at each stage would be detained against the Performance Guarantee, which shall be released only on receipt of Performance Bank Guarantee.

### Payment terms for site fabrication & erection items specified in schedule B



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- a) 10% (Ten percent) of site fabrication & erection items on submission of drawings on pro data basis. along with bank guarantee of 10% value.
- b) 50% (Fifty percent) payment shall be released against running bills as per the BOQ rates.
- c) 20 % (Twenty percent ) on erection on pro rata basis.
- d) 10% ( Ten percent ) Against successful commissioning ,testing& validation by you; taking over of the entire HVAC system by us; submission of validation / qualification documents and AS- built drawings on pro rata basis.
- e) 10% (Ten percent) value against submission of Performance Bank Guarantee by you from a public sector bank for the like amount valid till the guarantee period (One Year from the date of approval / certification of commissioning of the system). Alternatively, 10% of Gross payment at each stage would be detained against the Performance Guarantee, which shall be released only on receipt of Performance Bank Guarantee.

**General:**

- 1) At the time of submission of invoices following documents need to be submitted for settlement of any claim as per the payment terms
  - a) Invoices to be submitted in original plus two extra copies.
  - b) Excise Gate passes for RDPL to be able to claim cenvat benefit as per cenvat rules.
  - c) Copies of Challans of materials received at site by the Officer-in-charge of RDPL duly certified as approved.
  - d) TDS and any other applicable taxes shall be deducted as per prevailing rates.

**2) Special Conditions**

- a) For all the excisable goods, RDPL will claim the Cenvat benefit. All the gate passes required under the provisions of Central Excise Rules and Cenvat Credit rules for the relevant items should be in the name of RDPL. In absence of any documents required for Cenvat credit, no excise payments against the bills submitted by HVAC contractor shall be made.
- b) The rate of excise duty and its value for each item should be indicated separately & will be one of the criteria for evaluating the tender.
- c) The rates of service tax wherever applicable & quantum included in the tender should be indicated separately. The quantum of VAT on item-wise basis, along with its rate should be indicated separately.

**23. TRAINING OF EMPLOYER'S PERSONNEL**



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The HVAC Contractor shall make suitable arrangements at his own cost to train the operational and maintenance staff of the Employer during the installation and maintenance period. The HVAC Contractor shall if so desired by the Employer, also arrange training facilities at his manufacturers / supplier's offices and factories from whom the equipment and materials for the works are procured without any charge to the Employer for the training facilities, except for salaries, traveling and living expenses of the Employer's personnel which expenses shall be borne by the Employer.

**24. GUARANTEE**

The HVAC Contractor shall guarantee the electricity consumption and rated output of the plant offered by him. He shall state in his tender the KW of all equipment offered by him and the rated air supply quantity of each Air Handling Unit. The HVAC Contractor shall establish the electricity consumption of the plant during the test run, maintain a record and will make all necessary adjustments to ensure that the consumption is within the limits guaranteed by him.

The HVAC Contractor shall give a guarantee for the complete installation against defective materials and faulty workmanship for a period of one year from the date of issue of certificate of virtual completion by the Employer. All defects of material or workmanship found in the installation during the period of guarantee/ maintenance shall be removed and defective items replaced or repaired by the HVAC Contractor without any additional cost to the Employer.

In the event of any defect of material or workmanship occurring or being discovered during the period of guarantee / maintenance, the period shall continue until the cause of the defect has been discovered and remedied to the satisfaction of the Employer.

**25. DRAWINGS & INFORMATION TO BE SUPPLIED.**

The HVAC Contractor when preparing any detailed working drawing shall carefully check for all clearances, field conditions, and avoidance of any hindrance with architectural features and proper co-ordination with all other services of the project. Each working drawing submitted by the HVAC Contractor shall include a certificate by the HVAC Contractor that all related conditions on the site relevant to that particular installation have been checked and that no conflict exists. The Employer may not approve any



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working drawing submitted by the HVAC Contractor without such a certificate.

Manufacturer's performance data, test certificates and shop drawings of all main items of the plant giving complete information regarding dimensions, materials and other details regarding the adequacy of the equipment to be supplied shall be submitted to the Employer for approval.

All working drawings prepared in the required scale, correct and conforming with the HVAC Contract requirements, shall be submitted to the Employer sufficiently in advance of actual requirements to allow ample time for checking and approval and no claim for extension of the HVAC Contract time will be considered by reasons of the HVAC Contractor failure to submit the correct drawings in time. The HVAC Contractor will submit 5 copies of final corrected drawings for approval out of which 2 duly approved copies would be returned to him.

The HVAC Contractor shall clearly point out the difference, if any between the details submitted and the requirements of the HVAC Contract in covering letters sent with the submitted documents and drawings. He should also give reasons for his request for substitution so that if substitutions are acceptable, necessary action may be taken for proper adjustment. The HVAC Contractor will not otherwise be relieved of his responsibility for executing the works in accordance with the terms of the HVAC Contract.

The HVAC Contractor shall supply five sets of, as fitted drawings and manufacturer's installation, commissioning, operation, services and maintenance manuals, technical catalogues and detail spare part manuals for the guidance of the Employer's operators in operation, servicing and maintenance of the plant. One set shall be supplied to the Employer for scrutiny and approval.

The approval by the Employer of any submitted data, working drawings, performance curves, test certificates for any item, arrangement or layout shall not relieve the HVAC Contractor from responsibility of error of any sort in the submitted data and working drawings.

## 26. NOTICES

Notices for the Employer or the Contractor may be served personally or being left at or sent through courier to the last known address of the party to whom the same is to be given or in the case of the Contractor by being handed over to his representative at the work site.



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## **27. TERMINATION OF CONTRACT BY THE EMPLOYER**

If the contractor be adjudged as Insolvent or shall have an order for compulsory winding up made against it and if the Contractor is unable to show to the reasonable satisfaction of the Employer that he is able to carry out and fulfil the contract and to give security thereof or has failed to commence the works, or has without sufficient and lawful excuse suspended the progress of work for 14 days after receiving written notice from the Employer to proceed or has persistently neglected or defied Employer instructions then the Employer reserves his right to terminate the contract.

## **28. ESCALATION IN PRICES OF HARDWARE & PIPING**

It is abundantly clarified by the company that during the currency of period of contract, no escalation in price or cost of hardware and piping etc accepted by the company (RDPL) shall be allowed for the first six months from the date of commencement of work at site by the contractor however after the expiry of aforesaid first six month period, the escalation claims if any shall apply only when it is proved undoubtedly that delay in execution of work at site was caused. Due to any act of default or delay on the part of the company (except the force majeure circumstance beyond the contract of the company) which resulted in effective delay in execution of the work assigned under the contract awarded.

## **29. SETTLEMENT OF DISPUTE (ARBITRATION)**

All disputes and differences of any kind whatever arising out of or in connection with the contract or the carrying out of the works, whether during the progress of the works or after their completion and whether before or after the determination or breach of the contract, shall be referred to Arbitration of a single Arbitrator. All disputes and differences of any kind whatever arising out of or in connection with the contract or the carrying out of the works, whether during the progress of the works or after their completion and whether before or after the determination or breach of the contract, shall be referred to INTERNATIONAL CENTRE FOR ALTERNATIVE DISPUTE RESOLUTION having its office at plot no.6, vasant kunj institutional area , phase –ii ,New Delhi-110070 and its decision/ award shall be binding on both the parties.

## **30. DEFINITION & INTERPRETATION**

In constructing the HVAC Contract, these conditions, HVAC Contract agreement and the interpretations of the following words and expressions



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shall have the meaning herein assigned to them except where the subject or context otherwise requires.

**“Employer / Owner”** means **M/s. RAJASTHAN DRUGS & PHARMACEUTICALS LTD** and includes their administrative and legal representative, assigns or successors.

**“HVAC CONTRACTOR”** means the tenderer whose tender has been accepted and who has been nominated by the Employer and shall include his legal and personal representative (s), successors and permitted assigns.

**“HVAC CONTRACT”** means the agreement contained in the HVAC Contract agreement and the documents set out in the HVAC Contract agreement as forming part thereof.

**“SITE”** means the site or the HVAC works and the lands, otherwise places buildings and erections thereon, under, in or through where the HVAC works are to be executed or carried out and any other land (inclusively) as aforesaid allotted by the Employer to the HVAC Contractor’s use.

**“APPROVED FOR CONSTRUCTION”** means approved in writing including subsequent written confirmation of previous oral approval.

**“MONTH”** means a Calendar month.

The singular includes the plural and vice versa. The masculine includes the feminine and vice versa. Words importing persons include firms, companies or other bodies corporate.

**“TEMPORARY WORKS”** means all temporary works of every kind required in or about the execution, completion or maintenance of HVAC works.

**“HVAC DRAWINGS”** means the drawing referred to in these specifications and any modification of such HVAC drawings approved in writing by the Employer and such other drawings as may from time to time be furnished or approved by the Employer.

**“CONSTRUCTIONAL PLANT”** means all appliances or things of whatsoever nature required in or about the execution, completion or maintenance of the HVAC works or Temporary works but does not include materials or other things intended to form or forming part of the permanent works.



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**SECTION 6**  
**SPECIAL CONDITIONS OF CONTRACT**



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## **6.0 SPECIAL CONDITIONS OF THE CONTRACT**

### **GENERAL**

Testing, Adjusting and Balancing of the system shall be performed under direct supervision of the Plant Engineers as per the requirements of the employer.

#### **1.0 TEST FOR AIR CONDITIONING PLANT / EQUIPMENT**

The plant and equipment shall be tested either for summer / monsoon or winter depending on the particular reason at which time plant is completed mechanically and ready for commissioning. The contractor shall arrange to carry out various initial tests as detailed below in the presence of and to complete satisfaction of the Employer or his representative. Any defects or shortcomings found during the tests shall be speedily rectified or made good by the Contractor at his own expenses.

The initial tests shall include but not be limited to

- i) Test and check the proper functioning and settings of switchgear, starters, contactors, safety controls and electrical motors etc., to ensure their proper functioning.
- ii) Check the system against leaks in different circuits, alignment of motors, V belts adjustments, control setting and all such other tests, which are essential for smooth functioning of the plant.
- iii) Operate and check the proper functioning of all components
- iv) Check and adjust the water flow in the system to the original design through such components viz. condenser, cooling coils etc.
- v) Check air distribution system and provide design air flow in all areas by adjusting the grilles, diffusers and dampers whether specifically shown on the drawings or not.
- vi) Check the performance of the equipment on cooling cycle in summer / monsoon taking hourly DB & WB reading in all rooms non-stop for 72 hours.





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- vii) The test performed in the above manner, shall be concluded with reports specifying completeness of all supplied equipment's.

## 2.0 PERFORMANCE TEST

After erection of various air handling units all the units shall be tested for their rated capacity.

Following parameters have to be assured by the contractor.

- i) TR PRODUCED
  - A) By air flow
  - B) By water circulation
- ii) CFM specified
- iii) Static pressure at given temp. & R.H. conditions
- iv) Electric power consumption for each equipment.
- v) Any other utilities required shall also have to be measured compared to the committed consumption.
- vi) Consumption of items whatsoever nature, considered as extra consumption and will disqualify the performance test.

## 3.0 CLEANLINESS TEST

- a) These tests will be carried out under static conditions
  - i) 'D.O.P ' Test:

ISO 14644 and BS 5295 describes DOP (Di Octyl Phthalate) test required for filters to be tested in place. A DOP generator introduces aerosol as challenge agent into the upstream side of the filter system.

A sample of these aerosol - air mixer will be taken on the up stream side of the filter with a linear forward light scattering photometer for use as a base line to compare the shown down stream readings. Since the up-stream concentration is known and photometer is linear, the shown down stream samples may be read out in percentage of penetration, as recommended in



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the standards and specifications. Any leak greater than 0.01% of the upstream concentration is considered as a significant leak, and the spot should be marked and repaired in actuality. There should be no leaks around the filters seals. In practice, readings at the face of the filters should be in the range of 0.004 to 0.008%.

ii) In addition to the DOP test described above, further tests and checks will be performed and shall consist of air flow velocity, particle counting, air flow smoke pattern test, air balancing etc.

b) Qualification testing during dynamic state:-

These tests and checks shall be performed with all production machines installed and running and with production personnel within the facility. These tests will be performed to determine if, the operating equipment's / personnel present any abnormal conditions than previously recorded in static state.

The type of tests will include temperature and humidity monitoring, monitoring pressure differentials, etc.

The Contractor shall then hand over the facilities to the client and assist the client in final qualification testing. This testing will include non viable particulate counting, sampling for micro-organisms on surfaces and in the air and processing and tested under simulated production conditions.

**NOTE: All above qualification tests shall be performed as per Qualification Protocols checked and approved by the Employer.**



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#### **4.0 TESTING, ADJUSTING AND BALANCING (PROCEDURES)**

##### **SUBMITTALS**

- A. Procedures: Furnish procedures in accordance with general requirements specified.
- B. Schematic Drawings: Submit for Employer's information. Furnish schematic layouts for each system.
- C. Quality Control Testing and Inspection Reports: Submit for Employer's information. Furnish certified reports for the specified inspections and tests, signed by test and balance supervisor who performed testing, balancing and adjustment. In addition, have report certified by a Professional Engineer who is familiar with testing, adjusting and balancing work associated with the project. Include identification and types of instruments used and their most recent calibration date with test reports, and also include the names, signatures and registration numbers of the supervisor or engineer and technicians who were assigned to the project.

##### **QUALITY ASSURANCE**

- A. Contractor's Quality Assurance Responsibilities: Contractor is solely responsible for quality control of the Work.
- B. Certified Testing and Balancing Agency: A firm with at least 3 years testing, adjusting and balancing experience on projects with requirements similar to those required for this project, who is not the installer of the system to be tested and is otherwise independent of the project.
- C. Compliance: Comply with all relevant industry standards.
- D. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of the authorities having jurisdiction. Obtain necessary approvals from all such authorities.



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## **EQUIPMENT**

Provide testing and re-testing equipment including but not limited to instruments, gauges, blowers, scaffolding and ladders.

## **SOURCE QUALITY CONTROL**

Test, calibrate, retest and recalibrate measuring instruments at the laboratory.

### **5.0 Installation Qualification, Operational Qualification And Performance Qualification**

5.1 HVAC sub-contractor shall be responsible for doing installation qualification (IQ), operational qualification (OQ), and performance qualification (PQ) tests on all equipment related to HVAC system installed by him including client-supplied items. He shall submit IQ, OQ, and PQ protocols for approval and conduct tests as per the approved protocols. The complete IQ, OQ, and PQ documents with all test result and certification shall be submitted as part of final documentation for handling over.

### **5.2 Testing Instruments**

- a) Necessary instruments as required for testing will be arranged by the contractor at his own cost.
- b) All the instruments to be used during testing and in the regular operation of the system shall be calibrated and calibration certificates shall be submitted for review & approval.
- c) All the necessary instruments shall be able to calibrate.

### **6.0 Documents/Drawings**

The entire HVAC system documentation will be divided in 3 parts and relevant documentation to be furnished by Vendor are listed below. These are the minimum documents to be furnished by Vendor but not limiting to the list.

- (A) **Design Qualification** – Minimum 3 sets of Approved drawing with reproducible.
  1. Duct layout detailed, plan and minimum one elevation.
  2. P & ID near AHU.



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3. HVAC schematic showing flow direction, flow, filtration level, dampers locations, heaters, T & RH sensors location.
4. Pressure flow diagram – In & Ex filtration.
5. Control logic for maintaining T & RH.
6. Air change calculation.
7. Representation of system design on Psychometric Chart.
8. Electrical Circuits Diagram.
9. Panel drawing.
10. Typical Drawing to show –
  - a. Longitudinal and transverse joints of duct.
  - b. Duct flanges.
  - c. Risers and installation details of riser.
  - d. Pre/Fine/HEPA filter.
  - e. HEPA filter housing, filter mounting details.
  - f. Duct support.
  - g. Pressure differential measurement for individual rooms.
  - h. GA for T & RH indication near room for each system.
  - i. Duct insulation.
  - j. Fire damper/VCD.
  - k. AHU/Dehumidifier.
12. Fan Performance curve and selection data. Preferably using fan performance curve, showing the selection criteria & making operating point on the same.
13. List of interlocks & logic of operation of interlocks
14. DQ summary sheet.
15. Equipment location diagram.
16. Data sheet of all bought out equipment.
17. MOC's of all components of the system.

**(B) Installation Qualification**

1. Insulation check sheet format – To be approved by client before use.
2. Hydro test format and duct leakage test format – To be approved by client before use.
3. As built -
  - a. Duct layout.
  - b. HVAC schematic.
  - c. AHU location (plant room).
  - d. Wiring (ckt) diagram.
4. Fan performance curve and test certificate.
5. MCC panel certificate.
6. Pre-Fine filter test certificates and Ref. Std. used for test.



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7. Individual HEPA filter certificates with filter identification number and test method or standard.
8. Calibration certificates of all following, traceable to NPL/NIST/equivalent with traceability mentioned in certificate or provided with adequate documents.
  - a. All T & RH sensors
  - b. Controllers
  - c. Pressure differential gauges
  - d. Pressure switch

Following drawing approved during DQ, one copy each having approval stamp and signature of client to be made available for IQ.

- a. Duct layout.
- b. P & ID near AHU.
- c. Typical duct jointing, support, filter housing, RA installation.
- d. Wiring diagram.
- e. Plant layout.
- f. AHU/Dehumidifier drawing.
- g. HVAC schematic with location of damper, filter, T & RH sensors etc.
- h. Control Logic.
- i. All bought out item data sheet.
- J. Verification of received material with respect to DQ approved data sheets/Drawings

/Details.

10. IO Summary sheet-Format approved by client.
11. Test certificates for
  - i. GI sheets of ducting
  - ii. Thermal insulation
  - iii. Gaskets

**(C) Operation And Performance Qualification**

1. Commissioning procedure.
2. T & RH reading format - To be approved by client before use.
3. T & RH reading using calibrated traceable T & RH meter at location and time intervals given by client for at least 10 days.
4. Velocity measurement & ACPH calculation – Format for these readings to be approved by client.
5. Particle count measurement – At location given by client in a format approved by client



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6. DOP of individual HEPA insitu – Format and limits of local and average leak permissible as per client.
  7. SOP of using following instrument and taking reading -
    - Velocity/Anemometer
    - DOP
    - Particle count

*(These SOP's to be approved by client before start of validation)*
  8. Calibration certificate of following measuring instruments with their Sr. No. or identification and traceability to NPL/INST or equivalent.
    - a. Anemometer.
    - b. T & RH meter.
    - c. DOP testing instrument.
    - d. Particle count testing instrument.
    - e. Measurement of differential pressure using installed gauge in a format, to be submitted by vendor & approved by client prior to using it. The reading should be taken every alternate date such that minimum 7 readings are available.
- D. At the end of contract, the sub-contractor shall submit **“COMPLETION DOCUMENTS”** as noted in Section - I



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**SECTION 7**  
**GENERAL DESCRIPTION/BASIS OF DESIGN**





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## **7.0 GENERAL DESCRIPTION/BASIS OF DESIGN**

### **1. SCOPE:**

The work stated in these specifications together with drawings cover the design, manufacture, testing performance at manufacturer's works, delivering and receiving goods at site, handling at site, installation, commissioning and carrying out performance test at site of the complete equipment required for the HVAC Systems for Pharma Formulation facility of M/s. RAJASTHAN DRUGS & PHARMACEUTICALS LTD, Jaipur, as per WHO cGMP requirement.

Details of spaces covered under this contract are indicated in the drawings and shall be designed for the conditions and cleanliness levels indicated in the HVAC data sheets enclosed as Annexure to this tender.

### **2. BASIS OF DESIGN**

- 2.1. LOCATION : JAIPUR
- 2.2. ROOM INSIDE COND : REFER ENCL. DATA SHEET
- 2.3. LIGHTING : 2 WATTS / SQ.FT.(APPROX.)
- 2.4. FRESH AIR : REFER HVAC DATA SHEET

### **3. POWER SUPPLY**

415 Volts, 3 phase, 50 c/s, 4 wire A.C. electric power supply including earthing at the main panel will be made available by the Employer.

### **4. DESCRIPTION OF THE WORK TO BE CARRIED OUT**

Each system is fed chilled water from central A.C. plant as described in BOQ and in HVAC Room data sheet.

### **LIST OF AIR HANDLING UNITS**

Various Air Handling Units provide conditioned and filtered air to the various production rooms.



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All air-handling units are re-circulation types with pre filtered fresh air to balance the loss of air by overpressure or by extraction.

**Room Characteristics:** Defined in the HVAC data sheet.

**Thermal Loads:** The thermal loads given in the technical schedule are approximate and the contractor is expected to recheck and confirm the same. The responsibility and guarantee for achieving the required room environmental conditions shall rest with the contractor. **The contractor is expected to submit load calculation sheets along with the offer.**

**NOTE: These drawings are only indicative and are being issued purely for tendering purposes and actual work shall be carried out based on approved working drawings to be prepared by the tenderer and approved by the Employer.**

### **SCOPE OF SERVICES**

The scope of services of this contract shall generally comprise the following and shall include all works and material required for the complete design, development & installation of the HVAC system as detailed in this specification, as indicated in the Room Data Sheets and as generally shown in the accompanying drawing.

The supply and installation of all Air Handling Units required for the system. These shall be supplied as complete units, including hot water coils, damper systems, supply and wherever required exhaust fans and all other essential components.

The supply and installation of AHU's include the complete system of air filtration equipment, including pre, final and HEPA filtration systems etc.

The supply and installation of cooling tower, condenser water pumps along with condenser water piping and valves.

The supply and installation of complete system of ducts for all the systems. This includes supply and installation of necessary support systems for the ductwork, branches and outlets and all other components of the ductwork system. The actual duct routing shall be the responsibility of the contractor. However, all duct routing drawings shall be submitted for the employer's approval before actual fabrication of the ducts.

The supply and installation of all ventilation & exhaust systems



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The supply and installation of all controls including motor control centres, associated cabling, wiring etc.

The complete painting and labelling of all items of pipework and other items of equipment.

The complete balancing of water and air quantities for the equipment installed as part of this contract.

Testing and commissioning of the entire system.

Preparation of complete set of workshop drawings accurately showing the sizes and locations, and all other relevant details of the plant intended for installation prior to commencement of work at site.

Provision of complete set of “as installed” drawings for the whole of the completed installation, together with a comprehensive Operating and Maintenance Manual.

The work shall include all minor and incidental work to produce a complete, operational and safe installation regardless of specific mention being made & included in this tender.



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## **SECTION 8**

### **SITE DATA**



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## **8.0 SITE DATA**

1. OWNERS / PURCHASERS : **M/s. RAJASTHAN DRUGS & PHARMACEUTICALS LTD.**
2. PROJECT TITLE : PHARMA FORMULATION FACILITY
3. PROJECT SITE : JAIPUR
4. NEAREST RAILWAY STATION: JAIPUR
5. NEAREST AIRPORT : JAIPUR
6. CONDITIONS :
- TEMPERATURE
- SU : DB –110°F / WB- 75°F/RH 20%
- MO : DB –95°F / WB- 78°F/RH 48%
- WI : DB – 46°F / WB- 41°F/RH 65%



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**SECTION 9**  
**TECHNICAL SPECIFICATIONS**



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## **9.0 TECHNICAL SPECIFICATIONS**

**NOTE:** The information required as below is the minimum requirement. However the tenderer is expected to submit comprehensive technical information for all pieces of equipment and material

**Technical catalogues and performance tables/curves for all equipment's and machines must be submitted with the offer.**

### **1. Water cooled screw chillers:**

#### **A. SPECIFICATIONS OF WATER COOLED SCREW CHILLERS 2X110 TR**

Supply, Installation, testing and commissioning of Water Cooled Screw Chiller : 2x110 TR

Chilled water outlet temp. : 5°C

Chilled water inlet temperature : 10°C

Cooling Water Inlet Temperature: 32°C

Cooling water outlet temperature: 36°C

Power Supply : 415V / 3φ / 50Hz

Specific Power consumption : **vender to specify**

The Chiller shall be factory assembled on a robust base frame. The unit shall be tested at full load in the factory at the nominal working conditions and water temperatures. Before shipment a full load test shall be conducted, and the units shall be shipped with oil and refrigerant.

**Refrigerant - HFC 134a**

Noise level and vibrations **-vender to specify**

Units will have the following components:

COMPRESSOR -

The compressor shall be rotary Twin screw type. The compressor housing will be of cast iron, precision machined to provide minimal clearance for the rotors. The rotors will be manufactured from forged steel. The compressor will incorporate a complete anti-friction bearing design to reduce power and increase reliability. Capacity control will be achieved by controlling the speed of compressor to provide fully modulating control from 100% to 35% of full load through microprocessor based controller. Compressors should be fitted with gauge connection for reading oil, suction & discharge pressure & fitted with sight glasses, crankcase heaters. Check valve is used to prevent back spin during shut down The unit shall be provided with oil separator with high efficiency, augmented gas impingement and demister to maximise oil extraction.



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#### MOTOR DRIVELINE–

The motor shall be, continuous duty, squirrel cage induction type, and semi hermetically sealed. Motor will be factory mounted and directly connected to the compressor to provide compressor/ motor alignment. PTC type motor winding temperature sensors should be provided to protect it from high winding temperature.

#### LUBRICATION SYSTEM–

An adequate supply of oil will be available to the compressor at all times. During operation, oil will be delivered by positive system pressure differential Oil separator will be provided to ensure full supply of lubricants to all bearings, to handle radial & axial loads. Horizontal oil separator shall be provided to reduce the noise level.

EVAPORATOR Evaporator will be shell & tube designed for 150 psig working pressure on the refrigerant side and will be tested in accordance with ASME code. The water heads should be made of fabricated steel. The water sides should be designed for a minimum of 10.5 kg/cm<sup>2</sup>. Refrigerant flow to the evaporator is controlled by a self-metering and adjustable Electronic expansion valve. The liquid line is having moisture indicating sight glass. Vents and drain connections with plug shall be are provided. Pressure relief valve shall be mounted on the suction side of the refrigerant circuit.

CONDENSER Each unit shall have Shell & tube type Condenser. Shell, tube sheet and water boxes shall be of M.S. plate to IS 2062 Gr. A. Tubes shall be of Copper Provide isolation valves and sufficient volume to hold the full refrigerant charge in the condenser during servicing.

#### MOTOR STARTER -

Variable Frequency Drive starter with suitable enclosure shall be provided to get smooth starting and no jerk on DG Set. The Each starter shall include the following protections:

1. Single phasing and phase reversal
2. Overload
3. Over / under voltage
4. Voltage unbalance
5. Short circuit
6. Winding temperature high

MCCB shall be provided in each circuit for isolation and short circuit protection.





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#### ELECTRONIC EXPANSION VALVE

The unit shall be equipped with electronic expansion valve that allows control that quickly reacts to load variations and ensures precise refrigerant flow to the evaporator using input from suction superheat.

The refrigerant circuit will be equipped with all the necessary components in order to ensure proper operation of the unit such as filter drier, liquid sight glass, shut-off valve, etc. Refrigerant piping shall include factory insulated suction line, liquid line, shut-off valve with charging connection.

#### CAPACITY CONTROL

Stepless capacity control shall be achieved by using VFD mechanism. The unit shall be capable of operating at lower temperature of cooling tower water during part load operation in accordance with AHRI 550-590/ 2003.

#### MICROPROCESSOR BASED CONTROL PANEL

##### A) Microprocessor based controller with

- a. CPU, 16 bit, 24MHz.
- b. Program Memory 2+2 MB , 16 bit
- c. Data memory (RAM) 512 KB, 16bit
- d. Permanent memory 13 KB
- e. Working cycle duration approx. 200 ms

##### B) Data Available on Display:

- 1) Suction Pressure
- 2) Discharge Pressure
- 3) Chilled Water Inlet Temp
- 4) Chilled Water Outlet Temp
- 5) Condenser Water Inlet Temp
- 6) Condenser Water Outlet Temp
- 7) Liquid Line Refrigerant Temp
- 8) Suction Line Ref. Temp.
- 9) Sat. Suction Temp.
- 10) Suction Super Heat
- 11) Sat Discharge Temp.
- 12) Discharge line Ref. temp.
- 13) Discharge Super Heat
- 14) Load in Percentage
- 15) Compressor Motor Current in Amp (only one phase)
- 16) Compressor Motor Current in % RLA
- 17) Date & Time
- 18) Comp On / Off



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- 19) Water flow ON / OFF indication (Condenser)
- 20) Water flow ON / OFF indication (Evaporator)
- 21) Differential Oil pressure
- 22) Motor winding temperature – Healthy or Unhealthy
- 23) Voltage Protection Device – Healthy or Unhealthy
- 24) Compressor loading percentage
- 25) EXV opening % age

C) Safeties: - Following safeties are directly sensed by the controller & acted upon

- 1) High Condenser Pressure
- 2) Low Condenser pressure
- 3) Low Evaporator Pressure
- 4) Low Oil Pressure Differential
- 5) Antifreeze Trip.
- 6) Compressor Motor Overload on Current. (High Amps)
- 7) Compressor Motor Underload on current (Low Amps)
- 8) No Flow (Evaporator & Condenser Flow)
- 9) High Oil Temperature
- 10) Mechanical High pressure / High Discharge Gas temp. & Trip. (HP/ DISCH.)
- 11) Pro Active unload for
  - a. High current
  - b. High Discharge Pressure
  - c. Low Suction Pressure
  - d. High Discharge Temperature
  - e. High Oil Temperature

D) Other safeties which are sensed by other devices, but action is taken by the controller:

- a) Over Voltage /Under Voltage/Single phasing/Reverse phasing/Voltage unbalance.
- b) Motor Winding Overheat.
- c) Low Condenser Water Flow
- d) Low Chilled Water Flow

E) Other Features:

- 1) PGD0 display with backlight, IP65, 6 silicon keys with LEDs  
Text mode- 4 rows X 20 columns, font size 5 X 7
- 2) Facility to change units for Temperature (°F / °C) and Pressure (PSI / Bar) with automatic changing all the set points.
- 3) Battery backup to retain memory and clock in case of power failures



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- 4) Automatic startup on resumption of power after power failure.
- 5) Compressor lead-lag and sequencing facility for multi compressor units
- 6) Internal 7-day, 8 holiday clock with programmable Time Scheduling with Interval / RTC(In time scheduling operator, can specify week days as per mention. each weekday schedule will be followed on that particular weekday and the holiday schedule is followed on the days marked as holiday.
- 7) Alarm History : Logging of last 99 alarms with 4 Variables (critical parameters) which can be viewed with display
- 8) Selective lockout facility on alarms to avoid unauthorized operator control
- 9) RTC based Anti recycle time (Start to Start / Stop to Start).
- 10) Loading / Unloading / Starting / Stopping on Chilled Water Outlet is automatic.
- 11) PC-Connectivity is possible (separate software / hardware to be procured for this).
- 12) Important variables list incorporated for getting connected to BMS system
- 13) Access to all set points with 3 Levels of Password User, Supervisory and Manager
- 14) Alarm and Data Logging can be downloaded in CSV (comma separated variables) format
- 15) Multi Chiller sequencing: - This is useful where user has more than one chiller at site and would like to have one (or more) as standby as well as run time equalization among all chillers.

#### WITNESS TESTING

Witness testing of chiller shall be offered at manufacturer's works prior to dispatch on AHRI certifies test bed at 100% load and design conditions. Performance shall be demonstrated in line with tolerances as per AHRI 550-590 2003.

#### PAINTING

The chiller shall be painted as per manufacturer's standard. Polyurethane paint is preferred.

#### DELIVERY, PACKAGE & HANDLING

Chillers to be delivered at site completely assembled and charged with refrigerant and oil. Equipment shall be packed & sufficiently protected against corrosion. Equipment is shipped with all refrigerant piping & control wiring factory installed & charged with oil & refrigerant as specified. Chiller shall be supplied along with serrated rubber pads for vibration isolation.



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Chillers to be delivered at site completely assembled and charged with refrigerant and oil. Equipment shall be packed & sufficiently protected against corrosion. Equipment is shipped with all refrigerant piping & control wiring factory installed & charged with oil & refrigerant as specified. Chiller shall be supplied along with serrated rubber pads for vibration isolation.

#### B. SPECIFICATIONS OF WATER COOLED SCROLL CHILLERS 85TR

Supply, Installation, testing and commissioning of Water Cooled Scroll Chiller :85TR

Chilled water outlet temp. : 5°C

Chilled water inlet temperature : 10°C

Cooling Water Inlet Temperature: 32°C

Cooling water outlet temperature: 36°C

Power Supply : 415V / 3φ / 50Hz

Specific Power consumption : **vender to specify**

Water cooled scroll chiller with 4 Nos. scroll compressors in independent circuit to be operated with equipment Refrigerant HFC 134a

#### WITNESS TESTING

Witness testing of chiller shall be offered at manufacturer's works prior to dispatch on AHRI certifies test bed at 100% load and design conditions. Performance shall be demonstrated in line with tolerances as per AHRI 550-590 2003.

#### PAINTING

The chiller shall be painted as per manufacturer's standard. Polyurethane paint is preferred.

#### DELIVERY, PACKAGE & HANDLING

Chillers to be delivered at site completely assembled and charged with refrigerant and oil. Equipment shall be packed & sufficiently protected against corrosion. Equipment is shipped with all refrigerant piping & control wiring factory installed & charged with oil & refrigerant as specified. Chiller shall be supplied along with serrated rubber pads for vibration isolation. Chillers to be delivered at site completely assembled and charged with refrigerant and oil. Equipment shall be packed & sufficiently protected against corrosion. Equipment is shipped with all refrigerant piping & control wiring factory installed & charged with oil & refrigerant as specified. Chiller shall be supplied along with serrated rubber pads for vibration isolation.



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**C PUMPS :**

1) **CONSTRUCTION :**

Pumps shall be of the following construction:

Pump	Horizontal Split casing type
a) Casing	Cast Iron
b) Impeller	Gun Metal
c) Impeller ring	White metal
d) Shaft	High Tensile Steel
e) Shaft Sleeve	Mild Steel
f) Bearings	Heavy Duty Ball /Roller Bearings
g) Stuffing Box Bushes	White Metal
h) Base Plate	Cast Iron / Fabricated M.S. Drip Rim type
i) Gland	Cast Iron
j) Flanges	as per IS standard
k) Coupling	Tyre coupling FENNER make
l) Packing	Graphite Asbestos
m) Max Speed	1500 R.P..M. / 2950 RPM
n) Driver	TEFC INDUCTION MOTOR/ water proof out door mounting

Driver ratings shown are only tentative and Tenderers shall select their drivers at least 10% in excess of the maximum B.H.P. of the pump plus transmission losses, if any. Pump motors shall be selected not to overload for the entire range of the pump impeller operation.

Driver shall be supplied with starters.



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Pump and drivers shall be mounted on single bedplate and directly driven through flexible coupling in case of horizontal split casing pumps.

**2. Accessories and Fittings :**

The following accessories shall be provided with each pump among other standard accessories required.

- a) Coupling guard for horizontal split casing pumps.
- b) Lubrication fittings and seal piping.
- c) Test and / or air vent cocks.

Following fittings shall be provided with each pump among other standard fittings required:

- a) Suction and discharge pressure gauges not less than 150 mm dia. And of the appropriate rating, with gauge cocks etc.
- b) 25 mm G.I. gland drain
- c) Air Valve, grease lubricators and water seal connections.

**3. Installation :**

Pump shall be installed as per manufacturers recommendations. Pump sets shall be mounted on concrete block, which in turn is mounted on machinery isolation cork or any other equivalent vibration isolation fittings. Concrete foundation will be made by the Client to the drawings and specifications of the supplier and the isolation pad shall be supplied by the AC Contractor.

Pump sets shall preferably be factory aligned. Whenever necessary site alignments are made, these shall be done by competent persons. Before the foundation bolts are grouted and the couplings bolted, the bedplate levels and alignment results shall be submitted to the Client's site representative.



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### **Testing**

Pumps performance shall conform to ISS 1520 and ISS 5120 for clear cold water.

Tenderer shall submit the performance curves of the pumps supplied by them; Tenderer shall also check the capacity and total head requirements of each pump to match his own piping and equipment layout.

On completion of the entire installation, pumps shall be tested wherever, possible, for their discharge head, flow and B.H.P. Where it is not possible, at least the discharge head and HB.H.P. (as measured on the input side) shall be field tested. Test result shall correspond to the performance curves.

Contractor shall furnish the required testing instrument and arrange for their connection as required.

#### **Painting:**

Pump shall be factory painted with anticorrosive paint and finished with two coats, synthetic enamel paint of make and colour approved Client. Insulated pumps may be supplied with anticorrosive paint only.

After complete installation and testing, pumps accessories and fittings shall be given two coats, of approved finishing paint, if required and as directed by Client.

## **D) AIR HANDLING UNITS**

### **1.0 SCOPE OF WORK**

- 1.1 This specification covers design, manufacturing, inspection, testing at works, packing, forwarding, supply and providing performance guarantee of air handling units. The scope also covers assembly/ erection of units at site and commissioning.
- 1.2 The specification is to be read in conjunction with datasheets, standards and all attached annexures.
- 1.3 It is not the intent to completely specify all the details of design and construction, nevertheless, the equipment shall conform in all respects to high standards of engineering, design, workmanship and shall be able to meet all



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statutory requirements, perform continuous commercial operation up to contractor's guarantee in a manner acceptable to purchaser who will interpret drawings and specification and shall have the power to reject the work or material which is not in accordance with one specifications.

## 2.0 CODES & STANDARDS

- a) Electric Motor : IS : 325 : 1996
- b) Flame proof Motor : IS : 2148 :1989,  
IS : 2147 : 1989,  
IS : 5571 : 1994
- c) SMACNA STD : IS : 4894 : 1987
- d) Centrifugal Fan : AMCA 803-94
- e) Testing & Balancing : ASHRAE 11-1988  
SMACNA

## 3.0 TECHNICAL REQUIREMENT OF AIR HANDLING UNIT (DOUBLE SKIN TYPE)

### 3.1 Type

The air handling units shall be double skin construction, draw through type comprising of various sections such as fan section, pre-filter section, coil section and fine filter section as per arrangement shown in enclosed airflow diagrams

### 3.2 Design Parameters

Maximum face velocity across pre-filters	1.75 m/sec
Maximum velocity across cooling coils	2.5 m/ sec
Maximum fan outlet velocity	10 m/ sec
Maximum noise level (outside the AHU at 1 m distance)	60 dBA

### 3.3 Casing

Double skinned panels to be fabricated with anodized extruded aluminum section framework bolted together with sandwich panel having pre-coated coated 24-gauge sheet for outer skin and plain galvanized 24-gauge sheet for inner skin. 25 mm thick PUF insulation material to be injected between





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the two panels. Construction should be such that inner skin is isolated from outer skin by insulation and condensation on outside skin is avoided completely. The aluminum framework shall have thermal break construction with no heat transfer path to outside.

The entire frame shall be mounted on sheet steel channel base. The panels shall be sealed to the framework by heavy-duty 'O' ring gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall be made of hard nylon and be operational from both inside and outside of the unit. Units supplied with various sections shall be suitable for a suite assembly with continuous gasket (non hygroscopic seal). All fixing and gasket shall be concealed.

The volume control dampers to be opposed blade construction. Damper shall be made out of casing of 18 SWG and louvers of 20 SWG. Geared operator with self-lubricated bearings/ bushes shall be provided for dampers. If link operators are given then linkages to be mounted such that insulation is complete all over.

Units shall have hinged, quick opening access door in the fan and filter section. Access doors shall be double skin type.

The casing and all other sections shall have non-shedding internal finish, with all interiors accessible for cleaning.

The casing shall have earthing connection at two ends.

### **3.4 Motor and Drive**

The motor selected shall be least 15% higher capacity than BHP of fan requirement. 415± 10% Volts, 50 cycles, three phase, totally enclosed fan-cooled class F, with IP-55 protection. The fans shall be of direct drive. Motors shall be especially designed for quiet operation. Wherever specified the motor shall be flame proof.

### **3.5 Fan**

Fans shall be DIDW, centrifugal, forward inclined blades. Fan casing shall be made from galvanized steel sheet. Fan wheels shall be made of galvanized steel. Fan shaft be ground C40 carbon steel and supported in self-aligning Plummer block operating less than 75% of first critical speed, grease lubricated bearings. Fan wheels shall be individually tested and precision balanced dynamically.



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The fan shall be isolated from casing by fire retardant canvass double flexible connection mounted inside the casing of unit, not less than 100 mm wide.

Motors shall be factory assembled mounted outside the AHU casing on sturdy bas plate.

**Make of fan shall be Nicotra/ Kruger**

**3.6 Cooling Coils**

Chilled water coils shall have 12.5 to 15 mm dia. Tubes minimum 26G thick with sine wave aluminum fins with anti oxidant coating, 0.15 mm minimum thickness firmly bonded to copper tubes assembled in zinc coated steel frame. Alternatively copper fins shall be offered.

Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across the coil shall not exceed 150 meters per minute and water velocity inside tube shall not exceed 1.8 mps. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory-tested at 10 kg/cm<sup>2</sup> air pressure under water.

Tubes shall be hydraulically / mechanically expanded for minimum thermal contact resistance with fins, fin spacing shall be 4-5 fins per cm. Water coil capacity and pressure drop shall be in accordance with ASHRAE 33-1978.

**3.7 Pre-Filter Section**

Each unit shall be provided filter test certificate from filter manufacturer. Pre-filter shall be tested as per EN 779 to meet atmospheric dust spot (opacimetric) efficiency of 80% to 90% as per EU7/F7 grade. Provision for measuring differential pressure shall be provided in the AHU. The tap off points for the measurements shall be legibly marked. Filter shall be numbered, shall be water washable.

**3.8 Fine Filter Sections**

Each unit shall be provided with a factory assembled fine-filter section with washable synthetic type air filters. Filter media shall be as per enclosed specification.

3.9 The filter medium for pre & fine filters shall be synthetic non-woven bonded fiber. The medium shall be permanently bonded top the frame with fire retardant and self-extinguishing type adhesive. The frame shall be considered from aluminium.



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Subcontractor shall provide fine-filter test certificate at factory. Fine filters shall meet EU9/F9 grade standard efficiency as per EN 779 i.e. atmospheric dust spot (opacimetric) efficiency greater than 95%. Provision for measuring Differential pressure shall be provided in the AHU. The tap off points for the measurements shall be legibly marked. Filters shall be numbered.

### **3.10            Mixing Box Section**

The two-way mixing box shall be designed for efficient mixing of fresh air and return air by means of interconnecting dampers. Mixing box dampers shall be opposed blade type.

### **3.11            Isolators**

Dunlop cushy type vibration isolator shall be provided with all air-handling units for support from structure/ floor, spring mounting shall be provided for fan & motor.

### **3.12            Accessories**

All air-handling units shall be supplied with following accessories. However the accessories will be measured as per the actual quantities.

- 1)    Supply air, return air and fresh air opposed blade volume control dampers.
- 2)    Inlet and Outlet chilled water pressure and temperature gauges.
- 3)    Viewing windows in fan section
- 4)    Stainless steel drain pan with siphon break arrangement for proper draining of condensed water.

### **3.13            Inspection**

3.13.1        Inspection including witnessing of tests will be carried out by purchaser or his authorized representative, if required. However, test certificate shall be submitted and clearance obtained before dispatch of the assembled unit.

3.13.2        Vendor shall notify purchaser or his authorized representative in writing at least fifteen (15) days prior to the schedule for inspection/ tests.



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3.13.3 Vendor shall submit calibration certificate for all instruments/ pressure switches etc. supplied with the equipment.

**3.14 Testing and Commissioning**

3.14.1 Unit shall be tested for establishing the capacity and power consumption including all other standard parameters, as applicable.

3.14.2 Refrigeration capacity of the unit shall be computed from measurement of water flow and entering and leaving water temperature and related tests shall be carried.

3.14.3 Computed results shall tally with the specified capacities. All meters, gauges, thermometers, watt meters and similar items shall be duly calibrated and shall be supplied by vendor.

**4.0 Shop Drawings**

Within two weeks after the award of the contract, the contractor shall furnish, for the approval of the Owner/ Architect three sets of detailed shop drawings of AHUs & other equipment and bar chart of complete the project as per (accordingly to Owners instructions) required to complete the project as per specification. These drawings shall contain details of construction, size, arrangement. Operating clearances, performance characteristics and capacity.

Please note that total drawing and documentation shall be responsibility of HVAC system contractor.

**5.0 Operating Instruction and Maintenance Manual**

The contractor shall submit a draft copy of comprehensive operating instruction, maintenance schedule and log sheets for the AHU's and associated equipment included in this contract. This shall be supplementary to manufacturers operating and maintenance manuals. Upon approval of the draft, the contractor shall submit two (2) complete bound sets of type written operating instructions and maintenance manuals and relevant P & ID drawings etc.

**6.0 On Site Training**

Contractor shall depute skilled operators and helpers for operating the entire installation for a period of seven (7) days each to enable the Owner's staff to get acquainted with the operation of the system. During this period,



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the contractor shall train the Owner's representatives in the operation, adjustments and maintenance of all equipments installed.

## **7.0 Performance Guarantee & Acceptance Tests**

### **7.1 Performance Guarantee**

Bidder shall guarantee that upon completion of the work all portions will be in full accordance with the requirements of the contract and will be perfect as to materials and workmanship and remain so for a minimum period of one year from the date of final acceptance by the Client. The Bidder shall also guarantee that the equipment will operate satisfactorily and the performance and efficiencies of the equipment when operating under normal conditions shall not be less than the guaranteed values. The Bidders further guarantee that during the one year period he will repair all defective work and will expeditiously replace all defective materials furnished or installed under the contract, free of cost to the Client within reasonable time from the detection thereof. The Bidder shall be responsible for the performance irrespective of the specification mentioned in these tender documents.

### **7.2 Acceptance Tests**

After the entire installation work has been completed the Bidder shall make all required adjustments until all guaranteed performance requirements are met. After the entire system is adjusted, the Bidder shall conduct acceptance tests of the installation in the presence of Engineer-in-charge during which the installation shall meet the guaranteed performance requirements to the satisfaction of Engineer-in-charge. All instruments and services required for the tests shall be provided by the Bidder. The tests reports shall be submitted for Client's approval before handing over the plant.

The tests should be carried out as per the detailed testing schedule given here. All tools, tackles, equipments and instruments required for erection, commissioning and carrying out acceptance tests shall be arranged by Bidder. Bidder shall also be responsible for clearing all debris during execution and after completion of work.



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## 8.0 Maintenance during Defects Liability Period

### 1. **Complaints:**

The Contractor or his sub contractor for AHU shall receive calls for any and all problems experienced in the operation of the AHUs under this contract, attend to these within 4 hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist.

### 2. **Repairs:**

All equipments that require repairing shall be immediately serviced and repaired. Since the period of mechanical maintenance runs for one year concurrently with the defects liability period, all replacements parts and labour shall be supplied promptly free-of-charge to the Owners.

### 3. **Spares:**

Any additional accessories/ spares required before and after installation of Air Handling Unit shall be informed to Client.

## E) **FILTERS:**

### 1.0 High Efficiency Particulate Air (HEPA) Filter (Plenum mounted supply air at AHU)

HEPA shall conform to applicable specification of BSEN 1822 –1,1998/ IEST RP-CC001.3

The overall efficiency of filter shall not be less than 99.95% and local value of efficiency shall be 99.75 % conforming to EU 13 filter class as per EN 1822. Each filter shall be individually tested, labelled and certified by the contractor as per the procedures laid down in IEST-RP-CC001.3

For D.O.P testing of Filter the contractor shall provide the following:

#### a) **Aerosol Generator:**

A device called Laskin nozzle used for the generation of D.O.P aerosol by compressed gas at around 20 Psi. pressure.



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b) **Aerosol Photometer:**

A light scattering mass concentration indicator which has sensitivity of at least  $10^{-3}$  micrometer diameter, D.O.P. particles and is capable of measuring concentration over a range of 106 times the threshold sensitivity.

HEPA Filters will be scanned or volumetrically tested.

When operated at a capacity of 500 / 250 cubic feet per minute per square foot of filter area, the initial (clean) filter pressure drop shall be no more than 250 Pa. The filter medium shall be glass fibre with a water resistant binder and shall contain no asbestos. This medium shall be pleated back and forth to form a filter pack which is permanently bonded to the frame with fire retardant and self extinguishing type adhesive. All HEPA filters shall be super HEPA filters and shall be without separator and having minimum 35 sq. m. filter media.

The filter frame shall be constructed from aluminum or stainless steel material. Each filter shall be marked with D.O.P. efficiency rating.

The design of the filter housing shall ensure that they are of high quality and integrity.

- 1.1 Panel Filter – Pre Filter (Grade EU7/ F7) These are to be installed in AHU/ Dehumidifier before the coil. This shall have atmospheric dust spot (opacimetic) efficiency of 80% to 90% when tested as per EN 779. These shall be washable filters. Each filter shall be three ply filter media. The first two plies shall be Du Pont 15-40 media. (Dacron). A tackifier adhesive shall be applied between these two plies and the third ply which is also a Dacron.

Each panel shall be supported by an internal ring with cross wire. This wire shall be 5/32 inch Dia. 1018 bright basic wire. The media shall extend  $\frac{1}{2}$  inch beyond the wire perimeter and be completely sealed on the periphery. The filter shall contain no asbestos and be non-fibre releasing. Filter shall be water washable.

When operated at a capacity of 400 cubic feet per minute per square foot of face area the initial (clean) resistance shall be not more than 70 Pa.

- 1.2 **Pre-filter Grade EU3/ G3**



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This filter to be used in return air riser/ fresh air intake shall be having gravimetric synthetic dust retention of 80 to 90% when tested as per Standard EN 779/EN 1822-1. These shall be washable filters.

### 1.3 Testing and Inspection

Filter testing shall be carried out at works for measuring filtration efficiency and pressure drop. The tests shall be tested after installation at site for leakage by DOP or equivalent test. The HEPA filters shall be sent to site for installation only after the testing at vendors site.

## F) AIR DISTRIBUTION SYSTEM (DUCTING)

### 1.1 General

The design, construction/fabrication, erection and performance of ducting shall comply, in general, with all currently applicable standards, codes, regulations and safety measures as applicable in the locality where it is to be installed. The items covered shall conform to IS 655.

### 1.2 Design Parameters

Refer design parameters and limits in Section 11, for duct air velocities.

### 1.3 Material

Ducting shall be made out of cold rolled, cold Annealed (CRCA) sheets, continuous galvanised with a Zinc coating of 120 g/m<sup>2</sup> on both sides. Sheets shall be flat and free from twists. Zinc coating shall be clean, even and free from ungalvanised spots. Sheets shall not crack or peel during bending or fabrication.

### 1.4 Fabrication

Fabrication should be as per IS 655 Standard. Ducting shall be fabricated at factory / site with slip type GI flange joints. Ducting shall be rectangular in cross section. As far as possible abrupt change of duct size and shape shall be avoided. In order to maintain decreased turbulence and low noise level, long radius elbow and gradual change in shape shall be adopted.

All lateral joints between two ducts shall be provided with **rubber gaskets** to render the joints leak proof. Branch take-offs shall be arranged to cut or slice into the air streams to minimize the losses in velocity head. All bends/elbows shall have suitable vanes to guide the air streams. Standard elbows with a R/D ratio of not less than 1.25 shall be used. Where space restrictions do not permit the use of standard radius elbow with lesser R/d ration, square elbows with a R/D ratio of not less than 1.25 shall be used.





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Where space restrictions do not permit the use of standard radius elbow with lesser R/d ratio, square elbows with equally spaced double thickness vanes may be used. The length of taper ducts shall be at least four times the maximum size difference

between the ends. All duct pieces shall be properly aligned before connection to each other on both sides. The ducts shall be tapped 6 mm across the flanges. All flanges shall be connected to the ducts by rivets. All longitudinal and transverse joints shall be sealed by silicone RTV sealant.

### **1.5 Construction of Rectangular Ducts**

The general construction of rectangular ducts shall be as per IS 655 standards for low / high pressure ducting.

Pressure rating of the ducting shall be appropriate to the duct section i.e. low pressure (2 inch wg) for duct section from return air terminals to AHU and high pressure (4 inch wg) between AHU fan and terminal HEPA filter.

Ducting sheet gauge, type of joint reinforcement and spacing of joints / reinforcement shall be selected as per IS655 depending on pressure class and dimension of bigger side of duct. All sides shall have same gauge. Necessary calculation for selection of duct sheet gauge and reinforcement shall be submitted.

Following table may be followed for low-pressure ducting:



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FOR RECTANGULAR DUCT CONSTRUCTION FOR LOW STATIC  
PRESSURE UPTO 50 MM OF WG**

Maximum Side	Thickness of Sheet		Type of Transverse Joint Connections	Bracing
	(1) mm	(2) mm		
Up to 300	0.63	0.80	S-drive, pocket or bar slips, on 2-5 m centres	None
301 to 600	0.63	0.80	S-drive, pocket or bar slips, on 2-5 m centres	None
601 to 750			S-drive, 25 mm pocket or 25 mm bar slips, on 2-5 m centres	None
			Drive, 25 mm pocket or 25-mm bar slips on 2.5 m centres	25 x 25 x 3 mm angles, 1.2 m from joint
751 to 1,000	0.80	1.00	40 x 40 mm angle connections, or 40-mm pocket or 40-mm bar slips, with 35 x 3 mm bar reinforcing on 2.5 m centres	40 x 40 x 3 mm angles, 1.2 m from joint.
1001 to 1500				
1501 to 2250	1.00	1.50	40 x 40 mm angle connection or 40-mm pocket or 40-mm bar slips, 1 m maximum centres with 35 x 3 mm bar reinforcing	40 x 40 x 3 mm angles, or 40 x 40 x 3 mm angles 60 cm from joint.
2.251 and above*	1.25	1.80	50 x 50 mm angle connection or 40-mm pocket or 40-mm bar slips, 1 m maximum centres with 35 x 3 mm bar reinforcing	40 x 40 x 3 mm diagonal angles, or 40 x 40 x 3 mm angles 60 cm from joint.

\* Ducts 2-250 mm and larger require special field study for hanging and supporting methods.



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FOR RECTANGULAR DUCT CONSTRUCTION FOR HIGH STATIC  
PRESSURE UPTO 125 MM OF WG**

Maximum Side	Thickness of Sheet		Type of Transverse Joint Connections	Bracing
	(1) mm	(2) mm		
Up to 300	0.63	0.80	S-drive, pocket or bar slips, on 2-5 m centres	None
301 to 600	0.80	1.00	S-drive, pocket or bar slips, on 2-5 m centres	25 x 25 x 3 mm angles, 1.2 m from joint
601 to 750			S-drive, 25 mm pocket or 25 mm bar slips, on 2-5 m centres	25 x 25 x 3 mm angles, 1.2 m from joint
			Drive, 25 mm pocket or 25-mm bar slips on 2.5 m centres	25 x 25 x 3 mm angles, 1.2 m from joint
751 to 1,000	0.80	1.00	40 x 40 mm angle connections, or 40-mm pocket or 40-mm bar slips, with 35 x 3 mm bar reinforcing on 2.5 m centres	40 x 40 x 3 mm angles, 1.2 m from joint.
1001 to 1500				
1501 to 2250	1.00	1.50	40 x 40 mm angle connection or 40-mm pocket or 40-mm bar slips, 1 m maximum centres with 35 x 3 mm bar reinforcing	40 x 40 x 3 mm angles, or 40 x 40 x 3 mm angles 60 cm from joint.
2.251 and above*	1.25	1.80	50 x 50 mm angle connection or 40-mm pocket or 40-mm bar slips, 1 m maximum centres with 35 x 3 mm bar reinforcing	40 x 40 x 3 mm diagonal angles, or 40 x 40 x 3 mm angles 60 cm from joint.



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## 1.6 Accessories

### 1.6.1 Splitters and Dampers

Splitters and volume control dampers shall be placed at all suitable points in Supply & Return duct for proportional volume control of the system. Louvers dampers shall be provided in all branches.

Volume control dampers shall be multiple opposed blade type with extended lever for operation and shall be lockable.

### 1.6.2 Air Turning Devices

Air turning devices shall be provided at least for the first four outlet collars after fan. Turning blades shall be fabricated out of 22 S.W.G. galvanized steel sheets and equally spaced on side, runner to be riveted/bolted to duct sheets (As per IS 655).

### 1.6.3 Access Doors & Inspection Window

Access doors shall be provided in the duct work where specified or in casing on the both sides of equipment to be serviced. All access doors to be of adequate size and shall be lined with substantial felt edging to prevent air leakage. Access doors shall be built-up construction structurally strong and each shall have at least two hinges. Inspection window of standard size shall be provided for inspection purpose, where specified.

### 1.6.4 Caulking

Where duct passes through wall, all openings between masonry and duct work shall be neatly caulked or sealed to prevent movement of air from one space to adjoining space.

### 1.6.5 Curves & Bends

All curves, bends, offsets and other transformations shall be made for smooth and noiseless flow of air. The throat of every branch duct shall be sized to have the same velocity as in the main duct to which the branch duct is connected.



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#### 1.6.6 Flexible Connections

Where the duct is connected to make or discharge of fan units, a flexible connections of at least 150 mm width shall be provided. Flexible connection shall be fire resistant made of closely woven, double layer canvass or neoprene coated fiberglass. The material shall be attached to casing by means of a steel bank or collar fitting over the end of the flexible connection and bolted through angle iron frame so as to clamp securely between band.

A standard tapping shall be provided next to flexible connection to facilitate the measurement of outlet air temperature. Where ducts are connected to the wall, such connections shall be made through mild steel frames fixed to the wall through suitable shear fasteners.

#### 1.6.7 Easement

Where pipe hangers or rods pass through the ducts, a tight and streamlined easement around the same shall be provided to maintain smooth flow of air.

#### 1.6.8 Duct Supporting Arrangement

The duct shall be supported at maximum 2400 mm distances. The duct shall be supported by means of not less than 10mm dia. G.I. threaded tie rods / Enamel painted M.S. rod and G.I.C. channels with rubber bushings angles. The G.I. support rods shall be hung from anchor fasteners to be fastened in the RCC ceiling or with care of minimum damage. The rubber gasket shall be fixed in between ducts and M.S. angle. The steel rods are further fastened with the help of nut and bolts from structural members of roofing where practicable. Where ducts are to be supported from steel root, sub-contractors shall provide cross members from purl in /truss and support the ducting from them.

In all, the duct shall not sag or vibrate due to lack of supports. All angles & rods shall be not hot dip galvanized / Enamel painted M.S. rod and hardware shall be chrome plated.

Additional supports wherein considered necessary by the Engineers-in-charge shall be provided. The entire supporting system shall be met with the approval of the Engineers-in-charge.

#### 1.6.9 Inspection & Testing



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The duct branches, elbows, etc. shall be inspected and the joints, connections are to be checked before they assembled in position. After assembly of the system shall be checked for tightness, vibration and noise due to turbulence.

After assembly the entire ducting shall be tested for leakage test with specified pressure in presence of Engineers-in-charge, as per DW143.

#### **1.6.10 Ducting Measurement**

The entire ducting assembly including S.A. plenums shall be measured for its running length & perimeter. The total sq.ft of finished surface area. Ducting erection/ commission shall be calculated on the basis of actual measurements taken at site in presence of engineer/ a representative of client. Payment will be based on actual surface area ducting, face areas of grilles/diffusers and dampers.

#### **1.6.11 Fresh Air Intake & Exhaust Air Assembly**

Both shall comprise of:

- i) Sand trap louvers shall be provided at all intake & exhaust air points. Sand traps shall be powder-coated steel.
- ii) Non return dampers shall be provided.
- iii) For fresh air intake EU4/G4 grade filters shall be provided.
- iv) Filter areas shall be suitable for twice the quantity of fresh air.

#### **1.6.12 Grilles & Diffusers**

##### **1.6.12.1 For Socially Clean Areas (Comfort non-classified air conditioning)**

All grilles and diffusers shall be fabricated out of stainless steel material SS 316 grade . All duct collars terminating on to grille or diffuser shall be given two coats of black paint for a minimum length of 300mm.

##### **1.6.12.2 For ISO Class 8 Areas**

For ISO Class 8 Areas, which are equivalent to Class 100,000, AHU mounted HEPA filter shall be provided. Return air risers shall be



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provided with SS 316 grills. The risers shall be of powder coated. The color of powder coating shall be decided by the employer. Return air risers of specified room shall be provided with EU3/G3 grade filters. These filters shall be water washable easy to install/remove. All supply and return Air Grilles/Diffusers shall be provided with opposed blade volume Control Dampers.

## 2.0 Testing Of Duct

2.1 Wherever specified duct system after installation shall be tested for leakage as per DW-12. The fan and flow measuring orifice capacity shall be suitable to test entire supply/return ducting of each system. Measure leakage of duct at maximum operating pressure should be less than 1% of supply air quantity or as per limits for Class 'C' ducts as per DW-142 (0.17 liters per sec. per square meter of duct surface area for duct pressure rating of 500 Pascal). Whichever is higher.

2.2 The duct system shall be tested by smoke test after connection with AHU and terminals and installation of all accessories are completed to find gross leak points for rectification.

## 3.0 Design Parameters and Limit

### a) Duct Air Flow Velocities

Main supply & Return Air ducts	:	2200 – 2500 FPM
Main branches	:	2000 – 2200 FPM
Branch ducts	:	1000 – 2000 FPM
Branches to air terminals	:	500 – 1000 FPM

### b) Noise Level

NC rating of Diffusers	:	45dB Max
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## 4.0 Codes & Standards\_ (Latest Edition as Applicable)

1. IS: 277-1977 Galvanized Steel Sheet (plain & Corrugated) (Amendment-1)
2. IS: 655-1963 Metal Air Ducts (Amendment-2)
3. IS: 659-1964 Safety Code for Air-conditioning (Amendment-1)



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4. IS: 660-1963 Safety Code for Mechanical Refrigeration
5. IS: 900-1992 Code of Practice for installation and Maintenance of Induction Motors. (Amendment-1)
6. IS: 2441-1984 Code Practice for Fixing Ceiling Covering
7. IS: 4894-1987 Test Code for Centrifugal Fans
8. IS: 5111-1993 Code of Practice and measurement Procedure for Testing Refrigerant Compressors (Amendment-1)
9. IS: 7613-1975 Method of Testing Panel Type Air Filters for Air-conditioning and Ventilation Purpose.
10. IS: 3588-1987 Specification for Electrical Axial Flow Fan
11. DW 142 Testing of Leakages in ducting
12. ISO 14644, Clean rooms and associated controlled Part 1,2,4,5:1999s environments
13. IEST Recommended Practices
  - IES-RP-CC001.3 HEPA & ULPA filters
  - IES-RP-CC006.2 Testing Clean Rooms
  - IES-RP-CC012.1 Considerations in clean room design
14. BS. EN 1882-1:1998 High efficiency air filters (HEPA & ULPA) Classification, performance, testing and marking





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- 15. BS. EN 779:1998 Air filters
- 16. ANSI/ASHRAE Gravimetric and dust  
52.1/52.2:1992 procedures for  
testing air cleaning devices.

**G) THERMAL INSULATION**

**1.0 Scope Of Work**

- 1.1 The insulation contract includes supply of all necessary insulating materials, with accessories including scaffolding/weather protection etc. as specified in this specification at the works side.
- 1.2 The Contractor shall supply and install the insulating materials on the respective surfaces as described in these specifications.
- 1.3 The Contractor shall supply all necessary skilled and unskilled labour and supervision required for carrying out the installation as per these specifications and good engineering practice.
- 1.4 The insulation applications details specified herein need not necessarily be conclusive. Any additional information or deviation from these specifications to proposed practices of insulation application shall be brought to the notice of the Owner and concurrence shall be obtained. These shall be supported by sketches, details and diagrams for removable housings, insulation supports, flashing details, expansion joints etc.
- 1.5 This specification covers design and material requirements for above ground, external insulation of piping and equipment operating between ambient temperature and  $-25^{\circ}\text{C}$  for the purpose of heat conservation, process stabilization, temperature maintenance, personnel protection.
- 1.6 The insulation work covered under this specification falls under the following categories:
  - a) Thermal insulation for duct and cold service insulation for pipelines (IS7240-1990)
  - b) Insulation for personnel protection.



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1.7 Generally rigid preformed pipe sections and logs (IS 9842-1994) shall be used. Unbounded fibrous material shall not be used.

2.0 **Purpose**

Cold temperature insulation shall be installed on piping and equipment to conserve refrigeration. Insulation thickness shall be such as to avoid condensation on the external surface.

3.0 **Equipments & Services To Be Provided\_**

To supply & delivery to site and apply thermal insulation for ducting and piping and satisfactorily hand over whole system as per attached Schedule and as specified here.

Arrange for all necessary inspection by owner/Engineer-in charge at various stages as needed.

4.0 **Thermal Insulation For Ducts:**

4.1 **General**

Insulation work shall be carried out for ducts and chilled water piping as per latest BS/American or equivalent IS standards for thermal insulation materials and finishing materials and also codes of practice for industrial applications.

4.2 **Material**

Insulation material shall be closed cell elastomeric nitrile rubber or cross linked, closed cell polyethylene (PE) CFC free foam sealed/backed by aluminum sheet/foil or equivalent as described in Bill of Quantities.

Thickness of the insulation shall be as specified for the individual application as given in table-1. Each lot of insulation material delivered at site shall be accompanied with manufacture's test certificate for thermal conductivity values and density.

Samples of insulation material from each lot delivered at site shall be selected at random for approval and shall be tested for thermal conductivity values and density, if needed by Owner Engineer-In-charge.

Adhesive used for setting the insulation shall be non-flammable, vapour proof adhesive, supplied by insulation manufacturer or



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- 4.3 Shalimar CRPX compound, or approved equal, cold setting compound.  
**Duct Insulation**

**High quality closed cell insulation.** The thermal conductivity of insulation shall not exceed 0.03 w/m<sup>2</sup>K (0.26 Btu. In/hr. Sq.ft.°F) at 20°C (68°F) mean temperature and density shall not be less than 60 kg/m<sup>3</sup>. Temperature range shall be 40°C to + 105°C and should be self extinguishing type.

Thickness of Insulation

- a. For Duct passing through return air areas = 9 mm
- b. For Duct passing through non air conditioned space = 13 mm

Application

- a. Clean the surface of duct and apply a thin coat of adhesive and leave it for 2-3 minutes for drying once the adhesive is dry but tacky to touch place the insulation sheet in designed position.
- b. Join seams after insulation in place by separating the cut edges and brushing a thin coat adhesive on both surfaces.
- c. Seams / Flange joints shall be insulated with strips of insulation sheet.
- d. Apply self adhesive black cotton tape (PCS 2550) on both the longitudinal and the circumferential joints.

5.0 **Thermal Insulation For Hot water piping :**

All hot water pipes shall be insulated in the manner as under:

- a) The surface shall be thoroughly cleaned and allowed to dry. Pressure / leakage test shall be carried out before application of insulation.
- b) 50 mm thick semi rigid, resin bonded mineral wool pipe sections of 48 kg / m<sup>3</sup> density, shall be stuck to the surface using insulation clips.
- c) The surface shall then be wrapped with 19 mm chicken wire mesh with 24 SWG wire with all joints butted. Thereafter 22 SWG GI lacing wire shall be used for retaining the mesh in position and for giving it a true finish.



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- d) 26G Aluminum cladding with grooved joints shall then be applied. All joints shall be locked with self locking screws at a preferred pitch of 100 mm.
- e) Under no circumstance shall be cladding work be taken up before completion of all works by all Contractor's engaged on the Service floor to avoid damage to the cladding. Failure to comply with this requirement leading to consequential damage to the insulation or cladding shall necessitate the Contractor to redo the work at no extra cost to the owner.

**H) ELECTRICAL WORKS**

**1.0 SCOPE OF WORK:**

The scope includes following for electrical works for HVAC system.

- a) Design, manufacture, shop assembly, testing at manufactures works Transportation, erection at site, testing and commissioning of low tension switchboard for Air Handling Units, Duct heater & other HVAC electrical equipment.
- b) Carry out design and detailed engineering required electrical works for HVAC system.
- c) Supply, installation and termination of power and control cables from L.T. switchboard (HVAC – Electrical Panel) upto all electrical equipment / other HVAC Electrical panels.
- d) Supply and installation of earthing system for equipments supplied by sub- contractor for HVAC work.
- e) Supply and installation of cable trays, required for HVAC work.
- f) Supply and installation of supports including steel, Anchor fastener, etc. for cable trays, all the equipments supplied by sub-contractor.
- g) Start / Stop push Button.

**2.0 OWNER'S RESPONSIBILITY :**

- 2.1 Provide . 415V, TPN, 50 Hz. Supply at the incomers of HVAC Electrical Panels.



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2.2 To provide main earthing grid for HVAC – Electrical Panels.

**3.0 HVAC – ELECTRICAL PANEL :**

Supply, Manufacture, Erection, Testing and Commissioning of HVAC – Electrical Panel as per specification “ Electrical Panels for HVAC”.

**4.0 ENGINEERING DOCUMENTS :**

Following documents shall be prepared. These documents shall be submitted for approval of owner. Equipments Fabrication / Site work shall be carried out after obtaining the approval of following documents :-

- a) Motor List
- b) Switchboard design
  - i) Incoming breaker / switch fuse / MCCB sizing.
  - ii) Busbar sizing calculation.
- c) Cable sizing calculation
- d) Cable schedule
- e) Earthing design calculation
- f) Equipment layout
- g) Cable layout
- h) Earthing layout
- i) Quality Assurance plan for all equipments / work

**5.0 STANDARDS :**

All the equipments shall be supplied and installed as per following standards :-

- IS-3043-1987 : Earthing System
- IS-1554-1988 : Cables

**6.0 GENERAL :**

- 6.1 No fabrication shall be undertaken by the contractor without approval of components, G.A.drawing and QAP.
- 6.2 No equipment shall be dispatched without inspection and/or clearance by owner.



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6.3 The scope of contractor includes all relevant electrical equipment / sensors / interlocks required for smooth and efficient working of the system.

7.0 **DESIGN CRITERIA :**

7.1 **Site Conditions :**

-Ambient Temp : 45°C Maximum  
-Humidity : 65 % Maximum

7.2 **System Conditions :**

Supply Voltage and Frequency :

-Voltage : 415V,  $\pm 7.5\%$   
-Frequency : 50 Hz.  $\pm 3\%$

solidly grounded.

Control Voltage : 230V A.C

7.3 Motors upto 5.5 KW with DOL Starter. Motor above 5.5 KW, with Star-Delta Starter.

7.4 Motor feeders above 15 KW shall be provided with Ammeter on L.T. panel.

7.5 For cable sizing voltage drop of 2% from L.T. switchboard upto motor, will be allowed.

7.6 For cable sizing, starting voltage drop shall be 10%.

7.7 -Control Cable shall be 2.5 mm<sup>2</sup> copper.  
-Power cable minimum size shall be 2.5 mm<sup>2</sup> copper or 4 mm<sup>2</sup> copper.

Aluminum armored cable shall be used above 6 mm<sup>2</sup>

7.8 Painting shade shall be Siemens grey – RAL – 7032.

7.9 Earthing shall be done using G.I. wire / strip.



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7.10 Component selection of switchgear shall be as per manufacturer's recommendation with type 2 co-ordination subject to following :

- Minimum Contactor Rating : 16 Amp.
- Minimum Switch Rating : 32 Amp.

7.11 Components to be provided on incomer of HVAC panel :

- Switch fuse / Breaker
- Voltmeter
- RYB indicating lamps
- 3 Nos. CTS & Ammeters with selector switch.

7.12 CT wiring shall be 2.5 mm<sup>2</sup>

7.13 Outdoor glands shall be of double compression type brass glands with accessories to suit outgoing cable sizes. For indoor FLP areas, double compression glands shall be used. For indoor non- FLP areas, single compression glands shall be used.

7.14 Crimping type lugs shall be used for cable termination.

#### 8.0 LOCAL CONTROL PB STATIONS:

All motors shall have local control push button stations mounted near driven mechanism.

They shall be of wall / column mounting design.

The material of construction of all PB stations shall be die-cast aluminium.

Wiring shall be done using 1.5 mm<sup>2</sup> 660V grade cable and all components shall be wired to terminal block.

Two number earthing studs shall be provided on frame of push button station.

The component details of local PB station shall be as follows :

- For motors - START PB ( Flush type)



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- STOP PB (mushroom headed, press to lock, turn to release type).

9.0 **PAINTING :**

All sheet metal work shall undergo a process of the following :

- De-greasing
- Pickling in acid
- Cold rinsing & phosphating
- Anti – corrosion and acid resistant paint
- Final coat of painting

The interior of panel shall have eggshell white paint or as per approved manufacturer's standard & exterior shall be painted with Siemens grey RAL 7032.

10.0 **CABLES :**

Supply of cables from outgoing of HVAC Electrical panel to various drives / PB station level controllers / control etc. is included in the scope of work of the HVAC contractor.

All cables shall be 660/1000V grade PVC insulated extruded PVC inner sheath, armoured overall PVC sheathed conforming to IS : 1554.

All power cables of size 6mm<sup>2</sup> & above shall be with stranded and 6 mm<sup>2</sup> & below shall be solid copper core. All control cables shall be of stranded copper core of size 1.5 mm<sup>2</sup>.

Cables shall be selected considered a combined de-rating factor as recommended by cable manufacturer and site condition of cable installation. There shall be no joint in the run of a cable. Also, due consideration shall be given to starting & running voltage drop in the cable whilst selecting the cable sizes for motors, which shall be limited to 10% & 2% respectively between HVAC panel & motor.

Control cables shall be provided with 20% cores as spare.

11.0 **EARTHING :**





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A continuous earth bus shall be provided for the HVAC – Electrical panel earthing bolt at each end.

The earth bus shall be of copper.

Neutral and earth bus bars shall be connected through a link.

All Electrical equipment shall be provided with double earthing. Earthing material shall be G.I.

Panel earthing shall conform to IS : 3043.

Internal earthing network shall be connected at 2 places minimum to the external earthing network. Earthing system of the plant shall be designed as per IS : 3043.

## 12.0 **CABLE TRAY & CABLE LAYING :**

All cable trays installed shall be of G.I ladder type while crossing the floor for entry to the equipment terminal, the same shall be taken in GI Pipe of Class – B.

Proper supports for cables shall be provided at all places.  
All cables shall be provided with tag no. as per approved drawings.

All cables shall be neatly dressed.

Double layer of cables on tray is not acceptable.

Anchor fasteners or any material for supporting cable / cable tray is included in scope.

The cable tray shall be fabricated out of 14 SWG (2 mm. Thick) M.S. sheet with side runner channels of 15 x 70 x 20 mm. And slotted rungs of 15 x 50 x 15 mm. at every 250 mm. in standard length of 2500 mm. duly hot dip galvanized after fabrication complete with coupler plates and hardwares.

The tray shall be hot dip galvanized as per IS 2629 with Zinc coating of 65 Microns.



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**13.0 ERECTION ACCESSORIES :**

13.1 All erection accessories (i.e. Anchor fasteners, steel, etc.) required for installation of various units/cables shall be supplied by the Contractor.

13.2 All supporting structural items shall be painted with anti-corrosive paint as approved by the Owner.

13.2.1 HVAC-Electrical panel shall be mounted on base frame supplied by panel manufacturer.

**14.0 DRAWINGS :**

The following drawings / details to be furnished by the Contractor for approval :

- Electrical Equipment layout.
- Cable layout.
- Earthing
- Single line diagram of HVAC Electrical panel.
- GA drawing for HVAC Electrical Panel.
- Wiring diagram of panel
- Motor data sheet for HT & LT motors
- Drive list

Drawings to be furnished after commissioning (Two copies)

The following drawings to be furnished after commissioning :

- As built drawings
- Operating & instruction manuals
- As built drawings shall include all approved & revised drawings as per finally erected & commissioned equipment.
- Catalogues of all components used.
- Soft copy of all as built drawings shall be submitted.

**15.0 INSPECTION & TESTING :**

- All electrical equipment shall be routine tested at manufacturer work to check the conformity to the specification and specific technical requirement as per relevant IS specification OWNER shall be given



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notice of readiness of equipment and proposed date of testing giving 5 days notice.

- In addition to the above, the following site tests shall be carried out; but not necessarily limited to :

**15.1 Motors :**

- 1) Megger / IR test
- 2) No load run for 30 minutes / till temperatures stabilized with time vs temperature chart.
- 3) Recording of
  - i) Cold armature / winding resistance
  - ii) Phase voltages
  - iii) No load currents
  - iv) Load (rated) current
- 4) Load run for 8 Hrs.
- 5) Alignment check, shaft runout where applicable e.g.main blower motor air gap measurement.
- 6) Vibration check for main blower motor.

**15.2 EARTHING:**

- 1) Earth resistance check for grid (< 1 ohms)
- 2) Size of Earthing conductor.

**15.3 HVAC PANEL :**

- 1) Megger test / IR test with outgoing feeders open.
- 2) Megger test / ir test for individual outgoing module.
- 3) Phase polarity test
- 4) Control circuit check
- 5) Relays functional test
- 6) Load test on outgoing feeders

**15.4 CABLES :**

- 1) Megger test
- 2) Continuity test



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Note : 3 bound copies of site test certificates shall be handed over to the **OWNER by the CONTRACTOR**

## I) PIPING WORK

### HOT AND CONDENSER WATER PIPING :

All hot water circulation pipes shall be of plain steel. All pipes and fittings shall be new and from Standard manufacturers. Unless otherwise stated, the materials and type of fittings shall be as given hereunder.

Pipe Size	Material	Joint & Fittings	Sealing Material
Up to 65 mm	M.S. Tube Heavy Class ( C ) I.S. 1239	1 Welded fittings	1. Non-hardening
		2 Unions	2. Lubricant
		3 Screwed Flanges	3. 3 mm 3-ply rubber Insertion
		4 Screwed fittings	4.
75 mm – 150 mm	M.S. Tube Heavy Class ( C ) I.S. 1239	1 Welded	1
		2 Slip-on Flanges	2. 3mm 3-Ply rubber insertion
		3 Screwed Flanges For G.I. Pipes	3. --- do ---
200 mm-300 mm	Electric Resistance Welded (ERW) pipe from 6 mm plate IS 3589 (Class 2)	1 Welded	1.
		2 Slip - on	2. 3 mm 3-ply insertion
300 mm & Over	--- do ---	----- do ----	6 mm 3-ply rubber insertion

All welded piping is subject to the approval of Client and sufficient number of flanges and unions shall be provided as required.

All flanges shall be forged steel and shall have dimensions as per BS 10 Table F/IS 6392 Class 1 with matching flanges on valves and other equipments. Use of flange made from plates will not be permitted. Supply of flanges shall include bolts, nuts, washers, sealing materials etc. as required.



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Fitting for screwed piping shall be malleable casting. Fittings for piping with welded joints shall be of weldable type. All fittings shall have the same pressure ratings as that pipes.

Threads of screwed fittings shall conform to IS 554.

Tee-off connection shall be through reducing tees up to 150 mm otherwise ferrules welded to the main pipe shall be used. Drillings and tapping of the walls of the main pipe shall not be permitted.

**All equipment and valve connections, or connections to any other mating pipes, shall be through unions/ screwed flanges up to 50 mm dia. And flanges for larger sizes or as required for the mating connections.**

Gate and Globe Valves shall be provided as shown in the applicable drawings or as required and shall conform to the following specifications.

	CONSTRUCTION	ENDS
12 mm to 65 mm	Gun Metal	Screwed Female
65 mm & Over	1. Body case: Iron 2. Spindle Valve Seat: Bronze or Wedge Nut etc. : Gun Metal sheet	Flanged

Gun metal valves up to 65 mm shall conform to IS 778. Cast iron valves with Bronze / Gun Metal spindles, seats etc. from 65 mm to 300 mm sizes shall conform to IS 780 Class 2 and from sizes 350 mm and above shall conform to IS 2906. Globe valves shall have brass plated indicators. The valve shall have rising spindles only.

Check Valves shall be provided as shown in the drawings or as required and shall conform to IS 5312. Check valves up to 65 mm size shall be of gunmetal construction with screwed female ends. Check Valves of sizes 65 mm and above shall be of C.I. constructions with flanged ends and gunmetal seat rings. Swing check valves shall normally be used. Lift type valves may be used in horizontal runs. Air release and clean-cut plugs shall be provided wherever required.

Strainers shall be preferably of the approved Pot type, if required, "Y" type with C.I. or fabricated steel bodies. Strainers shall have 0.6 mm bronze screen having 3 mm diameter perforations to provide minimum net free area of 4 times the cross section area of the pipeline in which it is installed. Strainers shall be provided with flanges or threaded sockets depending on pipe size. They shall be provided with



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removable cover and designed so as to enable blowing out accumulated dirt and facilitate and replacement of screen without disconnection of main pipe. Strainers shall be provided as shown in applicable drawings or as required at suction of pump, dirt sensitive, automatic controls valves etc.

Butterfly valves shall be of short wafer flangeless type with cast iron body. The disc shall be high duty cast iron nylon/epoxy power coated. The valve shall be lined with suitable elastomers like black rubber nitride to form a bubble tight sealing. The seat may be in-situ moulded or press fitted in such a way that it also forms a gasket on either side of the valve eliminating requirement of additional gaskets for installations. The shaft shall be of steel with proper water seal rings / bushings. Unless otherwise indicated in the schedule of quantities or drawings, each valve shall be provided with manual flow controls lever with locking arrangements. Butterfly valves with flow control lever may be installed in place of combination gate and globe valves where high degree of water flow control is not required or as shown in the applicable drawings. The valve shall be bolted to pipe line flanges.

**DRAIN PIPING :**

All drain piping shall be of G.I. Glass 'B' as per IS 1239 and shall include necessary loops, U- traps with plugs, fitting and accessories as required.

**G.I. PIPES AND FITTINGS :**

All pipes shall be of heavy I.S. quality or as specified in the schedule.

Wrought Iron pipes shall be galvanized inside and outside treated and fixed in accordance with the requirements. The joints shall be distributed in strict conformity with regulations. They shall be secured clear off the wall surface by means of G.I. holder bats. All controls valves, stop-cocks, ball valves, bib – cocks shall be of the best approved quality procurable, of heavy cast drawn brass. They shall be of best Indian manufacture specified in the Schedule of quantities and of tested stamping and bear I.S.I markings. All fittings shall be either 'RR' OR Ring and equivalent make.

Laying and Fixing: Where pipes have to be cut or rethreaded, ends shall be carefully filled out so that no obstruction to bore is offered. In joining the pipes, the inside of the socket and the screwed ends of the pipe shall be rubbed over with white zinc and few turns of hemp yarn wrapped round the screwed end of the pipe which shall then be screwed home in the socket with a pipe wrench. Care must be taken that all pipes and fittings are kept at all times free dust and dirt during fixing.



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The water-tightness of joints shall be assured by approved methods of jointing material. Wherever a G.I. pipe crosses a floor, then a C.I. sleeve with 15 mm all round clearance and projecting by 80 mm and below the floor should be provided. On no account should lime or lime concrete come in direct contact with G.I. pipe and fittings. This important condition shall not be waived under any circumstances.

Internal Work : For internal work G.I. pipes and fittings outside the wall shall be fixed either visible by means of standard pattern holder – bat clamps, keeping the pipe clear off the plastered wall by 15 mm for cold water and 38 mm for hot water. Wherever indicated on the drawing or as directed by the Employer, chasing of walls shall be done to embed pipes. All pipes and fittings shall be fixed truly vertical and horizontal or as directed by the Employer. All embedded cold water pipes are to be covered with bituminous polyethylene wrapping or equivalent approved by local regulations and National Building Code. All embedded hot water pipes are to be painted with at least three coats of bituminous anti-corrosive paint and coated and wrapped as above and then wrapped with three ply asbestos twine wrapped tightly around the pipe.

External Work : For external work, G.I. pipes and fittings shall be laid in trenches. They should be wrapped, as specified above. The width of the trench shall of minimum width required for working. The pipes laid underground shall not be less than 600 mm from the ground level. They shall be surrounded on all sides by sand of approved quality. The work of excavation and refilling shall be done in accordance with the general specifications by the other agencies.

Where permitted the wrapping of pipe shall be with 0.3 mm thrice FRP tissue as per manufacturer's specifications.

Testing: All G.I. Pipes and fittings are to be tested to a pressure of one and half times the operating pressure but not less than 10.54 Kg/cm<sup>2</sup> for 8 hours to ensure that pipes have proper threads and that proper materials (such as white zinc and hemp) have been used in joints. All leaky joints must be made leak proof by tightening or redoing at Contractor's expense.

All water fittings shall be of RR or Rings or equivalent manufacture and shall in all respects comply with the latest Indian Standard Specification I.S. 1239 (Part II). The brass fittings shall be fixed in the pipeline in a workman like manner. Care shall be taken to see that the joints shall be tested to a pressure of 10.54 Kg/cm<sup>2</sup>, unless otherwise specified. The defective fittings and the joints shall be repaired, redone or replaced.



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**TESTING :**

All MS piping shall be tested to hydrostatic test pressure of at least one and half times the maximum of operating pressure, but not less than 7 Kg/cm<sup>2</sup> for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the Owner.

Piping repaired subsequent to the above pressure test shall be retested in the same manner.

Systems may be tested in sections and such sections shall be secure capped.

The Engineer-in-charge shall be notified well in advance the Contractor of his intention to test a section or sections piping and all testing shall be witnessed by the Engineer-in-charge or their authorized representatives.

The Contractor shall make sure that proper noiseless circulation fluid is achieved through all coils and other heat exchange equipment in the system concerned. If proper circulation is not achieved due air bound connections, the Contractor shall rectify the defective connections. He shall bear all the expenses for carrying out the above rectifications including the tearing-up and re-finishing of floor walls, etc. as required.

No insulation shall be applied to piping until after completion of the pressure testing to the satisfaction of the Owner.

**The Contractor shall provide all materials tools, equipment, and instruments, Services and labour required to perform the test and to remove water resulting from cleaning and after testing.**

**PAINTING :**

After all the piping has been installed, tested and run for at least ten days of eight hrs. each, the piping shall be given two finish coats of epoxy paint as follows:-

SERVICES	FLOOR	COLOUR
Condenser water	Supply & Return	
Chilled water	- do -	
Refrigerant	Liquid, suction and Discharge	As per Engineer-in-Charge's approval.
Steam, Hot water	Supply	
Condensate	Return	

The direction of flow of fluid in the pipe shall be visibly marked by white arrows.





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Pipe supports shall also be coated with rust preventive red oxide paint and two coats of epoxy paint.

### **DETAILS FOR MEASUREMENT**

**All piping shall be measured along the centre of the pipe and shall include all fittings, thermowells, drains with valves, supports, erections, painting etc. and paid unit per length.**

All gate, globe and check valves, strainers, butterfly valves, balancing valves and manometers shall each measured as a unit and shall include all accessories and supports.

Expansion tank with all fittings, insulation, supports including M.S. Frame work if required, of appropriate size to suit site requirements, finishes etc. shall form one unit of measurement.

Pressue gauges, thermometers, gauge cocks shall each measured as a unit and shall include all accessories and supports.

Refrigerant piping including its insulation shall form part of refrigeration equipment / system and shall not be payable separately.

All civil, masonry or structural works required for installation of piping etc. and painting shall be carried out by AC Contractor and the cost of such works shall be deemed to be included in the unit rates of respective items. The pipings iof the chilled water , hot water is included in their unit rate of the respective items & shall not be payable separately.

### **J) ELECTRICAL PANEL**

#### **1.0 SCOPE**

1.1 Vendor to design, manufacture, test, supply, erect and commission electrical panel.

#### **2.0 CODES AND STANDARDS**

2.1 The design, manufacture and performance of equipment shall comply with all currently applicable IS/IEC, statutory regulations and safety codes in the locality where the equipment will be installed.



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2.3 Unless otherwise specified, equipment shall conform to the latest applicable following standards :-

<b>CODES</b>		<b>DESCRIPTION</b>
IS	: 2147,1962	Degree of protection provided by enclosure for low voltage switchgear & controlgear
IS PART – 1	: 13947 : 1993	Specification for low voltage switchgear and control gear.
IS PART – 2	: 2705 : 1995	Specification for current Transformers
IS PART-2	: 3156 : 1992	Specification for voltage transformer
IS PART-1	: 1248 : 1993	Specification for direct acting indicating analogue electrical measuring instrument and their accessories
IS PART-1	: 8623 : 1993	Specification for factory built assemblies of switchgear and controlgear (upto 1000 Volts)
IS PART-1 & 2	: 8544 : 1977	AC motor starter of voltage not exceeding 1000V
IS	: 11353 : 1985	Guide for uniform system of marking and identification of conductors and apparatus terminals.
IS PART-1	: 13703 : 1993	Low-voltages fuses not exceeding 1000V AC or 1500V DC.

### 3.0 DRAWINGS

3.1 The following enclosed drawings and / or data sheets form part of the specification.

#### 3.2 GENERAL REQUIREMENTS

4.1 All identical equipment and corresponding parts shall be fully interchangeable.

4.2 Switchgear shall comprise of indoor, floor mounted metal enclosed compartmentalized modular type vertical sections.

4.3 Switchgear shall be dust and vermin proof and shall be easily extensible on both sides.



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- 4.4 All doors, panels, removable covers shall be gasketed all around with neoprene gaskets.
- 4.5 Each vertical section shall comprise the following:
- 4.5.1 Metal enclosed busbar compartment running horizontally throughout the length of switchgear and shrouded by barrier plates.
- 4.5.2 Individual feeder modules in multitier formation.
- 4.5.3 Shrouded vertical bus bars or individual feeder connections by 650V grade stranded PVC insulated wires/strips.
- 4.5.4 Vertical cable alley with doors or covers covering entire height, and shrouded by barrier plates. Every panel shall have independent cable alley.
- 4.5.5 Horizontal wireway for control wiring shall be provided for full length of panel.
- 4.5.6 Sheet steel between two adjacent vertical sections except for horizontal bus bar compartment.
- 4.5.7 Separate door for each feeder module.
- 4.6 Metal enclosed unit shall comprise rigid structural frame enclosed by 2mm thick cold rolled sheet steel. Doors and covers shall be of 1.6mm thick cold rolled sheet steel. Structural frame work with foundation bolts etc. shall be provided at the bottom to mount switchgear directly on concrete steel channel base.
- 4.7 Switchgear shall be provided with removable cable gland plate.
- 4.8 Separate labels shall be provided for switchgear modules, relays, instruments, switches, etc. Approval for the type of label shall be taken from the purchaser during drawing approval.
- 4.9 Control switches, push buttons, indicating lamps, meters and relays shall be mounted on the front door. CT,VT, shall be mounted on fixed portion.



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- 4.10 Painting shall include seven tank process like emulsion cleaning, pickling with dilute acid, washing and rinsing by water, phosphatising and oven drying. One (1) coat of phosphate paint and coat of yellow zinc chromate primer and two (2) coats of dark grey colour shall be spray painted after the primer dries.
- 4.11 Type of execution shall be fixed type.
- 4.12 Name plate of acrylic having white letter in black back ground, rear engraved type, shall be provided for all feeders. Also each component of the switchgear shall be provided with identification labels.
- 4.13 The switchboards shall be divided into convenient shipping sections not exceeding 2.5 meters.
- 4.14 Complete panel shall be mounted on a base frame made out of ISMC 100 x 50 section.
- 4.15 Every panel shall have independent vertical busbar chamber / alley with vertical busbars are PVC shrouded.
- 4.16 The panel shall be divided into following compartment :-
- a. Busbar Chamber (300 mm width)
  - b. Connector Chamber (230 mm width)
  - c. Main Income feeder
  - d. Individual switch – disconnecter fuse chamber with motor starters etc.
- 4.17 Each chamber shall be divided into two by 16 SWG cold rolled steel plate and shall be removable type screwed to the lugs projecting from the main body of the panel.
- 4.18 Door opening shall be away from the cable alley and be provided with interlocking arrangement. Suitable keys shall be provided. Door interlock defeat arrangement shall be provided.
- 4.19 Cross ferruling shall be provided.

## 5.0 MAIN BUSBARS



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- 5.1 Main bus bars shall be of uniform cross section of Copper. There shall be 3 Nos. phase busbar, 1 No. neutral busbar and 1 No. earthing busbar.
- 5.2 Maximum temperature of bus bars and bus connection shall not exceed 85 deg.c
- 5.3 Bus bars shall be air insulated. Busbars shall also be heat shrinkable PVC tapes insulating sleeve type and phase colour coded.
- 5.3 Separate support shall be provided for each busbar. If common support is provided for all busbars, anti-tracking barriers shall be incorporated.
- 5.4 Busbars shall run through out the length of the chamber and shall be extensible type on either side.
- 5.5 The diameter of the hole shall be 2 mm more than the bolt diameter.
- 5.6 Provision shall be made to connect the earthing busbar to the main earthing grids at the two ends.
- 5.7 The busbars shall have sufficient cross section to carry full load current and fault current without any damage.

**6.0 MOULDED CASE CIRCUIT BREAKER (MCCB)**

- 6.1 MCCB shall be suitable for fault level indicated on the single line diagram.
- 6.2 Pad locking arrangement shall be provided.
- 6.3 It shall be possible to open the door only when MCCB is in off position and it shall not be possible to close MCCB when door is open. It should be provided with Defeat Interlock facility.
- 6.4 Feeder shall be such that operating handle of any switch shall be above 300 mm but within 1900 mm from the base.
- 6.5 MCCB shall be provided with current limiting feature.

**7.0 FUSES**



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7.1 Fuses shall be of link type with visible indication of operation and shall have rupturing capacity of more than the fault level specified.

7.2 One No. (1) fuse pulling handle shall be provided with each switchgear.

Fuses of smaller capacity rating for control circuit shall be of cartridge type.

### **8.0 MOTOR STARTERS**

8.1 Contactors:

8.1.1 Contactor shall be air break, double break single throw, and electromagnetic type.

8.1.2 Main contacts shall be of silver faced copper.

8.1.2.1 Two 'NO' and two 'NC' auxiliary contacts shall be provided for each power contactor.

8.1.3 The auxiliary contacts shall be wired to the terminals.

8.2 Direct on Line Starter

8.2.1 DOL starters shall be suitable for AC3 utilisation category/ BS 5486/ IEC 19-1.

8.2.2 Motor Protection Circuit Breakers shall be provided.

8.3 Automatic Star-Delta Starters

8.3.1 Starters shall comprise three sets of contactors and a timer relay.

8.3.2 Starters shall be suitable for AC3 utilisation category.

### **9.0 SINGLE PHASING PREVENTERS (SEPARATELY MOUNTED)**

9.1 Separate single phasing preventers shall be provided. The relay shall be current operated type and hand rest type with separate hand rest push button.

### **10.0 INSTRUMENT TRANSFORMERS**

10.1 CT and VT shall conform to the requirements of IS:2705 and IS:3156 respectively. The rating specified is indicative only and it shall be Contractor's responsibility to ensure that the ratings are adequate for relays/ meters application considering lead resistance etc.



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10.2 CT/VTs shall be of wound type.

10.3 Facility shall be provided for short circuiting and earthing the CT and terminal blocks.

10.4 VT shall be provided with adequately rated primary and secondary fuse.

### 11.0 INSTRUMENTS

11.1 Indicating instruments shall be of 96 mm square size suitable for flush mounting. (Any other instrument not specified but necessary, shall be provided at no extra cost)

11.2 Watthour and Varhour meters shall be suitable for 3 phase, 4 wire system, balanced as well as unbalanced load suitable for semi flush mounting.

### 12.0 MISCELLANEOUS ACCESSORIES

12.1 Indicating lamps shall be of cluster LED type and translucent covers. Lamp shall have diameter of 22.5 mm.

12.2 Push buttons shall be momentary contact type rated for 10A at 500V AC. The colour of push buttons shall be as follows:

Start - Green

Stop - Red

As per system requirement.

12.3 Bypass arrangement for VFD shall be provided with suitable starter as per rating.

### 13.0 INTERNAL WIRING

13.1 All wiring inside switchgear shall be carried out with 650V grade PVC insulated copper wires. Minimum size of conductor for control wiring shall be 1.5 mm<sup>2</sup>. Control circuits shall be provided with HRC fuses. Power connections for 63A and above shall be carried out with PVC insulated copper links.

13.2 All wiring shall be terminated on terminal blocks with crimping type cable lugs.



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13.3 Ferrules shall be provided on each wire and terminal block shall be numbered for ease in connection. Cross ferruling shall be used.

13.4 Control circuits shall be provided with HRC fuses.

13.5 The control power supply cable shall be tapped from R phase and Neutral after the main fuses of each feeder. Control circuit shall have protection fuses.

13.6 The cable alleys door shall be provided with hinged doors for easy access to cables inside the cable alley, which can be operated with special keys by authorized persons. The compartment door shall be as far as possible, open away from the cable alley. All cable entries from the top for incomer and bottom for outgoing.

13.7 The gland plate shall be provided with drilling holes for the cable glands.

#### **14.0 TERMINAL BLOCKS**

14.1 All terminal blocks for power and control circuits shall be of 650V grade stud type.

14.3 Terminal blocks of different voltage groups shall be segregated and suitably labeled.

14.4 Terminal shall be numbered as per wiring diagrams for ease in connection.

14.5 Minimum 20% spare terminals shall be provided.

#### **15.0 EARTHING**

15.1 An earthing copper bus extending throughout the length of switchgear shall be provided.

15.2 The earth bus bar shall be of sufficient across section to carry safely momentary short circuit and short time current for 1 sec.

15.3 All non-current metals parts shall be effectively bonded to the earth bus.

15.4 All doors shall be bonded to earth, however electrical switchgear bonded are mounted on door.

#### **16.0 TESTS**

16.1 Subcontractor shall test switchgear as per IS/IEC with all components assembled and fully wired.

16.2 Following routine tests shall be carried out on all components and assembled switchgear and as per relevant standards.





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- 16.2.1 Mechanical and Electrical Operation tests by stimulating site condition.
- 16.2.2 High voltage test (2.5 KV for one minute)
- 16.2.3 Tests for verification of calibration of releases.



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**SECTION 10**  
**INFORMATION TO BE PROVIDED BY THE**  
**TENDERER ALONGWITH THE TENDER**



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## 10.0 INFORMATION TO BE PROVIDED BY THE TENDERER ALONG WITH THE TENDER

### A) AIR HANDLING UNITS

#### SCHEDULE OF DATA FOR AIR HANDLING UNIT (DOUBLE SKIN)

For each AHU, the Contractor shall furnish the following details with computerized selection for Fans & Coils enclosed with the offer.

A) General		
1	Manufacturer	
2	Material thickness of outer casing	
3	Material/ finish of outer casing	
6	Material thickness of inner casing	
7	Material/ finish of inner casing	
8	Insulation Material	
9	Insulation thickness (MM)	
10	Material thickness of drain pan	
11	Insulation material drain pan	
12	Thickness of drain pan insulation	
13	Number of section offered include	
	F/A & R/A mixing section	
	Pre filter section	
	Microvee filter section	
	Fan section	
	Cooling coil section	
	Brine coil section	
	Heating coil section	
14	Material of structural member	
15	Noise level (db) for fan and outside AHU	

B) Fan Section		
1	Maximum air discharge capacity (m <sup>3</sup> / hr)	
2	Maximum static pressure (mm wg.)	
3	Maximum permissible fan speed (rpm)	
4	Fan diameter (mm)	



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5	No. of fans	
6	Balance (static and / or dynamic)	
7	Design air quantity (m <sup>3</sup> / hr)	
8	Design static pressure (mm wg.)	
9	Design fan speed (rpm)	
10	BKW at full load	
11	Motor H.P.	
C) Motor		
1	Manufacture Model	
2	Type	
3	Service (Duty)	
4	Type of power supply	
5	Type of enclosure	
6	Degree of Protection	
7	Efficiency	
8	Ambient design temperature	
9	Max. design temperature	
10	Type of Starter	
11	Speed (rpm)	
12	Frame (size)	
13	Electrical Power (kw)	
14	Starting Current (A)	
15	Operating weight (kg)	
16	Whether flame proof or not	
D) Cooling Coil		
1	Tube material	
2	Tube diameter (mm)	
3	Tube thickness (mm)	
4	Fin material & Fin thickness	
5	No. of fins per cm	
6	Coil face area ( m <sup>2</sup> )	
7	No. of rows	
8	Design ADP ( °C)	
9	Deign water circulation through coil (Rec.pm)	
10	Design water inlet temp. (°C)	
10	Design water outlet temp. (°C)	
11	Design air inlet temp. DB (°C)	
12	Design air outlet temp. DB (°C)	



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13	Design air inlet temp. WB (°C)	
14	Design air outlet temp. WB (°C)	
15	Air velocity across coil (m/s)	
16	Design heat absorbing capacity (TR)	

**B OTHER ITEMS**

TECHNICAL DATA SHEETS

**A. SHEET METAL DUCTING**

1. Manufacture of ducting :
  2. Zinc Coating thickness :
  3. Thickness of Galvanized sheet :
  4. Type of Sealant :
  5. GI Sheets :
  6. Ducting leak test : Required  
as per DW142
- SMOKE TEST

**B. GRILLES & DIFFUSERS**

1. Manufacturer :
2. Type :
3. Capacity (cfm) :
4. Material of construction :
5. Type of finish :
6. Volume control damper :  
Sample to be provided for  
approval

**C. FIRE DAMPER**

1. Manufacturer :
2. Type :
3. Material of construction :
  - a) Frame :
  - b) Louvers :
  - c) Shaft :
  - d) Bearing housing :



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e) Actuator mounting :  
bracket

- 5. Type of actuator :
- 6. Operating weight :
- 7. Overall dimensions :

**D. PIPING WORKS**

**a) Pipes**

- 1. Make/Manufacture :
- 2. Service :
- 3. Rating :
- 4. Material :
- 5. Thickness :
- 6. Size :

**b) Valves**

**Butterfly Valve**

- 1. Make/Manufacture :
- 2. Service :
- 3. Rating :
- 4. Material :
- 5. Test pressure :
- 6. Size :

**Ball Valves**

- 1. Make/Manufacture :
- 2. Service :
- 3. Rating :
- 4. Material :
- 5. Test pressure :
- 6. Size :

**Gate Valves**



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1. Make/Manufacture :
2. Service :
3. Rating :
4. Material :
5. Test pressure :
6. Size :

**Globe Valves**

1. Make/Manufacture :
2. Service :
3. Rating :
4. Material :
5. Test pressure :
6. Size :

**Balancing Valve**

1. Make/Manufacture :
2. Service :
3. Rating :
4. Material :
5. Test pressure :
6. Size :

**2/3 – Way Control Valves**

1. Make/Manufacture :
2. Service :
3. Rating :
4. Material :
5. Test pressure :
6. Size :
7. Type of Thermostat :

**Isolation Valve**

1. Make/Manufacture :
2. Service :
3. Rating :
4. Material :
5. Test pressure :
6. Size :



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**c. Pressure Indicators**

1. Make :
2. Pressure Element :
3. Type :
4. Mounting :
5. Dial size :
6. Dial Colour :
7. Range & gradation :
8. Accuracy :
9. Case :
10. Pressure element :
11. Movement :
12. Connection :

**d. Temperature Indicators**

1. Make & Model :
2. Case :
3. Mounting :
4. Temperature Compensation:
5. Over range Protection :
6. Accuracy :
7. Fill material :
8. Bulb & Capacity :
9. Case :
10. Connection type :

**e. Thermal Insulation**

**1. Cold Insulation:-**

1. Manufacturer :
2. Type :
3. Service :
4. Thermal Transmittance : Max 0.04
5. Thermal Conductivity 'K' value  
(at 10°C mean temp.) Kcal/M.h°C : 0.0346
6. Density Kg/m<sup>3</sup> :





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7. Operational Range : - 40°C to 105°C  
8. Thickness :  
9. Finishing Material :  
10. Adhesive tape :  
11. Water Vapour permeability :  
12. Fire performance : Class 1 as per BS 476.

**Filters**

**a) All non – HEPA Filters**

1. Application :  
2. Type/Location :  
3. Size of each filter (- x-)  
4. No. of filters/Material of filters:  
5. Velocity across filter  
6. Pressure drop through filter when clean :  
7. Allowable pressure drop (when dirty) :  
8. Efficiency as per BS EN 779 Atmospheric Duct Spot or ASHARE Synthetic duct :  
9. Code :  
10. Method of cleaning : (confirm water washable)  
11. Material of frame :

**b. HEPA Filters:**

1. Application :  
2. Type/Location :  
3. Gross filter media area (m<sup>2</sup>):  
4. Size of each filter ( -x- )  
5. No. of filters/Material of filter:  
6. Velocity across filter :  
7. Pressure drop through filter when clean :  
8. Allowable pressure drop (when dirty) :



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9. Efficiency as per BS EN 1822:
10. Code :
11. Testing at site :
12. Material of frame :

**TECHNICAL SPECIFICATION**  
**(Water cooled screw chiller & Scrolled Chiller )**

**I. DUTY**

Air conditioning is required for 24 hours / day for areas related to process application & for 10 hours / day for non process application. The plant shall be suitable for maintaining inside design condition all round the year .Not withstanding the duty specified ,all equipment shall be suitable for continuous operation of 8000 hours .

The bidder has to submit the complete technical details for screw chiller & screw chiller along with the bid.



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***PART – II***

***TECHNICAL SPECIFICATIONS: DEVIATION  
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***PART – III***

**TESTING, ADJUSTING & BALANCING**



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## TESTING, ADJUSTING AND BALANCING (TAB) OF HVAC SYSTEMS

### 1.0 OBJECTIVE

This document is intended to provide guidance in the testing, adjusting and balancing of HVAC systems to assure that installed systems operate in accordance with approved design requirements.

### 2.0 SCOPE

This standard shall apply to all facilities when new HVAC systems are installed or when existing HVAC systems are modified. It may also be useful in providing guidance in routine systems balancing by plant operation and maintenance groups as required.

This standard outlines the general requirements for total mechanical systems testing, adjusting and balancing. Requirements include measurement and establishment of the fluid quantities and temperatures of HVAC systems as required meeting design specifications, and the recording and reporting of the results.

This includes, but is not limited to testing, adjusting and balancing of the following parts of the HVAC systems:

- Supply air systems
- Return air systems
- General exhaust air systems
- Temperature control system operation.



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### 3.0 DEFINITIONS

**Systems Testing, Adjusting and Balancing (TAB):** Is the process of checking and adjusting all building environmental systems to produce design objectives. It includes:

- The balancing of air and water distribution
- Adjustment of the total system to provide design quantities
- Electrical measurements
- Temperature measurements
- Verification of performance of all equipment and automatic controls
- Sound and vibration measurement

**Test:** To determine quantitative performance of equipment.

**Adjust:** To regulate the specified fluid flow rate and air patterns at terminal equipment (e.g., reduce fan speed, throttling).

**Balance:** To proportion flows within the distribution system (sub-mains, branches, and terminals) according to specified design quantities.

**Procedure:** Standardized approach and execution of sequence of work operations to yield reproducible results.

**Reports forms:** Test data sheets arranged for collecting test data in logical order for submission and review. This data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.

**Terminal:** The point where the controlled fluid enters or leaves the distribution systems. These are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, hoods and variable or constant volume boxes.

**Main:** Duct or pipe containing the system's major or entire fluid flow.

**Sub-main:** Duct or pipe containing part of the system's capacity and serving two or more branch mains.



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**Branch main:** Duct or pipe serving two or more terminals.

**Capture velocity:** The velocity of air at a point in space sufficient to draw the contaminated air into the local exhaust hood.

#### 4.0 GENERAL

##### 4.1 Quality Assurance

Agency Qualifications:

The HVAC contractor will undertake the single source of responsibility to test, adjust, and balance the systems to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and the recording and reporting of the results.

Test and balance Engineer should have at least 3-years of successful testing, adjusting and balancing experience on projects with testing and balancing requirements similar to those required for this project.

Codes and Standards:

**ASHRAE:** ASHARE Standard 111, “Practices for measurement, testing and balancing of building heating, ventilation, air conditioning and refrigeration systems”.

ASHRAE Handbook, “HVAC Application” (last edition), Chapter 34, Testing, Adjusting, and Balancing.

**IS 655:** “HVAC Systems Testing, Adjusting and Balancing’, Last Edition.





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Pre-Balancing Conference:

Prior to beginning of the testing, adjusting, and balancing procedures, designated Client's representative should schedule and conduct a conference with TAB agency, Architect/Engineer and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

**4.2 Project conditions**

Systems shall be fully operational prior to beginning procedures. Duct leakage test shall be performed and report approved. Systems affecting each other must be tested and balanced with all systems in operation.

Sequencing and Scheduling: \_

The air systems shall be tested, adjusted, and balanced before refrigerant systems.

Systems affecting each other must be tested and balanced with all systems in operation.

Air conditioning systems should be tested, adjusted and balanced during summer season, including at least a period of operation at outside conditions within 3°C (6°F) wet bulb temperature of maximum summer design. The final temperature readings should be taken during seasonal operation.

Heating systems should be tested, adjusted and balanced during winter season, including at least a period of operation at outside conditions within 5°C(10°F) dry bulb temperature of minimum winter design condition. The final temperature readings should be taken during seasonal operation.



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## 5.0 PRELIMINARY PROCEDURE FOR BALANCING

### **Air System Balancing**

Before operating the system, TAB agency shall perform and document the following:

Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.

Check filters for design specifications and for cleanliness.

Check dampers (both volume and fire) for correct and locked positions, and temperature control for completeness of installation before starting fans.

Prepare report test sheet for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

Determine best locations in main and branch ductwork for most accurate duct traverses.

Place outlet dampers in the full open position.

Prepare schematic diagrams of systems 'as-built: ductwork and piping layouts to facilitate reporting.

Check if all motors and bearings are lubricated.

Check fan belt tension.

Check fan rotation.

### **Hydraulic Systems Balancing**\_\_\_\_

Before operating system TAB agency shall perform the following:

Inspect the system completely to ensure that;

It has been flushed out, it is clean, and all air is out of the system;

All manual valves are open, or in operating position;



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All automatic valves are in their proper positions and operative; and the expansion tank is properly charged.

Open valves to full open position. Close coil bypass valves.

Check if construction strainer baskets have been replaced with permanent clean baskets.

Check pumps alignment and rotation.

Check and set valves for required systems pressure.

Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).

Set temperature controls.

Check and set operating temperature of chillers to design requirements

Check if all temperature/pressure ports have been installed correctly and functional.

Check chiller and condenser are started properly.

Check if all motors and bearings are lubricated.

## 6.0 EXECUTION OF THE TESTING, ADJUSTING AND BALANCING

### **Measurements:**

TAB agency should provide all required instruments with necessary calibration certificates. Instruments shall be properly maintained and protected against damage.

All provided instruments should meet the requirements of this procedure.

Only those instruments that have the maximum field measuring accuracy and are best suited to the function being measured should be used.

Instruments for airflow measurements must be applied as recommended by the manufacturer.



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Rotating Vane Anemometer could be used to measure air quantities at grilles, registers, and velocity across the filter and coil face areas.

Hot wire Anemometers should be used to measure airflow in local hoods (may be used to measure velocity at grilles and register).

The following devices should be used for the balancing of the hydraulic system:

Flowmeters (ultrasonic stations, turbines, venturi, orifice plate, multi-ported Pitot tubes, and flow indicators).

Manometers, ultrasonic digital meters, and differential pressure gauges (either analog or digital).

Portable digital meter to measure temperature flow and pressure drop.

Test pressure taps, pressure gauges, thermometers, and wells.

Instruments must have a minimum scale and maximum subdivisions and have scale ranges proper for the value being measured.

When averaging values, a sufficient quantity of readings should be taken which will give a true picture of the system.

All readings must be taken with the eye at the level of the indicated value to prevent parallax.

Coil testing should be performed with electronic temperature probes. The probes to be used should be immersed in a water bath along with mercury thermometer, traceable to a standard thermometer, before starting coil testing. All probes should be accurate to within  $\pm 0.5^{\circ}\text{C}$  ( $1^{\circ}\text{F}$ ) of the true temperature and all probes should read within  $0.1^{\circ}\text{C}$  ( $0.2^{\circ}\text{F}$ ) of each when read with the same instrument.

### **Performing Testing, Adjusting and Balancing:**

Air Flow Testing, Adjusting and Balancing:

Testing and balancing procedures should be performed on each system identified in accordance with the detailed procedures.



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Location of test measurement (traverse) planes on ductwork and equipment should be determined according to recommendations of the Project Management Team. Project Management team, responsible for review and approval of the project should ensure that location of the measurement traverses, are correct and proper.

Measurement planes consist of series of taps (traverse points) located around the perimeter of duct or on the vertical sides of a central station air handling unit, packaged air conditioning unit, or plenum.

Static pressure measurement planes are required at both the fan suction and discharge. Airflow measurement planes can be located on both the fan suction and discharge. For dust collection systems, the airflow measurement plane shall be located on the fan suction side, or if space does not permit, on the collector inlet ductwork. When sufficient duct length is not available for a single airflow measurement plane, multiple planes in sub mains should be used to determine the total fan airflow.

If due to space considerations, the length of straight duct from fan suction and/or discharge to duct elbows (or any other reducing fittings) is below what is recommended, the System Effect should be calculated and added to the system total pressure losses.

Insulation, ductwork, and piping for installation of test probes should be cut to the minimum extent necessary to allow adequate performance of procedures.

Insulation, ductwork, and housing should be patched by using materials identical to those removed.

Ducts and piping shall be sealed and tested for repairs leaks.

Insulation should be re-sealed to re-establish integrity of the vapor barrier.

Equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices must be marked to show final settings. Permanent identification materials should be used.

If conditions at which fan operates during a test are difference from the fan rating conditions, the field test data should be converted to fan rated speed and inlet air density.

Enclosed attachments present minimum data required for establishing the fan's actual flow rates, conversion to the fan's rated conditions and subsequently to review the quality of the overall system balancing.

The variations of actual airflow rates from design criteria should be within  $\pm 10\%$  range for supply, return and general exhaust systems, and within  $-0/+10\%$  range for local exhaust systems.



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Variation of actual fan performance should be within  $\pm 10\%$  range of the vendor suggested operation.

Reset, adjust, and balance systems subsequent to significant systems modifications, and resubmit test results.

**Water Systems Testing, Adjusting and Balancing:**

The water systems should be balanced by direct flow measurement. Balance by direct flow measurement allows the pump to be matched to the actual system requirements.

Pump suction, discharge, and differential pressure readings should be taken both full flow and no flow. (For large pumps a no flow condition may not be safe – consult manufacturer). Based on pressure and power readings the pump curve should be established to determine the approximate flow rate.

Excess pump pressure and excess operating power should be eliminated by trimming the pump impeller, or by reducing the pump speed. The use of throttle valves to absorb the excessive pressure adds a lifelong operating cost penalty to systems operation, and therefore, is not allowed.

The variation of actual water flow from the design criteria should be within  $\pm 10\%$  range, however, the  $\pm 5\%$  tolerance band should be used for chilled water supplied to coils when high latent capacity is required, and for heating terminals using low temperature water.

Preference should be given to the proportional balancing method using direct measurement flow meters. The ratio between actual measured and design water flows should be determined and applied to all terminals. Manual balancing valves must be adjusted to proportionally balance the system. The balancing should be accomplished in a logical sequence from coil (branch, riser, and header) with the lowest percent of design flow to the one with highest percent of design.

The pressure drop across balancing valve at the pump discharge is the pressure produced by the pump that is not required to provide the design flow rate to the system. Once the excess pressure is removed as described above, the pump's discharge balancing valve must be reopened to its wide-open position.

When system uses three-way valves, balancer should set the coils for full flow and balance on full flow through the coil. Then change the three-way valve to full bypass and set the bypass balancing valve.

If system uses two-way valves with a bypass loop at the end of the system or at the pump, balancer should set the system to full flow and balance with



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the bypass closed, then measure the differential pressures between the supply and return mains, and set the bypass balancing valve to maintain the differential pressure.

When system with Primary and Secondary Loops is used, the primary loop should be balanced first. To balance, the system must be set for full flow in both the primary and the secondary loop.

After system is balanced, at least on one branch the balancing valve should be fully open.

**Steam Systems Testing, Adjusting and Balancing:**

Steam distribution systems should be balanced by ensuring that the pressure drops are equalized at design flow rates for all portions of the piping system.

The spring-type supply valves equipped with pre-calibrated orifices or orifice flanges could be used to regulate and measure steam flow at appropriate locations throughout the system.

The orifice sizes are determined by the pressure drop required to provide a given flow rate at given location in the system. A schedule should be prepared showing (1) orifice sizes, (2) valve or pipe sizes, (3) required flow rates, and (4) corresponding pressure differentials for each flow rate.

After the appropriate regulating orifices are installed in the proper locations, the system should be tested for tightness by sealing all openings in the system and applying a vacuum of 70kPa (20 in. Hg), held for 2 hours. Then, the system should be prepared for warm-up and pressurizing, with steam following the procedures outlined in countries Boiler and Pressure Vessel Code. After the initial warm-up and system pressurization, system steam flow should be re-evaluated and compared to system requirements.

**Coils Capacity Testing, Adjusting and Balancing:**

Each cooling should be tested for total performance. All coils shall be tested with the design air and water flows through the coil. Test shall not be performed a less than 90 to 95% of design load.

The entering and leaving air temperature shall be simultaneously recorded along with the entering and leaving water temperatures.

At least six temperature probes should be used for testing a chilled water coil:

Entering air dry-bulb temperature;

Entering air wet-bulb temperature;

Leaving air dry-bulb temperature;



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Leaving air wet-bulb temperature;  
Entering chilled water;  
Leaving chilled water.

DX coils require measuring the entering and leaving air temperature.

To compare the test results with specified coil capacity, the test results should be converted to specify conditions.

### **Record and Report Data**

All data obtained during testing, adjusting, and balancing should be recorded in accordance with, and on forms recommended by the referenced standards, and as approved on the sample report forms.

TAB agency shall prepare report of recommendations for correcting unsatisfactory mechanical performance when system cannot be successful balanced.

Based on the balancing report, forms should be finalized by the Engineering Department and attached to the TAB report, Installation Qualification and Validation Protocol.

### **Training**

Test and Balancing Engineer shall train Client's maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures. Review with Client's personnel, the information contained in the Operating and Maintenance Manual.

Training schedule should be made with Client and SPCPL with at least 7 days prior notice.





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***PART – IV***  
**LIST OF DRAWINGS**



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## LIST OF DRAWING

Sr. No.	Drawing No.	Drawing Title
1.	0205/01A	AHU-Wise classification on Ground Floor
2.	0205/01B	AHU-Wise classification on First Floor
3.	0205/09	Electrical Single Line Diagram



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***PART – V***

**LIST OF APPROVED MAKES**





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**B. ELECTRICAL**

<b>Sr.No</b>	<b>Equipments</b>	<b>Makes</b>
1.	Contactor/Overload Relay/ Fuse	Siemens / L & T
2.	Switch Units	Siemens/ Danfoss / ABB
3.	Variable Frequency Drive	Siemens / TEKNIC
4.	Push Button Station	Siemens / L & T
5.	Air Circuit Breaker / Switch Fuse Unit	Siemens / L & T
6.	MCCB	MDS/INDO KOPP/Siemens
7.	MCB	Tecknic/Siemens
8.	Indicating Lamps	Elmex / Connectwell Commet/Dowells
9.	Cables	CCI/UNIVERSAL/INCAB/FINOLEX/ POLYCAB
10.	Terminals	Dowells
11.	Cable Gland	Dowells
12.	Cable Lugs	Dowells



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### **A. LOW SIDE**

No deviation from this list is allowed unless approved during quotation stage:-

<b>Sr.No</b>	<b>Equipments</b>	<b>Makes</b>
1	GI Sheets	Jindal / SAIL
2	AHU's	Carryaire /Citizen/Zeco
3	Motors	Crompton/Bharat Bijlee/Kirloskar / Siemens
4	Pipes	Gujrat tubes/Jindal/TATA
5	Balancing valves	Advance/Tours & Andersen Automech / Sevcon Bell & Gosset / Castle
6	Pressure Gauge	H.Guru/Fiebig/Dwyer
7	MCC components	L&T/Siemens
8	T & RH Sensor	Sauter/ Landies & Stefa/ Honey well/Stachwell
9	Control system	Sauter/ Landies & Stefa/Honey well/ Stachwell
10	Pressure Switches	Sauter/ Landies & Stefa/Honey well/ Stachwell
11	Pre & Fine Filter	Klenzaid's/Pyramid/Camfil/Trox/ Dyna/Airtech
12	HEPA Filter	Klenzaid's/Pyramid/Camfil/Trox/ Dyna/Airtech
13	VCD	Carryaire/Citizen/Cosmos
14	Differential pressure gauge for	
15.1	Individual Room v/s Atmospheric	Magnehellic (Dwyer)
15.2	Diff. Pre. of pre filter	Magnehellic (Dwyer)
15.3	Diff. Pre. of pre filter fine filter	Magnehellic (Dwyer)
16	Blower/fan	Nicota/Kruger
17	Valves	
17.1	Butterfly Valve	Audco / Advance / Inter valve / C&R
17.2	Gate Valve	Leader / Kirloskar / Sant
17.3	Globe Valve	Leader / Kirloskar / Sant
17.4	NRV	Audco / Advance / Inter valve / C&R
17.5	Strainers 'Y' Type	Sant / Emerald/ Trishul
18	Fire Dampers	Carryaire / George Rao



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19	Grills/Diffusers,	Comos /Carryaire/Air products
21	Damper Actuators	Belimo/Sautter/Landies & Stefa/ Honey Well/ Joventa
22	Dehumidifiers	Bry-air

## **B. ELECTRICAL**

<b>Sr.No</b>	<b>Equipments</b>	<b>Makes</b>
2.	Contact/Overload Relay/ Fuse Switch Units	Siemens / L & T
3.	Variable Frequency Drive	Siemens/ Danfoss / ABB
4.	Push Button Station	Siemens / TEKNIC
5.	Air Circuit Breaker / Switch Fuse Unit	Siemens / L & T
6.	MCCB	Siemens / L & T
7.	MCB	MDS/INDO KOPP/Siemens
8.	Indicating Lamps	Tecknic/Siemens
9.	Cables	CCI/UNIVERSAL/INCAB/FINOLEX/ POLYCAB
10.	Terminals	Elmex / Connectwell
11.	Cable Gland	Commet/Dowells
12.	Cable Lugs	Dowells