



भारतीय स्टेट बैंक
State Bank of India

जयपुर
Jaipur

STATE BANK OF INDIA

**REPLACEMENT OF EXISTING 4X120 TR WATER COOLED CENTRAL HVAC PLANT
WITH ENERGY EFFICIENT 3x225 TR MAGNETIC CHILLER CENRALISED AIR-
CONDITIONING PLANT AT STATE BANK OF INDIA, LOCAL HEAD OFFICE, JAIPUR**

TENDER ID - LHOJAI/P&E/2025-26/HVAC

Tender Documents Consisting of :

**NIT, Instruction to Tenderer,
General Conditions of Contract, Articles of Agreement, Technical Specifications,
Approved make and Bill of Quantities**

For

CENTRAL HVAC PLANT WORK

PROJECT CONSULTANTS :

M/s LIMRA CONSULTING ENGINEERS
25T, THIRD FLOOR, SFS FLATS,
SECTOR 7, JASOLA VIHAR, JAMIA NAGAR,
NEW DELHI : 110025
Phon: 011-26946981/9810450857/7703857484
E-mail: limrace@rediffmail.com &

limrace3@gmail.com

Signature of bidder with stamp

GENERAL INDEX

S No	Description	No of Pages
1	Notice Inviting Tender	3 - 5
2	Letter of Undertaking	6 - 8
3	Instructions to the Tenderers	9 - 13
4	General Conditions of Contract	14 - 38
5	Special conditions of contract	39 - 46
6	Technical Specifications	47 - 121
7	List of approved make	122 - 125
8	List of Tender Drawing	Attached

NOTICE INVITING TENDER

M/s Limra Consulting Engineers on behalf of State Bank of India (SBI) invites tender in two bid system from pre-qualified eligible bidders for replacement of existing 4x120 TR water cooled reciprocating chiller plant with Energy Efficient **3x225 TR water cooled oil free magnetic chiller based central HVAC plant** at our Local Head Office, JAIPUR (RAJASTHAN) Details of tenders are as under :

1	Name of Work	Replacement of existing 4x120 TR water cooled reciprocating chiller plant with Energy efficient 3x225 TR water cooled oil free magnetic chiller plant and allied work at Local Head Office, Jaipur (RAJ).
2	Time allowed for completion	120 calendar days from the date of issue of Work Order/ handing over of site.
3	Earnest Money Deposit	Rs. 4,50,000.00 (Rupees four lakhs fifty thousand only) in the form of Bank Draft/Pay Order drawing in favour of “ State Bank of India AGM(P&E), LHO Jaipur ” and payable at Jaipur.
4	Security Deposit	5% of contract value.
5	Additional Security Deposit (ASD)	Additional Security deposit (ASD)/Additional performance Guarantee (APG) shall be applicable if the bid price is below 10% of the estimated cost put to tender. The amount of such ASD/ APG shall be the difference between 90% of estimated cost put to tender and the quoted price.
6	Pre-bid meeting	18.11.2025 @ LHO, Jaipur (Vendor shall submit their queries to be discussed in prebid meeting by 17.11.25 to agmpremises.lhojai@sbi.co.in)
7	Last date and time for submission of EMD in hard copy at LHO, Jaipur.	12.11.2025 to 02/12/2025 Up to 03:00 PM @ AGM(P&E), SBI, LHO, C-Scheme , Near Udyog Bhawan , Jaipur-302005(<u>EMD to be submitted in Hard copy and also uploaded online in the portal</u>)
8	Time period for Submission of Technical & Price Bid	From 12.11.2025 to 02.12.2025 by 03:00 PM at www.tenderwizard.com/SBIETENDER <u>(Duly signed and stamped Technical bid and Price bid on each page to be submitted online at online portal)</u> After evaluation of the tender, L1 bidder shall submit the hard copy of the complete tender document duly

		signed and stamped on each page along with the price bid at LHO, Jaipur)
9	<u>Date and time of opening of tender</u>	Online on 02/12/2025 at 03:30 PM
10	<u>Place of opening tenders</u>	LHO, Jaipur (Online)
11	<u>Defects Liability Period</u>	24 months from the date of completion
12	<u>Validity of offer</u>	90 days from the date of opening of tenders.
13	Liquidated Damages	At the rate of 0.5% of the contract value per week of delay subject to a maximum of 5% of the accepted contract value.
14	Rates	Rates quoted by the bidder shall remain firm throughout the contract period (including variations) taxes, duties, levies, royalties, transportations, labour other incidental charges, WCT etc. PVA & PVA clause shall not be applicable, rates are inclusive of all taxes except GST. GST shall be paid as per Bank's norms.
15	Payment Terms	40% of contract value after receiving of chillers, pumps, motors, AHUs, Colling Tower etc at site, 30% after installation work completed and 30% after successful commissioning of the work and handing over the plant to SBI
16	Working Schedule	The L-1 Bidder has to submit the timelines in the form of PERT Chart and get it approved from Architect/Banks Engineer.
17	Insurance	The contractor shall obtain all necessary insurance policies as per the law applicable at the center and shall be required to produce the original policies and receipts of the premium applicable in the matter to the Bank.
18	Water & Electricity	Water and Electricity shall be provided by the Bank at one point. However, further distribution and extension and light fixtures etc. with required MCB switches. Switch boards, lamp, tube etc shall be arranged by the contractor at their own cost with the accepted tender cost.
19	For e-tender related queries	Service provider: <u>www.tenderwizard.com/SBIETENDER</u> M/s. Antares Systems Limited, Registered Office: #24, Sudha Complex, 3rd Stage, 4thBlock, Bangalore – 560079, Karnataka. Ph.: 080-49352000 / 40482000 Fax:080-49352034

		Contact 1. Mr. Parvej, Mobile No.: +91 9044314492 e-Mail: parvej@antaressystems.com 2. Mr. Kushal Bose, Mobile No.: +91 7686913157, e-Mail: kushal.b@antaressystems.com	Persons:
20	Project Consultant	M/s LIMRA CONSULTING ENGINEERS 25T, THIRD FLOOR, SFS FLATS,SECTOR 7, JASOLA VIHAR, JAMIA NAGAR,NEW DELHI : 110025 Phone: 011-26946981/9810450857/7703857484 E-mail: limrace@rediffmail.com & limrace3@gmail.com	
In case the date of opening of tenders is declared as a holiday, the tender will be opened on the next working day at the same time.			
SBI has the right to accept/reject any/ all tenders without assigning any reasons.			
For any queries, please contact Sh Bhanu Pratap Singh, Chief Manager (Electrical), P& E department, LHO, Jaipur. (8826613205)			

Yours Faithfully,

Astt General Manager(P&E),
State Bank of India,
LHO, C-Scheme ,
Near Udyog Bhawan ,
Jaipur-302005

LETTER OF UNDERTAKING

The Asstt General Manager,
State Bank of India,
LHO, Jaipur

Dear Sir,

Having examined the drawings, specification, design and schedule of quantities relating to the works specified in the memorandum hereinafter set out and having visited and examined the site of the works specified in the said memorandum and having acquired the requisite information relating thereto as affecting the tender, I/We hereby offer to execute the works specified in the said memorandum at the rates mentioned in the attached Schedule of Quantities and in accordance in all respects with the specifications, design, drawings and instructions in writing referred to in conditions of tender, the Articles of Agreement, Special Conditions, Schedule of Quantities and Conditions of Contract and with such materials as are provided for by, and in all other respects in accordance with such conditions so far as they may be applicable.

MEMORANDUM

Description of work	Replacement of existing 4x120 TR water cooled reciprocating chiller plant with Energy efficient 3x225 TR water cooled oil free magnetic chiller plant and allied work at Local Head Office, Jaipur (RAJ).
Earnest Money	Rs. 4,50,000.00 (Rupees four lakhs fifty thousand only) in the form of Bank Draft/Pay Order drawing in favour of “ State Bank of India AGM(P&E), LHO Jaipur ” and payable at Jaipur.
Time Allowed for Completion	120 calendar days from the date of issue of Work Order/ handing over of site.

1) Should this tender be accepted, I/we hereby agree to abide by and fulfill the terms and provisions of the said conditions of contract annexed hereto so far as may be applicable or in default thereof to forfeit and pay to SBI, the amount mentioned in the said contract.

2) I / We have deposited a sum of **Rs. 4,50,000.00 (Rupees four lakhs fifty thousand only)** of the total tender amount as Earnest Money with the SBI which amount is not to bear any interest. Should I / We fail to execute the Contract when called upon to do so I / We do hereby agree that this sum shall be forfeited by me/us to SBI ,

Signature of bidder with stamp

3) I/ We have read and understood various clauses of this tender and hereby submit our specific undertaking and concurrence in terms clause 6.2 of "Instruction to tenderer" to deposit Additional Security Deposit (ASD) of required amount as provided for in this tender and within the stipulated period, in case, my/our tender is found too low (i.e. beyond 10% of the estimated cost), as a performance guarantee for due fulfilment of our contractual obligation for the project.

Further, under any circumstances, whatsoever, if I/We fail to comply the same including compliance of any such other conditions of tender within the stipulated time. I /We hereby, authorized SBI to cancel my/Our tender, to forfeit my EMD/ISD/ASD and to take further necessary action as deemed fit including debarring our firm from participating in SBI future tenders/de-paneling etc.

4) I/ We understand that as per terms of this tender, the SBI may consider accepting our tender in part or whole or may entrust the various work proposed in phases. We, therefore, undertake that we shall not raise any claim/ compensation in the eventuality of Bank deciding to drop any of the work from the scope of work of this tender at any stage during the contract period. Further, we also undertake to execute the work entrusted to us in phases on our approved rates and within stipulated time limit without any extra claim for price escalation as also provided for in the clause 11.1.6 "Instructions to Tenderers" of this tender.

5) I/ We, hereby, also undertake that, we will not raise any claim for any escalation in the prices of any of the material during the currency of contract/execution/completion period including authorized extended contract period, if any.

6) Our Bankers are:

i)

ii)

The names of partners of our firm are:

i)

ii)

Name of the partner of the firm

Authorised to sign

Or

(Name of person having Power of

Signature of bidder with stamp

Attorney to sign the Contract.

(Certified true copy of the Power
of Attorney should be attached)

Yours faithfully,

Signature of Contractors.

Signature and addresses of Witanesse

i)

ii)

Signature of Contractor with Seal

Signature of bidder with stamp

INSTRUCTIONS TO THE TENDERERS

1.0 Scope of Work

Replacement of existing 4x120 TR central AC plant with 3 x 225 TR magnetic chiller plant at Local Head Office, Jaipur. Details of activities under scope of work covered are as under:

- a) Dismantling of 4 nos reciprocating 120 TR Reciprocating chillers with slip ring induction motors, 2 nos cooling tower, 3 nos chilled water pumps, 3 nos condenser water pumps, old MS 6"/8"/10"/12" chilled water condenser water pipelines with Valves, cables, wires or any other equipment connected with the plant as per on site basis .
- b) SITC of 3x225 TR, water cooled magnetic chiller with VFD and active harmonic filters based central AC plant as per BOQ.
- c) SITC 2 nos 275 TR cooling towers with side stream filtration system as per BOQ
- d) SITC of chilled water pumps in the primary and secondary circuits as per BOQ
- e) SITC of condenser water pumps as per BOQ
- f) Replacement of 10 nos AHU as per BOQ.
- g) Replacement of old MS pipe lines connecting these AHUs.
- h) SITC of valves as per BOQ
- i) Minor GI duct work as per site requirement.
- j) Acoustic work as per BOQ

Electrical panel work, cabling up to VFD and RCC/PCC foundation for chiller/pump/CT/expansion shall be provided by Bank as per GAD (General arrangement drawings)

1.1 Site and Its Location

The proposed work is to be carried out at State Bank of India, Local Head Office Jaipur (Rajasthan).

2.0 Tender Documents

- 2.1 The work has to be carried out strictly according to the conditions stipulated in tender consisting the following documents and the most workman like manner,

Instructions to tenderers
General Conditions of Contract
Special Conditions of Contract
Technical Specifications
Drawings
Priced Bid

2.2 The above documents shall be taken as complementary and mutually explanatory of one another but in case of ambiguities or discrepancies, shall take precedence in the order given below :

- a) Price Bid
- b) Technical Specifications
- c) Instructions to Tenderers
- d) Special Conditions of Contract
- e) General Conditions of Contract

2.3 Complete set of tender documents including relative drawings can be downloaded from the Bank's e-tender portal. The process involves vendor's registration with e-tender portal which is free of cost. Only after registration, the vendor(s) can submit his/their bids electronically. Electronic Bidding for submission of indicative price bid and e-reverse auction will be done over the internet. The Vendor should have valid Digital Signature Certificate (DSC). Vendors are to make their own arrangement for bidding from a PC connected with Internet.

2.4 The tender documents are not transferable.

3.0 Site Visit

3.1 The tenderer must obtain and on his own responsibility and expenses all information and data which may be required for the purpose of filling this tender document and enter into a contract for the satisfactory performance of the work. The Tenderer is requested to satisfy himself regarding the availability of water, power, transport and communication facilities, the character quality and quantity of the materials, labour, the law and order situation, climatic conditions local authorities requirement, traffic regulations etc;

The tenderer will be fully responsible for considering the financial effect of any or all the factors while submitting his tender.

4.0 Earnest Money

4.1 The tenderers are requested to submit the Earnest Money of **Rs. 4.5 lakh in the** form of Demand Draft or Banker's Cheque in favour of State Bank of India drawn on any nationalised Bank in India.

4.2 EMD in any other form other than as specified above will not be accepted. Tender not accompanied by the EMD in accordance with clause 4.1 above shall be rejected.

- 4.3 No interest will be paid on the EMD.
- 4.4 EMD of unsuccessful tenderers will be refunded within 30 days of award of Contract.
- 4.5 EMD of successful tenderer will be retained as a part of security deposit.

5.0 Initial Security Deposit

The successful tenderer will have to submit a sum equivalent to **2% of contract value** less EMD by means of D/D drawn in favour of State Bank of India within a period of 15 days of acceptance of tender.

No interest shall be paid to the amount retained by the SBI as Security Deposit.

6.0 Security Deposit /Retention Money

- 6.1 Total security deposit shall be **5% of contract value**. Out of this 2% of contract value is in the form of initial security deposit which includes the EMD. Balance 1% shall be deducted from the running account bill of the work at the rate of 10% of the respective running account bill i.e. deduction from each running bill account will be 10% till total 3% of contract value is reached. 50% of the total security shall be paid to the contractors on the basis of consultant's certifying the virtual completion. The balance 50% would be paid to the contractors after the defects liability period as specified in the contract. **No interest shall be paid to the amount retained by the Bank as Security Deposit.**

6.2 Additional Security Deposit:

Additional Security deposit (ASD)/Additional performance Guarantee (APG) shall be applicable if the bid price is below 10% of the estimated cost put to tender. The amount of such ASD/ APG shall be the difference between 90% of estimated cost put to tender and the quoted price.

7.0 Signing of Contract Documents

The successful tenderer shall be bound to implement the contract by signing an agreement and conditions of contract attached herewith within 15 days from the receipt of intimation of acceptance of his tender by the Bank. However, the written acceptance of the tender by the Bank will constitute a binding agreement between the Bank and successful tenderer whether such formal agreement is subsequently entered into or not.

8.0 Completion Period

Time is essence of the contract. The work should be completed in all respects in accordance with the terms of contract within a period of **120 calendar days** (3 months for delivery of chiller machine at site including factory test and 1 month for installation and commissioning) from the date of award of work.

9.0 Validity of Tender

Tenders shall remain valid and open for acceptance for a period of 3 (Three) months from the date of opening price bid. If the tenderer withdraws his/her offer during the validity period or makes modifications in his/her original offer which are not acceptance to the Bank without prejudice to any other right or remedy the Bank shall be at liberty to forfeit the EMD.

10.0 Liquidated Damages

The liquidated damages shall be 0.5% per week subject to a maximum of 5% of contract value.

11.0 Rates and Prices

11.1 In case of item rate tender

11.1.1 The tenderers shall quote their rates for individual items both in words and figures in case of discrepancy between the rate quoted in words and figures the unit rate quoted in words will prevail. If no rate is quoted for a particular item the contractor shall not be paid for that item when it is executed.

11.1.2 The tenderers need not quote their rates for which no quantities have been given. In case the tenderers quote their rates for such items those rates will be ignored and will not be considered during execution.

11.1.3 The tenderers should not change the units as specified in the tender. If any unit is changed the tenders would be evaluated as per the original unit and the contractor would be paid accordingly.

The tenderer should not change or modify or delete the description of the item. If any discrepancy is observed he should immediately bring to the knowledge of the Consultant/Bank.

11.1.4 Each page of the BOQ shall be signed by the authorized person and cutting or overwriting shall be duly attested by him.

11.1.5 Each page shall be totaled and the grand total shall be given.

- 11.1.6 The rate quoted shall be firm and shall include all costs, allowances, taxes, VAT, levies, etc but excluding GST/Service Tax, which will be paid to the contractor separately on submission of Bill/Documents for onward payment to the Government Service Tax Department.

12.0 Warranty/Defect Liability period and Annual Comprehensive Maintenance Service.

The equipment's supplied & installed i.e. the entire work, shall be warrantied against all types of defects for a period of **two year** from the date of handing over of the equipment to the Bank. Any defects found in the system/sub-assemblies within the guarantee period shall be rectified / replaced by the tenderer free of cost. During this period, servicing at quarterly interval or earlier, as prescribed by the manufacturer and as mutually agreed to, shall be carried out free-of-cost

The tenderers shall also quote their charges for providing all-inclusive **comprehensive maintenance service** applicable after the expiry of the **two-year** guarantee period. Preventive maintenance should include all the activities as recommended by the OEM including topping up the refrigerant, filters cleaning etc. It may be noted by the tenderers that the Bank will not provide any kind of assistance in the form of man/material/transport etc and the tenderers will have to make their own arrangements for deputing the required skilled manpower including all necessary spares for setting right the reported/observed defects.

The quoted comprehensive AMC rate shall remain firm and valid for a period of one years from the date of expiry of warranty period without any escalation. The AMC shall be renewed annually. At the time of renewal of contract after the expiry of the initial contract period of one year and for all subsequent years, the new contract amount will be arrived at based on IEEMA formula applicable.

Payment for AMC shall be on half yearly basis on rendering satisfactory service. During the period of contract, the system shall be serviced and maintained as per frequency described in the contract agreement for AMC to ensure that all the system equipment's are functioning normally and satisfactorily. The routine maintenance shall also include cleaning of all equipment's. If the fault is not rectified within 24 hours of lodging a complaint with the firm either by an e-mail or over telephone, a penalty at the rate of ₹. 2000/- per day or part thereof will be levied and shall be payable by the contractor on demand or shall be recovered from any dues payable by the Bank to the contractor

13. Evaluation of Tenders: The tenders shall be evaluated not only on the basis of capital cost in BOQ but also taking into account the effect of rates quoted for comprehensive service/maintenance contract for a period of 1 years after the expiry of two-year defects liability/ guarantee period and buy-back cost of existing plant machinery. After one Year AMC shall be given on the basis of IEEMA /PVA formula as decided by the Bank.

GENERAL CONDITIONS OF CONTRACT

1.0 Definitions

“Contract” means the documents forming the tender and the acceptance thereof and the formal agreement executed between State Bank of India (Client) and the contractor, together with the documents referred therein including these conditions, the specifications, designs, drawings and instructions issued from time to time by the consultants /Bank and all these documents taken together shall be deemed to form one contract and shall be complementary to one another.

1.1 In the contract the following expressions shall, unless the context otherwise requires, have the meaning hereby respectively assigned to them.

1.1.1 ‘SBI’ shall mean State Bank of India (client) a body Corporate established under State Bank of India Act 1955, having its Corporate Centre at State Bank Bhavan, Madame Cama Road, Mumbai 400 021 and of its Local Head Office(LHO) at Jaipur and includes the client’s representatives, successors and assigns.

‘Consultants’ shall mean **M/s LIMRA Consulting Engineers, 25T, Third floor, SFS flats, sector-7, Jasola Vihar, Jamia Nagar, New Delhi - 110 025.**

1.1.2 ‘Site Engineer’ shall mean an Engineer appointed by the Bank as their representative to give instructions to the contractors.

1.1.3 ‘The Contractor’ shall mean the individual or firm or company whether incorporated or not, undertaking the works and shall include legal personal representative of such individual or the composing the firm or company and the permitted assignees of such individual or firms of company.

The expression ‘works’ or ‘work’ shall mean the permanent or temporary work described in the ‘Scope of Work” and/or to be executed in accordance with the contract and includes materials, apparatus, equipment, temporary supports, fittings and things of all kinds to be provided, the obligations of the contractor hereunder and work to be done by the contractor under the contract.

1.1.4 ‘Engineer’ shall mean the Bank’s Engineer.

1.1.5 ‘Drawings’ shall mean the drawings prepared by the consultant.
Contract value shall mean the value of the entire work as stipulated in the letter of acceptance of tender subject to such additions thereto or deductions there from as may be made under the provision herein after contained.

1.1.6 'Specifications' shall mean the specifications referred to in the tender and any modifications thereof as may time to time be furnished or approved by the consultant "Month" means calendar month.

1.1.7 "Week" means seven consecutive days.

1.1.8 "Day" means a calendar day beginning and ending at 00 Hrs and 24 hrs respectively.

Total Security deposit **5%** contract value and comprise of :

- a) Earnest Money Deposit
- b) Initial Security Deposit
- c) Retention Money

2.0 Scope of Work

The contractor shall carry out, complete and maintain the said work in every respect strictly in accordance with this contract and with the directions of and to the satisfaction of the Bank to be communicated through the consultant. The consultant at the directions of the Bank from time to time issue further drawings and/or written instructions, details directions and explanations which are hereafter collectively referred to as Consultant's instructions in regard to : the variation or modification of the design, quality or quantity of work or the addition or omission or substitution of any work, any discrepancy in the drawings or between the BOQ and/or drawings and/or specifications, the removal from the site of any material brought thereon by the contractor and the substitution of any other materials thereof, the demolition, removal and/or re-execution of any work executed by him, the dismissal from the work of any person employed/engaged thereupon.

3.0 Letter of Acceptance

Within the validity period of the tender the Bank shall issue a letter of acceptance either directly or through the consultant by registered post or otherwise depositing at the address of the contractor as given in the tender to enter into a Contract for the execution of the work as per the terms of the tender. The letter of acceptance shall constitute a binding contract between the SBI and the contractor.

4.0 Contract Agreement

On receipt of intimation of the acceptance of tender from the SBI/consultant the successful tenderer shall be bound to implement the contract and within fifteen days thereof he shall sign an agreement in a non-judicial stamp paper of appropriate value.

6.0 Ownership of drawings

All drawings, specifications and copies thereof furnished by the SBI through its consultants are the properties of the SBI. They are not to be used on other work.

7.0 Detailed drawings and instructions

The SBI through its consultants shall furnish with reasonable promptness additional instructions by means of drawings or otherwise necessary for the proper execution of the work. All such drawings and instructions shall be consistent with the contract documents, true developments thereof and reasonably inferable therefrom.

The work shall be executed in conformity therewith and the contractor prepare a detailed programme schedule indicating therein the date of start and completion of various activities on receipt of the work order and submit the same to the SBI through the Consultant.

8.0 Copies of Agreement

Two copies of agreement/tender document duly signed by both the parties with the drawings shall be handed over to the contractors.

9.0 Liquidated Damages

If the contractor fails to maintain the required progress in terms of clause 30 of GCC or to complete the work and clear the site including vacating their office on or before the contracted or extended date or completion without justification in support of the cause of delay, he may be called upon without prejudice to any other right of remedy available under the law to the SBI on account of such breach to pay a liquidated damages at the rate of 0.5% of the contract value per week subject to a maximum of 5% of the contract value.

10.0 Materials, Appliances and Employees

Unless or otherwise specified the contractor shall provide and pay for all materials, labour, water, power, tools, equipment transportation and any other facilities that are required for the satisfactory execution and completion of the work. Unless or otherwise specified all materials shall be new and both workmanship and materials shall be best quality. The contractor shall at all times enforce strict discipline and good order among his employees and shall not employ on the work any unfit person or anyone not skilled in the work assigned to him. Workman whose work or behavior is found to be unsatisfactory by the SBI/Consultant he shall be removed from the site immediately.

11.0 Permits, Laws and Regulations

Permits and licenses required for the execution of the work shall be obtained by the contractor at his own expenses. The contractor shall give notices and comply with the regulations, laws, and ordinances rules, applicable to the contractor. If the contractor observes any discrepancy between the drawings and specifications, he shall promptly notify the SBI in writing under intimation of the Consultant. If the contractor performs any act which is against the law, rules and regulations he shall meet all the costs arising therefrom and shall indemnify the SBI any legal actions arising there from.

12.0 Setting out Work

The contractor shall set out the work and shall be responsible for the true and perfect setting out of the same and for the correctness of the positions, levels, dimensions, and alignment of all parts thereof and get it approved by the consultant

Before proceeding with the work. If at any time any error in this respect shall appear during the progress of the works, irrespective of the fact that the layout had been approved by the consultant the contractor shall be responsible for the same and shall at his own expenses rectify such error, if so, required to satisfaction of the SBI.

13.0 Protection of works and property

The contractor shall continuously maintain adequate protection, of all his work from damage and shall protect the SBI's properties from injury or loss arising in connection with contract. He shall make good any such damage, injury, loss due to his fault or negligence except which are due to causes beyond his control.

He shall take adequate care and steps for protection of the adjacent properties. The contractor shall take all precautions for safety and protection of his employees on the works and shall comply with all applicable provisions of Government and local bodies safety laws and building codes to prevent accidents, or injuries to persons or property of about or adjacent to his place of work. The contractor shall take insurance covers as per clause 24.0 at his own cost. The policy may taken in joint names of the contractors and the SBI and the original policy may be lodged with the SBI.

14.0 Inspection of Work

The SBI/Consultant or their representatives shall at all reasonable time have free access to the work site and/or to the workshop, factories or other places where materials are lying or from where they are obtained and the contractor shall give every facility to the SBI, Consultant and their representatives necessary for inspection and examination and test of the materials and workmanship. No person unless authorized by the SBI/Consultant except the representative of Public authorities shall be allowed on the work at any time. The proposed work either during its construction stage or its completion can also be inspected by the Chief Technical Examiner's organization a wing of Central Vigilance Commission.

15.0 Assignment and subletting

The whole of work included in the contract shall be executed by the contractor and he shall not directly entrust and engage or indirectly transfer assign or underlet the contract or any part or share thereof or interest therein without the written consent of the SBI through the Consultant and no undertaken shall relieve the contractor from the responsibility of the contractor from active superintendence of the work during its progress.

16.0 Quality of Materials, Workmanship & Test

All materials and workmanship shall be best of the respective kinds described in the contract and in accordance with Consultant instructions and shall be subject from time to time to such tests as the consultant may direct at the place of manufacture or fabrication or on the site or an approved testing laboratory. The contractor shall provide such assistance, instruments, machinery, labor and materials as are normally required for examining measuring sampling and testing any material or part of the work before incorporation in the work for testing as may be selected and required by the Consultant. Factory Test/site test provided for in the specifications or BOQ

17.0 Obtaining Information related to execution of work

No claim by the contractor for additional payment shall be entertained which is consequent upon failure on his part to obtain correct information as to any matter affecting the execution of the work nor any misunderstanding or the obtaining incorrect information or the failure to obtain correct information relieve him from any risks or from the entire responsibility for the fulfillment of contract.

18.0 Contractor's superintendence

The contractor shall give necessary personal superintendence during the execution of the works and as long, thereafter, as the consultant may consider necessary until the expiry of the defects liability period, stated hereto.

19.0 Quantities

- i) The bill of quantities (BOQ) unless or otherwise stated shall be deemed to have been prepared in accordance with the Indian Standard Method of Measurements and quantities. The rate quoted shall remain valid for variation of quantity against individual item to any extent subject to maximum variation of the contract value by 25%. All the amount paid under Clause 20 hereof as well as amounts of prime cost and provisional sums, if any, shall be excluded.

- ii) Variation exceeding 25% : The items of work executed in relation to variation exceeding 25% shall be paid on the basis of provisions of clause 22(e) hereof.

20.0 Works to be measured

The Consultant may from time to time intimate to the contractor that he required the work to be measured and the contractor shall forthwith attend or send a qualified representative to assist the consultant in taking such measurements and calculation and to furnish all particulars or to give all assistance required by any of them. Such measurements shall be taken in accordance with the Mode of measurements detailed in the specifications. The representative of the Consultant and Bank shall take joint measurements with the contractor's representative and the measurements shall be entered in the measurement book. The contractor or his authorized representative shall sign all the pages of the measurement book in which the measurements have been recorded in token of his acceptance. All the corrections shall be duly attested by both representatives. No over writings shall be made in the M book. Should the contractor not attend or neglect or omit to depute his representative to take measurements then the measurements recorded by the representative of the consultant shall be final. All authorized extra work, omissions and all variations made shall be included in such measurements.

21.0 Variations

No alteration, omission or variation ordered in writing by the Consultant shall vitiate the contract. In case the Consultant thinks proper at any time during the progress of works to make any alteration in, or additions to or omission from the works or any alteration in the kind or quality of the materials to be used therein, the Consultant shall give notice thereof in writing to the contractor or shall confirm in writing within seven days of giving such oral instructions the contractor shall alter to, add to, or omit from as the case may be in accordance with such notice but the contractor shall not do any work extra to or make any

alteration or additions to or omissions from the works or any deviation from any of the provisions of the contract, stipulations, specifications or contract drawings without previous consent in writing of the Consultant and the value of such extras, alterations, additions or omissions shall in all cases be determined by the Consultant and the same shall be added to or deducted from the contract value, as the case may be.

22.0 Valuation of Variations

No claim for an extra shall be allowed unless it shall have been executed under the authority of the Consultant with the concurrence of the SBI as herein mentioned. Any such extra is herein referred to as authorized extra and shall be made in accordance with the following provisions.

- a)
 - i) The net rates or prices in the contract shall determine the valuation of the extra work where such extra work is of similar character and executed under similar conditions as the work priced herein.
 - ii) Rates for all items, wherever possible should be derived out of the rates given in the priced BOQ.
- b) The net prices of the original tender shall determine the value of the items omitted, provided if omissions do not vary the conditions under which any remaining items of works are carried out, otherwise the prices for the same shall be valued under sub clause (c) hereunder.
- c) Where the extra works are not of similar character and/or executed under similar conditions as aforesaid or where the omissions vary the conditions under which any remaining items or works are carried out, then the contractor shall within 7 days of the receipt of the letter of acceptance inform the Consultant of the rate which he intends to charge for such items of work, duly supported by analysis of the rate or rates claimed and the Consultant shall fix such rate or prices as in the circumstances in his opinion are reasonable and proper, based on the market rate.
- d) Where extra work cannot be properly measured or valued the contractor shall be allowed day work prices at the net rates stated in the tender of the BOQ or, if not, so stated then in accordance with the local day work rates and wages for the district; provided that in either case, vouchers specifying the daily time (& if required by the Consultant) the workman's name and materials employed be delivered for verifications to the consultant at or before the end of the week following that in which the work has been executed.
- e) It is further clarified that for all such authorized extra items where rates cannot be derived from the tender, the contractor shall submit rates duly supported by rate analysis worked on the "market rate basis" for material, labour, hire/running charges of equipment & wastages etc plus 15% towards establishment charges, contractor's overheads & profit. Such items shall not be eligible for escalation.

23.0 Final Measurement

The measurement and valuation in respect of the contract shall be completed within six months of the virtual completion of the work.

24.0 Virtual Completion Certificate (VCC)

On successful completion of entire works covered by the contract to the full satisfaction of the SBI, the contractor shall ensure that the following works have been completed to the satisfaction of the SBI.

- a) Clear the site of all scaffolding, wiring, pipes, surplus materials, contractor's labour, equipment and machinery.
- b) Demolish, dismantle and remove the contractor's site office, temporary works, structures including labour sheds/camps and constructions & other items and things whatsoever brought upon or erected at the site or any land allotted to the contractor by the SBI and not incorporated in the permanent works.
- c) Remove all rubbish, debris etc from the site and the land allotted to the contractor by the SBI and shall clear, level and dress, compact the site as required by the SBI.
- d) Shall put the SBI in undisputed custody and possession of the site and all land allotted by the SBI.
- e) Shall hand over the work in a peaceful manner to the SBI.
- f) All defects/imperfections have been attended and rectified as pointed out by the SBI to the full satisfaction of SBI.

Upon the satisfactory fulfillment by the contractor as stated above, the contractor shall be entitled to apply to the Consultant for the certificate. If the Consultant is satisfied of the completion of the work, relative to which the completion certificate has been sought, the Consultant shall within fourteen (14) days of the receipt of the application for virtual completion certificate, issue a VCC in respect of the work for which the VCC has been applied.

This issuance of a VCC shall be without prejudice to the SBI's rights and contractor's liabilities under the contract including the contractor's liability for defects liability period nor shall the issuance of VCC in respect of the works or work at any site be construed as a waiver of any right or claim of the SBI against the contractor in respect of works or work at the site & in respect of which the VCC has been issued.

25.0 Work by other agencies

The SBI/Consultant reserves the rights to use premises and any portion of the site for execution of any work not included in the scope of this contract which it may desire to have carried out by other persons simultaneously and the contractor shall not only allow but also extend reasonable facilities for the execution of such work. The contractor however shall not be required to provide any plant or material for the execution of such work except by special arrangement with the SBI. Such work shall be carried out in such manners not to impede the progress of the works included in the contract.

26.0 Insurance of Works

26.1 Without limiting his obligations and responsibilities under the contract the contractor shall insure in the joint names of the SBI and the contractor against all loss or damages from whatever cause arising other than the excepted risks, for which he is responsible under the terms of contract and in such a manner that the SBI and contractor are covered for the period stipulated in clause 28 of GCC and are also covered during the period of maintenance for loss or damage arising from a cause, occurring prior to the commencement of the period of maintenance and for any loss or damage occasioned by the contractor in the course of any operations carried out by him for the purpose of complying with his obligations under clause.

- a) The works for the time being executed to the estimated current Contract value thereof, or such additional sum as may be specified together with the materials for incorporation in the works at their replacement value.
- b) The constructional plant & other things brought on to the site by the contractor to the replacement value of such constructional plant & other things.
- c) Such insurance shall be effected with an insurer and in terms approved by the SBI which approval shall not be unreasonably withheld and the contractor shall whenever required produce to the Consultant the policy of insurance and the receipts for payment of the current premiums.

26.2 Damage to persons and property

The contractor shall, except if and so far as the contract provides otherwise indemnify the SBI against all losses and claims in respect of injuries or damages to any person or material or physical damage to any property whatsoever which may arise out of or in consequence of the execution and maintenance of the works and against all claims proceedings, damages,

costs, charges and expenses whatsoever in respect of or in relation thereto except any compensation of damages for or with respect to :

- a) The permanent use or occupation of land by or any part thereof.
- b) The right of SBI to execute the works or any part thereof, on, over, under, in or through any lands.
- c) Injuries or damages to persons or properties which are unavoidable result of the execution or maintenance of the works in accordance with the contract.
- d) Injuries or damage to persons or property resulting from any act or neglect of the SBI, their agents, employees or other contractors not being employed by the contractor or in respect of any claims, proceedings, damages, costs, charges and expenses in respect thereof or in relation thereto or where the injury or damage was contributed to by the contractor, his servants or agents such part of the compensation as may be just and equitable having regard to the extent of the responsibility of the SBI, their employees, or agents or other employees, or agents or other contractors for the damage or injury.

26.3 Contractor to indemnify SBI

The contractor shall indemnify the SBI against all claims, proceedings, damages, costs, charges and expenses in respect of the matters referred to in the provision sub-clause 26.2 of this clause.

26.4 Contractor's superintendence

The contractor shall fully indemnify and keep indemnified the SBI against any action, claim, or proceeding relating to infringement or use of any patent or design or any alleged patent or design rights and shall pay any royalties which may be payable in respect of any article or part thereof included in the contract. In the event of any claim made under or action brought against SBI in respect of such matters as aforesaid the contractor shall be immediately notified thereof and the contractor shall be at liberty, at his own expenses to settle any dispute or to conduct any litigation that may arise there from, provided that the contractor shall not be liable to indemnify the SBI if the infringement of the patent or design or any alleged patent or design right is the direct result of an order passed by the Consultant in this behalf.

26.5 Third Party Insurance

26.5.1 Before commencing the execution of the work the contractor but without limiting his obligations and responsibilities under clause 26.0 of GCC shall insure against his liability for any material or physical damage, loss, or injury which may occur to any property including that of SBI, or to any person, including any employee of the SBI, by or arising out of the execution of the works or in the carrying out of the contract, otherwise than due to the matters referred to in the provision to clause 26.0 thereof.

26.5.2 Minimum Amount of Third Party Insurance

Such insurance shall be effected with an insurer and in terms approved by the SBI which approval shall not be reasonably withheld and for at least the amount stated below. The contractor shall, whenever required, produce to the Consultant the policy or policies of insurance cover and receipts for payment of the current premiums.

26.5.3 The minimum insurance cover for physical property, injury, and death is Rs.5.0 lacs per occurrence with the number of occurrences limited to four. After each occurrence contractor will pay additional premium necessary to make insurance valid for four occurrences always.

26.6 Accident or Injury to Workmen

26.6.1 The SBI shall not be liable for or in respect of any damages or compensation payable at law in respect or in consequence of any accident or injury to any workmen or other person in the employment of the contractor or any sub-contractor, save and except an accident or injury resulting from any act or default of the SBI or their agents, or employees. The contractor shall indemnify and keep indemnified SBI against all such damages and compensation, save and except as aforesaid and against all claims, proceedings, costs, charges and expenses whatsoever in respect thereof or in relation thereto.

26.6.2 Insurance against accidents etc to workmen

The contractor shall insure against such liability with an insurer approved by the SBI during the whole of the time any person employed by him on the works and shall, when required, produce to the consultant such policy of insurance and receipt for payment of the current premium. Provided always that, in respect of any persons employed by any sub-contractor the contractor's obligation to insure as aforesaid under this sub-clause shall be satisfied if the sub contractor shall have insured against the liability in respect of such persons in such manner that SBI is indemnified under the policy but the contractor shall require such sub-contractor to produce to the Consultant when required such policy of insurance and the receipt for the payment of the current premium.

26.6.3 Remedy on Contractor's failure to insure

If the contractor fails to effect and keep in force the insurance referred to above or any other insurance which he may be required to effect under the terms of contract, then and in any such case the SBI may effect and keep in force any such insurance and pay such premium or premiums as may be necessary for that purpose and from time to time deduct the amount so paid by the SBI as aforesaid and also deduct 15% of contract value from any amount due or which may become due to the contractor, or recover the same as debt from the contractor.

- 26.6.4 Without prejudice to the other rights of the SBI against contractors, in respect of such default, the employer shall be entitled to deduct from any sums payable to the contractor the amount of any damages costs, charges, and other expenses paid by the SBI and which are payable by the contractors under this clause. The contractor shall upon settlement by the insurer of any claim made against the insurer pursuant to a policy taken under this clause, proceed with due diligence to rebuild or repair the works destroyed or damaged. In this event all the monies received from the insurer in respect of such damage shall be paid to the contractor and the contractor shall not be entitled to any further payment in respect of the expenditure incurred for rebuilding or repairing of the materials or goods destroyed or damaged.

27.0 Commencement of Works

The date of commencement of the work will be reckoned as the recorded date of handing over site by the SBI or 15 days from the date of issue of Letter of Acceptance of Bank, whichever is later.

28.0 Time for completion

Time is the essence of the contract and shall be strictly observed by the contractor. The entire work shall be completed within a period of **120 calendar days** from the date of commencement. If required in the contract or as directed by the Consultant, the contractor shall complete certain portions of work before completion of the entire work. However the completion date shall be reckoned as the date by which the whole work is completed as per the terms of the contract.

29.0 Extension of Time

If, in the opinion of the Consultant, the work be delayed for reasons beyond the control of the contractor, the Consultant may submit a recommendation to the SBI to grant a fair and reasonable extension of time for completion of work as per the terms of contract. If the contractor needs an extension of time for the completion of work or if the completion of work is likely to be delayed for any reasons beyond the due date of completion as stipulated in the contract, the contractor shall apply to the SBI through the Consultant in writing at least 30 days before the expiry of the scheduled time and while applying for extension of time he shall furnish the reasons in detail and his justification if any, for the delays. The consultant shall submit their recommendations to the SBI in the prescribed format for granting extension of time. While granting extension of time the contractor shall be informed the period extended time which will qualify for levy of liquidated damages. For the balance period in excess of original stipulated period and duly sanctioned extension of time by the SBI the provision of liquidated damages as stated under clause 9 of GCC shall become applicable. Further contract shall remain in force even for the period beyond the due date of completion irrespective whether the extension is granted or not.

30.0 Rate of progress

Whole of the materials, plant and labour to be provided by the contractor and the mode, manner and speed of execution and maintenance of the works are to be of a kind and conducted in a manner to the satisfaction of the Consultant. Should the rate of progress of the work or any part thereof be at any time be in the opinion of the Consultant too slow to ensure the completion of the whole of the work by the prescribed time or extended time for completion the Consultant shall thereupon take such steps as considered necessary by the Consultant to expedite progress so as to complete the woks by the prescribed time or extended time. Such communications from the Consultant neither shall relieve the contractor from fulfilling obligations under the contract nor he will be entitled to raise any claims arising out of such directions.

31.0 Work during nights and holidays

Subject to any provision to the contrary contained in the contract no permanent work shall save as herein provided be carried on during the night or on holidays without the permission in writing of the Consultant, save when the work is unavoidable or absolutely necessary for the saving of life or property or for the safety of the work in which case the contractor shall immediately advise the Consultant. However the provision of the clause shall not be applicable in the case of any work which becomes essential to carry by rotary or double shifts in order to achieve the progress and quality of the part of the works being technically required/continued with the prior approval of the consultant at no extra cost to the SBI.

All work at night after obtaining approval from competent authorities shall be carried out without unreasonable noise and disturbance.

32.0 No compensation for restrictions of work

If at any time after acceptance of the tender SBI shall decide to abandon or reduce the scope of work for any reason whatsoever and hence not require the whole or any part of the work to be carried out, the Consultant shall give notice in writing to that effect to the contractor and the contractor shall act accordingly in the matter. The contractor shall have no claim to any payment of compensation or otherwise whatsoever, on account of any profit or advantage which he might have derived from the execution of the work fully but which he did not derive in consequence of the foreclosure of the whole or part of the work.

Provided that the contractor shall be paid the charges on the cartage only of materials actually and bonafide brought to the site of the work by the contractor and rendered surplus as a result of the abandonment, curtailment of the work or any portion thereof and then taken back by the contractor, provided however that the Consultant shall have in such cases the option of taking over all or any such materials at their purchase price or a local current rate whichever is less.

In case of such stores having been issued from SBI stores and returned by the contractor to stores, credit shall be given to him at the rates not exceeding those at which were originally issued to the contractor after taking into consideration and deduction for claims on account of any deterioration or damage while in the custody of the contractor and in this respect the decision of Consultant shall be final.

33.0 **Suspension of work**

- i) The contractor shall, on receipt of the order in writing of the Consultant (whose decision shall be final and binding on the contractor) suspend the progress of works or any part thereof for such time and in such manner as Consultant may consider necessary so as not cause any damage or injury to the work already done or endanger the safety thereof for any of following reasons.
 - a) On account any default on the part of the contractor, or
 - b) For proper execution of the works or part thereof for reasons other than the default of the contractor, or
 - c) For safety of the works or part thereof.

The contractor shall, during such suspension, properly protect and secure the works to the extent necessary and carry out the instructions given in that behalf by the Consultant.

- ii) If the suspension is ordered for reasons (b) and (c) in sub-para (i) above :

The contractor shall be entitled to an extension of time equal to the period of every such suspension. No compensation whatsoever shall be paid on this account.

34.0 **Action when the whole security deposit is forfeited**

In any case in which under any clause or clauses of this contract, the Contractor shall have rendered himself liable to pay compensation amounting to the whole of his security deposit the Consultant shall have the power to adopt any of the following course as they may deem best suited to the interest of the SBI.

- a) To rescind the contract (of which rescission notice in writing to the contractor by the Consultant shall be conclusive evidence) and in which case the security deposit of the contractor shall be forfeited and be absolutely at the disposal of SBI.

- b) To employ labour paid by the SBI and to supply materials to carry out the work, or any part of the work, debiting the contractor with the cost of the labour and materials (the cost of such labour and materials as worked out by the Consultant shall be final and conclusive against the contractor) and crediting him with the value of the work done, in all respects in the same manner and at the same manner and at the same rates as if it had been carried out by the contractor under the terms of this contract the certificate of Consultant as to the value of work done shall be final and conclusive against the contractor.
- c) To measure up the work of the contractor, and to take such part thereof as shall be unexecuted, out of his hands, and to give it to another contractor to complete in which case any expenses which may be incurred in excess of the sum which would have been paid to the original contractor, if the whole work had been executed by him (of the amount of which excess the certificates in writing of the Consultant shall be final and conclusive) shall be borne by original contractor and may be deducted from any money due to him by SBI under the contract or otherwise, or from his security deposit or the proceeds of sale thereof, or sufficient part thereof.

In the event of any of above courses being adopted by the SBI the contractor shall have no claim to compensation for any loss sustained by him by reasons of his having purchased or procured any material or entered into any engagements or make any advances on account of, or with a view to the execution of the work or the performance of the contract and in case the contract shall be rescinded under the provision aforesaid, the contractor shall not be entitled to recover or to be paid any sum or any work thereto for actually performed under this contract, unless, and until the Consultant will have certified in writing the performance of such work and the value payable in respect thereof, and he shall only be entitled to be paid the value so certified.

35.0 Owner's Right to Terminate the Contract

If the contractor being an individual or a firm commit any 'Act of Insolvency' or shall be adjusted an insolvent or being an incorporated company shall have an order for compulsory winding up voluntarily or subject to the supervision of Government and of the Official Assignee of the liquidator in such acts of insolvency or winding up shall be unable within seven days after notice to him to do so, to show to the reasonable satisfaction of the Consultant that he is able to carry out and fulfill the contract, and to give security therefore if so required by the Consultant.

Or if the contractor (whether an individual firm or incorporated Company) shall suffer execution to be issued or shall suffer any payment under this contract to be attached by or on behalf of any of the creditors of the contractor.

Or shall assign or sublet this contract without the consent in writing of the SBI through the Consultant or shall charge or encumber this contract or any payment due to which may become due to the contractor thereunder.

- a) Has abandoned the contract; or
- b) Has failed to commence the works, or has without any lawful excuse under these conditions suspended the progress of the works for 14 days after receiving from the SBI through the Consultant written notice to proceed, or
- c) Has failed to proceed with the works with such diligence and failed to make such due progress as would enable the works to be completed within the time agreed upon, or has failed to remove the materials from the site or to pull down and replace work within seven days after written notice from the SBI through the Consultant that the said materials were condemned and rejected by the Consultant under these conditions; or has neglected or failed persistently to observe and perform all or any of the acts, matters or things by this contract to be observed and performed by the contractor for seven days after written notice shall have been given to the contractor to observe or perform the same or has to the detriment of good workmanship or in defiance of the SBI's or Consultant's instructions to the contrary subject any part of the contract. Then and in any of said cases

the SBI and or the Consultant, may not withstanding any previous waiver, after giving seven days notice in writing to the contractor, determine the contract, but without thereby affecting the powers of the SBI or the Consultant or the obligation and liabilities of the contractor the whole of which shall continue in force as fully as if the contract had not been so determined and as if the works subsequently had been executed by or on behalf of the contractor. And, further the SBI through the Consultant, their agents or employees may enter upon and take possession of the work and all plants, tools, scaffoldings, materials, sheds, machineries lying upon the premises or on the adjoining lands or roads, use the same by means of their own employees or workmen in carrying on and completing the work or by engaging any other contractors or persons to complete the work and the contractor shall not in any way interrupt or do any act, matter or thing to prevent or hinder such other contractor or other persons employed for completing and finishing or using the materials and plant for the works.

When the works shall be completed or as soon thereafter as convenient the SBI or the Consultant shall give a notice in writing to the contractor to remove his surplus materials and plants and should the contractor fail to do so within 14 days after receipt thereof by him the SBI sell the same by public auction after due publication and shall adjust the amount realized by such auction. The contractor shall have no right to question any of the act of the SBI incidental to the sale of the materials etc.

Certificate of Payment

The contractor shall be entitled under the certificates to be issued by the project Consultant to the contractor within 10 working days from the date of certificate to the payment from SBI from time to time. The SBI shall recover the statutory recoveries and other dues including the retention amount from the certificate of payment.

The Consultant shall have power to withhold the certificate if the work or any part thereof is not carried out to their satisfaction.

The Consultant may by any certificate make any corrections required in previous certificate.

The SBI shall modify the certificate of payment as issued by the Consultant from time to time while making the payment.

The contractor shall submit interim bills only after taking actual measurements and properly recorded in the Measurement sheet.

The contractor shall not submit interim bills before supply of all material at site

The contractor shall submit the interim bills in the prescribed format with all details.

Schedule of payment : Payment shall be made against progress of work at site according to the following items:

a) 50% pro-rata against delivery of machines/material at site with all accessories.

b) 30% pro-rata against installation of AC machines

c) 20% pro-rata against commissioning & handing over of the entire installation.

The above payment terms shall however be subject to deduction of retention money and submission of security deposit as stated elsewhere.

The final bill may be submitted by contractor within a period of one month from the date of virtual completion and Consultant shall issue the certificate of payment within a period of two months. The SBI shall pay the amount within a period of three months from the date of issue of certificate provided there is no dispute in respect of rates and quantities.

Settlement of Disputes and Arbitration

Except where otherwise provided in the contract all questions and disputes relating to the meaning of the specifications, design, drawings and instructions herein before mentioned and as to the quality of workmanship of materials used on the work or as to any other question, claim, right, matter or thing whatsoever in any way arising out of or relating to the contract, designs, drawings, specifications, estimates, instructions, orders or these conditions or otherwise concerning the work or the execution or failure to execute the same, whether arising during the progress of the work or after the cancellation, termination, completion or abandonment thereof shall be dealt with as mentioned hereinafter :

- i) If the contractor considers that he is entitled to any extra payment or compensation in respect of the works over and above the amounts admitted as payable by the consultant or in case the contractor wants to dispute the validity of any deductions or recoveries made or proposed to be made from the contract or raise any dispute, the Contractor shall forthwith give notice in writing of his claim, or dispute to the Assistant General Manager (P & E), State Bank of India, Local Head Office, Premises Department, Jaipur and endorse a copy of the same to the consultant, within 30 days from the date of disallowance thereof or the date of deduction or recovery. The said notice shall give full particulars of the claim, grounds on which it is based and detailed calculations of the amount claimed and the contractor shall not be entitled to raise any claim nor shall the Bank be in any way liable in respect of any claim by the contractor unless notice of such claim shall have been given by the contractor to the Assistant General Manager (P & E), State Bank of India, Local Head Office, Premises Department, Jaipur (Raj) in the manner and within the time as aforesaid. The contractor shall be deemed to have waived and extinguished all his rights in respect of any claim not notified to the Assistant General Manager (P & E), State Bank of India, Local Head Office, Premises Department, Jaipur-302005 in writing in the manner and within the time aforesaid.

The Assistant General Manager (P & E), State Bank of India, Local Head Office, Premises Department, Jaipur-302005 (Rajasthan) shall give his decision in writing on the claims notified by the contractor. The contractor may within 30 days of the receipt of the decision of the Assistant General Manager (P & E), State Bank of India, Local Head Office, Premises Department, Jaipur 302005, submit his claims to the conciliating authority namely the Circle Development Officer, State Bank of India, Local Head Office, Jaipur 302005 for conciliation along with all details and copies of correspondence exchanged between him and the Assistant General Manager (P & E), State Bank of India, Local Head Office, Premises Department, Jaipur 302005 (Rajasthan)

If the conciliation proceedings are terminated without settlement of the disputes, the contractor shall, within a period of 30 days of termination thereof shall give a notice to the concerned Chief General Manager of the Bank for appointment of an arbitrator to adjudicate the notified claims falling which the claims of the contractor shall be deemed to have been considered absolutely barred and waived.

Except where the decision has become final, binding and conclusive in terms of the contract, all disputes or differences arising out of the notified claims of the contractor as aforesaid and all claims of the Bank shall be referred for adjudication through arbitration by the Sole Arbitrator appointed by the Chief General Manager. If the arbitrator so appointed is unable or unwilling to act or resigns his appointment or vacates his office due to any reason whatsoever another sole arbitrator shall be appointed in the manner aforesaid by the said Chief General Manager. Such person shall be entitled to proceed with the reference from the stage at which it was left by his predecessor.

It is a term of this contract that the party invoking arbitration shall give a list of disputes with amounts claimed in respect of each dispute along with the notice for appointment of arbitrator.

It is also a term of this contract that no person other than a person appointed by such Chief General Manager aforesaid should act as arbitrator.

The conciliation and arbitration shall be conducted in accordance with the provisions of the Arbitration & Conciliation Act 1996 or any statutory modification or re-enactment thereof and the rules made thereunder.

It is also a term of the contract that if any fees are payable to the arbitrator these shall be paid equally by both the parties.

It is also a term of the contract that the arbitrator shall be deemed to have entered on the reference on the date he issues notice to both the parties calling them to submit their statement of claims and counter statement of claims. The venue of the arbitration shall be such place as may be fixed by the arbitrator in his sole discretion. The fees if any, of the arbitrator shall, if required to be paid before the award is made and published, be paid half and half by each of the parties. The cost of the reference and of the award (including the fees, if any of the arbitrator) shall be in the discretion of the arbitrator who may direct to any by whom and in what manner, such costs or any part thereof shall be paid and fix or settle the amount of costs to be so paid

Method of Measurement

Unless otherwise mentioned in the schedule of quantities or in mode of measurement, the measurement will be on the net quantities or work produced in accordance with up to date. Rules laid down by the Bureau of Indian Standards. In the event any dispute/disagreement the decision of the Consultant shall be final and binding on the contractor.

Maintenance of Registers

The contractor shall maintain the following registers as per the enclosed proforma at site of work and should produce the same for inspection of Consultant whenever desired by them. The contractor shall also maintain the records/registers as required by the local authorities/Government from time to time.

- i) Register for secured advance
- ii) Register for hindrance to work
- iii) Register for running account bill
- iv) Register for labor

Price Variation

Not Applicable

Force Majeure

Neither contractor nor SBI shall be considered in default in performance of their obligations if such performance is prevented or delayed by events such as war, hostilities revolution, riots, civil commotion, strikes, lockout, conflagrations, epidemics, accidents, fire, storms, floods, droughts, earthquakes or ordinances or any act of god or for any other cause beyond the reasonable control of the party affected or prevented or delayed. However a notice is required to be given within 30 days from the happening of the event with complete details, to the other party to the contract, if it is not possible to serve a notice, within the shortest possible period without delay.

As soon as the cause of force majeure has been removed the party whose ability to perform its obligations has been affected, shall notify the other of such cessation and the actual delay incurred in such affected activity adducing necessary evidence in support thereof.

From the date of occurrence of a case of force majeure obligations of the party affected shall be suspended during the continuance of any inability so caused. With the cause itself and inability resulting therefrom having been removed, the agreed time of completion of the respective obligations under this agreement shall stand extended by a period equal to the period of delay occasioned by such events.

Should one or both parties be prevented from fulfilling the contractual obligations by a state of force majeure lasting to a period of 6 months or more the two parties shall mutually decide regarding the future execution of this agreement.

Accidents: The contractor shall immediately on occurrence of any accident at or about the site or in connection with the execution of the work report such accident to the Bank/Consultant. The contractor shall also report immediately to the competent authority whenever such report is required to be lodged by the law and take appropriate actions thereof.

Local Laws, Acts, Regulations

The contractor shall strictly adhere to all prevailing labour laws inclusive of contract labour (regulation and abolition act of 1970) and other safety regulations. The contractor shall comply with the provision of all labour legislation including the latest requirements of all the Acts, laws, any other regulations that are applicable to the execution of the project.

- i) Minimum Wages Act, 1948 (Amended)
- ii) Payment of Wages Act 1936 (Amended)
- iii) Workmen's Compensation Act 1923 (Amended)
- iv) Contract Labour Regulation and Abolition Act 1970 and Central Rules 1971 (Amended)
- v) Apprentice Act 1961 (Amended)
- vi) Industrial Employment (Standing Order) Act 1946 (Amended)
- vii) Personal Injuries (Compensation Insurance) Act 1963 and any other modifications
- viii) Employees' Provident Fund and Miscellaneous Provisions Act 1952 and amendment thereof
- ix) Shop and Establishment Act
- x) Any other Act or enactment relating thereto and rules framed there under from time to time.

SAMPLE AGREEMENT WITH CONTRACTORS ARTICLES OF AGREEMENT

This agreement made theday of between AGM/ DGM ,State Bank of India, -----(hereinafter called the Bank or SBI) which expression shall include the successors and assigns) of the one part and M/s. company / partnership for registered under the Indian Companies Act/ Partnership Act having its registered office..... (hereinafter called 'the Contractors' which expression shall include the present directors / partners and also the directors / partners from time to time as also their respective heirs, legal representatives, administrators and assigns) of the other part. WHEREAS the employer is desirous of execution of _____(Name of work)_____ and has caused drawings and specifications describing the works to be done prepared by Project Architects M/s _____ having their offices at _____ (hereinafter called "the Architect") AND WHEREAS THE SAID Drawings numbered as mentioned in the tender documents hereinafter mentioned and to be issued from time to time, the specifications and the Schedule of items and quantities have been signed by or on behalf of the parties hereto. AND whereas the contractors have agreed to execute upon and subject to the condition set forth herein and Schedule of items and quantities, General & special Conditions of Contract, specification etc. contained in the tendered documents including all correspondences exchanged by or between the parties from the submission of tender till the award of work, both letters inclusive, (all of which are collectively hereinafter referred to as "the said conditions"). The works shown upon the said drawing and /or described in the said specification and included in the schedule of Items and Quantities at the respective rates therein set forth amounting to the sum of Rs_____ (Rupees _____in words_____) as there in arrived at or such other sum as shall become payable there under (hereinafter referred to as " the said Contract Amount". NOW IT IS HEREBY AGREED AS FOLLOWS: 1. In consideration of the said Contract amount to be paid at the times and the manner set forth in the said Conditions, the Contractors shall upon and subject to the said conditions execute and complete the work shown upon the said drawings and described in the said specifications and the schedule of items and quantities. 2. The employer shall pay the Contractors the amount or such other sum as shall become payable, at the times and in the manner specified in the said conditions. 3. The term "the Architect" in the said condition shall mean the said "M/s _____" or in the event of their ceasing to be the Architect for the purpose of this contract for whatever reason, such other person or persons as shall be nominated for that purpose by the Employer, not being a person to whom the Contractor shall object for reasons considered to be sufficient by the Employer provided always that no person or persons subsequently appointed to be Architect under this contract shall be entitled to disregard or over rule any previous decisions or approval or direction given or expressed in writing by the architect for the time being. 226 | P a g e MANUAL OF INSTRUCTIONS ON PREMISES MATTERS- FEBRUARY 2025 4. The said conditions and appendix thereto shall be read and construed as forming part of this agreement, and the parties hereto shall respectively abide by / submit themselves to the said conditions and perform the agreements on their part respectively in the said conditions contained. 5. The plans, agreement and documents mentioned herein shall form the basis of this contract. 6. This contract is neither a fixed Lump sum contract nor a piece work contract but is a contract to carry out the work in respect of the entire project on item rate basis to be paid for according to actual measured quantities at the rates contained in the schedule of quantities and rates or as provided in the said conditions. 7. The Bank / Employer reserves to itself the rights of altering the

specifications and nature of work by adding to or omitting any item of work or having portions of the same carried out without prejudice to the contract. 8. Time shall be considered as the essence of this contract and the contractor here by agrees to commence the work soon after the site is handed over to him or from the 14th day after date of issue of formal work order as provided for in the said conditions of contractor whichever is later and to complete the entire work within ____ (period of contract) months subject never the less to the provisions for extension of time. 9. All payments by the Employer under this contract will be made only at _____. 10. Any dispute arising under this Agreement shall be referred to arbitration in accordance with the stipulations laid down in the tender. 11. That all the parts of this contract have been read by the contractor and fully understood by the contractor. They further agree to complete the said work to fullest satisfaction of architect / Employer. 12. IN WITNESS WHEREOF the Employer and the contractors have set their respective hands to these presents through their duly authorized official and the said two duplicates hereof to be executed on its behalf of the day and year first herein above written. Signed on behalf of the STATE BANK OF INDIA In the presence of : 1. Signature : Name : Address : In the presence of : 2. Signature : Name : Address : Signed-on behalf of the CONTRACTORS In the presence of : 1. Signature : Name : Address : In the presence of : 2. Signature : Name : Address :

SPECIAL CONDITIONS OF CONTRACT

	1. TOOLS: All measuring tapes shall be of steel. Suitable scaffolding and ladders that may be required for safe working and taking measurement shall be supplied by the contractor.
	The HVAC mistries and the supervisors on the works shall always carry with them a one metre or two metre steel tape, a measuring tape of 30 metres, a spirit level, a plumb bob and a square and or any other tool required and shall check the work to see that the work is being done according to the drawing and specifications. Electrical Mistries and Supervisors shall also carry one test lamp with leads and one neon tester and necessary working instruments. The Site Engineer will use any or all measuring instruments or tools belonging to the contractors as he chooses for checking the works executed or being executed on the contract.
	The contractor should cover in his rates for making provisions for all reasonable facilities for the use of his scaffolding, tools and plant etc by nominated sub-contractors for their work.

	2. Removal of Improper Work
	The Owner shall during the progress of the work have power to order in writing from time to time the removal from the work within such reasonable time or times as may be specified in the order of any materials which in the opinion of the Owner consultants are not in accordance with specification or instructions, the substitution or proper re-execution of any work executed with materials or workmanships not in accordance with the drawings and specifications or instructions. In case the contractor refuses to comply with the order the Owner shall have the power to employ and pay other agencies to carry out the work and all expenses consequent thereon or incidental thereto as certified by the Owner/ consultants shall be borne by the contractor or may be deducted from any money due to or that may become due to the contractor. No certificate which may be given by the consultants shall relieve the contractor from his liability in respect of unsound work or bad materials.
	3.0 Dismissal of Workmen

	<p>The contractor shall on the request of the Owner immediately dismiss from works any person employed thereon by him, who may in the opinion of the Owner be unsuitable or incompetent or who may misconduct himself. Such discharges shall not be the basis of any claim for compensation or damages against the Owner or any of their officer or employee.</p>
--	---

4. Tools, Storage of Materials, Protective Works and Site Office Requirements

The contractor shall provide, fix up and maintain in an approved position proper office accommodation for the contractor's representative and staff which offices shall be open at all reasonable hours to receive instruction notices or communications and for storage of tools, etc and clear away the same on completion of the works and make good all work disturbed.

5.0 Drawings

All drawings maintained on the site are to be carefully mounted on boards of appropriate size and covered with a coat of approved varnish. They are to be protected from ravages of termites, ants, and other insects and made available to the Owner/ consultants for inspection or such other purposes they may require.

The contractor shall provide at his own cost all artificial light required to complete the work within the specified time.

The contractor shall provide a suitable temporary hut for the watchmen and clear away the same when no longer required and to provide all necessary attendance, lights etc required.

The contractor shall arrange for temporary latrines for the use of workers and field staff and keep the same in a clean and sanitary condition to the satisfaction of the Public Health Authorities and shall cause such latrines and soil to be cleared away whenever necessary and shall make good all the works disturbed by these convenience.

6.0 Possession Prior to Completion

The Owner shall have the right to take possession of or use any completed or partially completed part of the work. Such possession or use shall not be an acceptance of any work not completed in accordance with the contract Agreement.

The contractor shall not fix or place any placards or advertisement of any description or permit the same to be fixed or placed or upon any boarding gantry, building structure other than those approved by the Owner.

7.0 Protective Measures :

The contractor from time to time of being placed possession of the site must make suitable arrangements for watching, lighting and protecting the work, the site and surrounding property by day, by night, on Sundays and other holidays.

8.0 Inspection on Completion

The whole of the work will be thoroughly inspected by the contractor and deficiencies and defects put right. On completion of such inspection the contractor shall inform the Owner that he has completed the work and it is ready for inspection

9.0 Defects after Completion

The contractor shall make good at his own cost and to the satisfaction of the Owner all defects and other faults which may appear within 12 months after completion of the work. In default, the Owner may employ other persons to amend and make good such damages, defects etc. Expenses consequent thereon or incidental thereto shall be recoverable from the contractor by the Owner from any money due to the contractor. In the event of the amount being insufficient the Owner may recover the balance from the contractor, from the amount retained under Clause No. 1 (Total Security Deposit) of General Conditions of Contract together with any expenses the Owner may have incurred in connection therewith.

10.0	Declaration
	I/We have inspected the site of works and have made me/us fully acquainted with the local conditions in and around the sites of works. I/We hereby declare that I/We have gone through the conditions laid down in the Notice Inviting Tender, General Conditions of Contract, Special Conditions of Contract, Additional Conditions for Electrical Installation, Technical Specifications and understood the same and on the basis of the same I/We quoted our rates in the schedule of quantities attached with the tender documents.

	I/We shall also uniformly maintain such progress with the work, as may be directed by the Owner/ consultants to ensure completion of same within the target date as mentioned in the tender document.

Signature of tenderer

RUNNING A/C BILL

- i) Name of Contractor/Agency :
- ii) Name of Work :
- iii) Sr No. of this bill :
- iv) No. and date of previous bill :
- v) Reference to Agreement No. :
- vi) Date of written order to :
commence
- vii) Date of completion as per
agreement

Sl. No.	Item Description	Unit	Rate (Rs.)	As per tender	
				Qty	Amount (Rs.)
1	2	3	4	5	

Signature of bidder with stamp

Upto Previous R/A Bill		Upto Date (Gross)		Present Bill		
Qty	Amount (Rs)	Qty	Amount (Rs.)	Qty	Amount (Rs.)	Remarks
6		7		8		9

Note : 1. If part rate is allowed for any item, it should be indicated with reasons for allowing such a rate.

2. If adhoc payment is made, it should be mentioned specifically.

Net value since previous bill

SAFETY CODE

1. First aid appliances including adequate supply of sterilized dressing and cotton wool shall be kept in a readily accessible place.
2. An injured person shall be taken to a public hospital without loss of time, in case where the injury necessitates hospitalization.
3. Suitable and strong scaffolds should be provided for workmen for all works that cannot safely be done from the ground.
4. No portable single ladder shall be over 8 meters in length. The width between the side rails shall not be less than 30 cm (clear) and the distance between two adjacent rungs shall not be more than 30 cm. When a ladder is used an extra mazdoor shall engaged for holding ladder.
5. The excavated material shall not be placed within 1.5 meters of the edge of the trench of the half of the depth of trench whichever is more. All trenches and excavation shall be provided with necessary fencing and lighting.
6. Every opening in the floor of a building or in a working platform be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or rails whose minimum height shall be one meter.
7. NO floor, roof or other part of the structure shall be so overloaded with debris or materials as to render it unsafe.
8. Workers employed on mixing and handling material such as asphalt, cement mortar of concrete and lime mortar shall be provided with protective footwear and rubber hand-glove.
9. Those engaged in welding works shall be provided with welder's protective eye shield and gloves.
10.
 - i) No paint containing lead or lead products shall be used except in the form of paste and readymade paint.
 - ii) Suitable facemasks should be supplied for use by the workers when the paints applied in the form of spray or surface having lead paint dry rubbed and scrapped.
11. Overalls shall be supplied by the Contractor to the painters and adequate facilities shall provide to enable the working painters to wash during the periods of cessation of work.

12. Hoisting machines and tackle used in the works, including their attachments, anchored and supports shall be in perfect condition.
13. The ropes used in hoisting or lowering material or as a means of suspension shall be durable quality and adequate strength and free from defects.
14. Since lift lobbies would remain in use , it is very important that all safety precautions like the doorway not being kept open for access , are taken to guard against any mishappening.
15. No one should be allowed to work/inspect at height without safety belt.

TECHNICAL SPECIFICATIONS

1. Basis of Design :

Site Location : JAIPUR (RAJASTHAN)

Geographic Location : 26.55 Deg. N (Latitude)/ 75.78 Deg. E
(Longitude)

Altitude : 390 M from MSL

Daily Range : 27°F

Outside Conditions:

Summer:	DB	WB
	45° C (113° F)	23.9 ° C (75° F)
Monsoon:	DB	WB
	35.0° C (95° F)	28.3° C (83° F)
Winter:	DB	WB
	7.2° C (45° F)	5.0° C (41° F)

Indoor Design Conditions:

Indoor design conditions for all centrally air-conditioned areas/spaces shall be taken as:

Summer/Monsoon/Winter :-

DB : 24 ± 1 Deg C

RH : below 60 %

Exposed Glasses : All glasses exposed in sun shall have suitable shading devices / Venetian blinds.

Lighting Load : 1.5 W per Square Ft

Roof Insulation : All the exposed roof/ ceiling to be insulated with 50mm thick EPS/ or Equivalent.

1.1 Mechanical Ventilation System

The following areas shall be provided with dedicated ventilation system with the number of air changes for each space as per National Building Codes (NBC) as identified hereunder:

- a) Basements/Toilets : 12 ACPH
- b) Pantry Kitchens : 12 ACPH
- c) Toilets : 10 ACPH

2. DESIGN PARAMETERS

2.1 Water Cooled Chilling Machine with Oil Free Magnetic Compressors:

Performance rating of the water chilling machine shall be based on following design parameters:

Temperature of chilled water
Entering chilling machine. : 54 Deg. F (12.2 deg. C)

Temperature of chilled water
Leaving chilling machine : 44 Deg. F (6.7 deg. C)

Fouling factor for chiller in
FPS unit : 0.0005

Environment friendly Green Refrigerant : R-134A

Capacity of water chilling machine
At above conditions : 225 TR X 3 nos (2W+1S)

2.2 Design parameters for selection of Air handling Unit and its Components shall be:

Maximum face velocity across
Profiler media : 350 Ft/Min. (100M /Min)

Maximum face velocity across
Cooling coil : 500 Ft/Min. (150M /Min.)

Maximum fan outlet velocity : 2000 Ft/Min. (600 M/Min.)

2.3 Piping shall be sized for the following design parameters:

Maximum velocity : 8 Ft/Sec (2.5 M/Sec.)

Maximum friction : 5 Ft/100 Ft. Run (5 M/100 M Run)

2.4 Design parameters for duct design shall be:

Maximum flow velocity (Conditioned air)	:	1500 Ft/Min. (450 M/Min)
Maximum flow velocity For ventilation	:	1800 Ft/Min. (550 M / Min)
Maximum friction	:	0.1 in. WG/100 Ft. Run (1cm WG/100M Run)
Maximum velocity at Supply air outlet	:	500 Ft/Min. (150 M/Min.)

3.0 Estimated HVAC Load Requirements:

Based on the above parameters the estimated Air conditioning requirements for the various areas are tabulated as below. Area wise breakup and the estimated heat loads requirements have been detailed as below:

AC Load Details of Indoor stadium Areas				
S. No.	Area Description	Area (Ft2)	AC(TR) Summer	AC(TR) Monsoon
1	Ground Floor	21800	113	98
2	First Floor	22000	78	79
3	Second Floor	22000	78	79
4	Third Floor	22000	78	79
5	Fourth Floor	22000	103	103
	Grand Total		450	438

4.0 Proposed Air-Conditioning system with water cooled chilling machines:

The total air-conditioning load for the above areas works out to be **450 TR**. It is proposed to install central chilled water air-conditioning system to provide year round thermal environmental control. The system configuration shall be as follows:

- 3nos X 225 TR Cooling Capacity centrifugal chilling machines with oil free magnetic type compressors (2 working + 1 stand by)
- 3 nos. chilled water primary pumps (2W + 1S)
- 3 nos chilled water secondary pumps (2W + 1S)
- 3 nos condenser water pumps (2W + 1S)
- 2 nos 275 TR CTI approved Induced Draft FRP cooling towers (Both working)

- Air Handling Units with Plug fans and VFDs as per the requirements at various floors/ areas.

The Equipments shall be installed at the plant room existing at the Basement Level and chilled water from this plant shall be supplied to various AHUs at various locations as per requirements. The system shall be complete with electrical panel boards, power cabling, control cabling, earthing and controls.

5.0 Energy Conservation measures :

1. Use of most efficient chilling machines, pumps, AHUs and Fans.
2. Use of primary and secondary pumping system. The secondary system works on the principle of reducing its speed and saving energy when the load is reduced.
3. Use of most efficient oil free magnetic centrifugal compressor type chilling machines with environment friendly refrigerants of zero ozone depletion potential and minimum green house gases effects.
4. Use of Variable Frequency Drives on Chilling machines, Pumps, Cooling Towers, AHUs motors to save energy. The motors with VFDs reduce their speed and save energy when the load in a certain zone is reduced.

Centrifugal Water Chilling Machine (Magnetic Bearing)

1. General

AHRI certified Supply, Installation, Testing & Commissioning of chilling machine shall consist of magnetic bearing centrifugal compressor, squirrel cage induction motor with suitable variable frequency drive, active harmonic filter, shell and tube type water cooled condenser, shell & tube chiller, refrigerant piping, wiring and automatic microprocessor controls, all mounted on a steel frame.

2. Compressor

- 2.1 The compressor shall be a single / multi-stage centrifugal type powered by a high speed electric motor. A cast aluminum, fully shrouded impeller shall be mounted directly to the motor shaft. The impeller shall be designed for balanced thrust, dynamically balanced and over speed tested for smooth, vibration free operation. Compressor castings shall be designed for 235 psig working pressure and hydrostatically pressure tested at 355 psig for HFC R-134A units. Capacity control shall be achieved by the combined use of variable speed and variable diffuser geometry / inlet guide vanes to provide fully modulating control from maximum to minimum load while maintaining constant chiller leaving water temperature. The drive should be field serviceable.

2.2 Motor & Bearings

The compressor motor shall be a hermetic, oil free, permanent magnet type directly coupled to the compressor. The motor will be bolted to a cast iron adapter plate mounted on the compressor to provide factory alignment of the shaft. The motor shaft shall be supported on active magnetic radial and thrust bearings. Magnetic bearing control shall be equipped with auto vibration reduction and balancing systems. During a power failure event, the magnetic bearings shall remain active throughout the compressor coast down. Rolling element bearings shall be provided as a backup to the magnetic bearings designed for emergency touch down situations. Motor stator and rotor shall be equipped with a pressure driven refrigerant cooling loop to maintain acceptable operating temperatures.

2.3 Capacity Controls

The compressor shall be equipped with an automatic suction damper or inlet guide vanes control or guide diffuser, for regulating its capacity. The positioning of the damper shall be done by means of thermostatically actuated electronic temperature controller differential type with its sensing elements in the outgoing chilled water lines. The automatic damper will maintain the constant temperature of chilled water. It should be possible to go down to 15% of full load. Compressor and motor sole plates, anchor bolts and sleeves and necessary vibration isolator pads must be included.

2.4 Drive:

The compressor shall be driven directly. Permanent magnetic bearing and Permanent magnet motor combination will drive this.

2.5 Evaporator and Condenser

2.5.1 Shells and Water Boxes

The evaporator and condenser shells will be of rolled carbon steel plate with fusion welded seams. Removable compact water boxes of cast iron or welded steel with stub-out water connections shall be provided to permit access for tube cleaning and replacement. Water boxes shall be designed for 150 psig working pressure and hydraulically tested at 225 psig. The tubes shall be finned from outside having spiral ridges from inside, roller expanded

into the tube sheets providing a leak proof seal. The tube material will be copper, intermediate steel tube support should be provided at intervals not exceeding 1200 mm.

2.5.2 Evaporator (Chiller)

Chiller shall be provided with eliminator to prevent liquid carry over to the compressor.

The chiller shall be provided with liquid level sight glass and a relief device (of the bursting

type) to prevent excess pressure in the heat exchanger. The refrigerant side shall be designed, and tested in accordance with ASME Pressure Vessel Code 2017, Section VIII-

Division 1/GB/PED. The chiller shall be horizontal, shell and tube flooded type, provided with the following connections and accessories.

- 1) Refrigerant inlet and outlet pressure gauges.
- 2) Water inlet and outlet connections with industrial type thermometers.
- 3) Drain and vent connections with stop valves.
- 4) Pressure gauges on Water inlet and outlet connections.
- 5) Descaling valves:

Chiller shall be insulated as per manufacturers standard. The insulation shall be applied in such a manner that water boxes and covers shall be removable without damaging it. The Connection shall be Flanged / Victaulic type to connect with piping at site.

2.5.3 Condenser

The condenser shall be horizontal, shell and tube type. The Connection shall be Flanged/

Victaulic type to connect with piping at site. The refrigerant side shall be designed, and tested in accordance with ASME Pressure Vessel Code, Section VIII- Division 1/GB/PED

Boiler and The condenser shell be complete with the following & accessories :-

- 1) Refrigerant inlet and outlet pressure gauges.
- 2) Water inlet and outlet connections with industrial type thermometers.
- 3) Drain and vent connections with stop valves.
- 4) Pressure gauges on water inlet and outlet connections & Descaling valves.

2.6 Performance Rating

The unit shall be selected for the lowest operating noise level. Capacity ratings, and power consumption with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation.

Power consumption shall be computed from measurements of incoming voltage & input current. Sound Pressure for the Chiller shall be < 79 dBA @ 1 meter distance.

Factory tests:

One Unit shall be factory tested to check the performance as required under the tender BOQ in the presence of Consultant, Bank's Representative and contractor for checking the capacity at required conditions.

2.7 Certification

The chilling unit shall be certified in accordance with ARI550/98 or equivalent. All suppliers shall furnish computer printouts giving details of capacity output at design conditions. Chiller shall be Factory Tested Before dispatch, at 4 Points at AHRI Conditions as per AHRI 550-590, to determine COP and IPLV.

Cooling Towers

1.0 GENERAL

Work of this section shall conform to the requirements of the Contract Documents

WORKS INCLUDED

The work of this section includes but it is not necessary limited to the following:

The design, fabrication, delivery and assembly of the cooling towers

The structural support and foundation shall be designed and constructed based upon certified loads and dimensions provided by the cooling tower manufacturer.

Start-up supervision and providing necessary documentation for operation.

SUBMITTALS

Submit the following: -

Tender Stage

Manufacturer's catalogues and equipment details

Certified dimension drawings indicating all equipment dimensions, weight materials.

Equipment layout details indicating equipment arrangement and plinth details.

Manufacturing Stage

Performance curves which show leaving water temperature from the tower at the design water temperature range at the design wet bulb. Packaging, transportation and storage notes.

Construction Stage

Installation manuals
Certificates from CTI
Operation and maintenance manuals.

QUALITY ASSURANCE

Cooling Towers shall be of reputable manufacture and shall have a capacity not less than that specified. The rated capacity shall be certified by the cooling tower institute (CTI) or an approved independent cooling tower authority based upon tests performed on the cooling tower.

The manufacturer's shall supply a written guarantee that the cooling tower offered for this project shall be capable of performing the duties required as stated in the schedule and specification, by submission of exact type technical data for the wet bulb temperatures anticipated at the project locality.

Guarantee that there shall be no water leakage from the cooling tower, basin and sump. Should the tower fail to perform after installation, according to the approved performance curves steps shall be taken to rectify and make good and defects or inadequacies, at no extra cost to the employers.

PRODUCTS

GENERAL

Cooling towers shall be mechanical induced draft, cross flow, vertical discharge type of outdoor installation and shall be complete with main casing, suction strainer, fan, tower fill and support, support stand, stand pipe, and supports, motor and supports, access hot dipped galvanized ladders and any other appurtenances necessary for satisfactory operation. All parts shall be extensively prefabricated for simple field assembly.

The cooling towers shall be modular design, where the modules can be assembled to form a row of cooling towers. Approved makes shall be - Nihon Spindle/ Marley/BAC.

DESIGN PARAMETERS

The cooling towers shall have a design life of 15 years.

The cooling tower design parameter shall be as follows: -

- a. Entering water temperature :As Mentioned in scheduled of Quantities.

- | | | | |
|----|--------------------------------|---|------------------------------|
| | b. Leaving water temperature | :As Mentioned in scheduled of Quantities. | |
| 1. | c. Ambient Wetbulb temperature | :As Mentioned in scheduled of Quantities. | |
| 2. | d. Drift loss | < 0.005% | capacity and number |
| | e. Water Flow Rate | :As Mentioned in scheduled of Quantities. | tower cells cooling shall be |
- The type of in the tower detailed in the schedule and/or as shown on the drawings.

FAN AND DRIVE

1. The primary air delivery system for each cell shall consist of an electric motor, a multi-bladed axial type fan of belt driven and rigid unitized support. All components shall be corrosion resistant in 100% humidity climates.
2. Motors shall be one speed single winding, and specially insulated for cooling water duty. The load applied to the motors shall not exceed 90% of their nameplate rating.
3. Motors shall IE4 type. The fan motor shall be a totally enclosed fan cooled weather proof IP55 with Class F Insulation type suitable for 415 volts/3 phase/50 Hz power supply and shall be located outside the discharge air stream through a set of wedge belt. A belt cover shall be provided to protect the wedge belt and shall be of FRP construction.
4. Fans shall be composite multi-blade, axial type with appropriate twist and taper to produce the design airflow at high efficiency and low operating horsepower. The fans and all blades shall be fabricated with consistent moment weights to permit the change-out of individual blades without need for total re-balance. Hubs shall be fabricated of hot-dipped galvanized steel and ductible cast iron assembled with HDGS / 316/304 stainless steel (optional) hardware. Hubs shall be statically balanced at the factory. All the components shall be fabricated of corrosion resistant materials throughout for long life when handling saturated air at high velocities. The construction material of the fan blade shall be FRP/Aluminum (optional). Hot dipped galvanized fan guard shall be provided over the fan cylinder.
5. The wedge- belt shall be with fabric impregnated type design to B.S 1400 standard. Means for adjusting the belt tension shall be provided. Positives means of locking shall be employed in order to maintain tension during operation.

2.2 WATER DISTRIBUTION SYSTEM

Hot water shall be distributed to the fill in each cell via a system of open type gravity type basin. Each cell shall be provided with internal piping system with branched pipes to the hot water inlet ports above the FRP distribution basin and with provision for water balancing via the internal valve arrangement. (Internal piping optional.)

The piping system shall be sized for a flow velocity that will ensure equal flow at all the hot water inlet ports.

2.3 CELL PARTITIONS AND CASINGS

The end main casing and water basin shall be FRP panel attached to tower columns with HDGS screw shank, self-tapping fasteners and self-sealing washers. Panel shall be lapped to shed water inwards to the tower. Vertical joints shall be lapped and sealed water tight.

2.4 IN-FILL

Infill shall be of ultra-violet rays treated polyvinyl chloride. The PVC infill shall be durable and highly efficient vacuum- formed type with patented intricate design to facilitate a good spread of water over the enhanced surface area against a cross flow of induced draft of air. The infill shall be incorporated with ribbed pattern on the opposite side to act as drift eliminator. Each PVC infill sheet is bonded with specially formulated glue in blocks of either 28 sheets or 30 sheets depending on the model.

The entire top layer of infill is supported to prevent the weight of the top layer infill being imposed on the bottom layer. No imitation infill from non authorized JCI manufacturer is acceptable. The design shall be such that drift loss does not exceed 0.005% of the circulating water quantity.

FAN DECK AND FAN STACKS

The fan deck shall act as a maintenance platform and shall be constructed from hot dipped galvanized. Fan deck panels shall be supported by framing grills and shall have integral structural ribs. The fan deck design shall provide for air flow into fan stack without the need for field cutting. To minimize turbulence of air flow into the fan stack, fan deck protrusion into the fan stack opening shall not exceed 25mm. Deck shall be capable of supporting fan/motor replacement.

Fan stacks shall be moulded FRP with eased inlets to promote smooth airflow at blade at blade tips. The operating plane of the fan shall be at a level above the fan deck of at least 15% of the overall fan diameter. Fan tip clearance shall not exceed 0.5% of the fan diameter. If velocity fan stacks are used they shall have a minimum flare angle of 12 deg., with a maximum assumed velocity recovery of 75% of the different in average velocity pressure. Each fan stack segment shall be through- bolted to both the fan deck and a primary fan deck faring member. Fan stack connection and anchorage hardware shall be HDGS / 304/316 stainless steel (optional).

STRUCTURE

Tower framework shall consist of structural shapes of hot dipped galvanized steel.

All structural connections and splices shall be through-bolted using HDGS/ 316/304 stainless steel (optional) machine bolts, nuts and washers. Glued connections of structure, decking, fan cylinders, or any other not.

3.0 EXECUTION

GENERAL

1. Install, test and commission cooling tower as specified in drawings and specifications in accordance with manufacturer's instructions.

INSTALLATION

Cooling towers shall be assembled, rigged and installed in accordance with the manufacturer's recommendations to the satisfaction of the Employer's Representatives. The associated auxiliary structural support shall be supplied.

Precautions shall be exercised throughout the assembly of cooling towers to minimize objectionable air-borne noise. Vibrations of the cooling towers must be effectively isolated from the structure of the building.

NAME PLATES AND MARKINGS

Nameplates shall be provide and shall be located at a convenient location for easy visibility.

The nameplate shall be inscribed with the following as a minimum requirement:-

- a. Manufacturer's name
- b. Item number
- c. Year of construction
- d. Design temperatures
- e. Design flow rate
- f. Fan motor kilowatt

SAFETY AND ACCESS

- 1. The tower shall be designed and equipped to provide comfortable, safe access to all components requiring routine inspection and maintenance.
- 2. An inspection door (internal walkway) shall be provided to gain entry into the tower to facilitate inspection and easy maintenance. Access ladder shall be installed on the tower permanently.

NOISE LEVEL

The cooling tower shall be on the low operating noise type. Noise level shall not exceed the sound level as indicated in the schedule.

MISCELLANEOUS

Supply and install all ancillary including make-up water supply pipe from the makeup tank , quick fill and bleed offs facilities.

Side Stream Filtration systems :

1.01 Furnish and install the liquid-solids separation system as specified herein.

A. Primary Purpose – The system will remove unwanted solids from a cooling tower sump or remote basin or condenser line using a centrifugal-action vortex separator. The liquid-solids separation system will help prevent particle fouling of the cooling system's components, reduce maintenance and servicing routines, maintain optimum energy efficiency of the heat exchange process, limit blow down & chemical use practices and control harmful bacteria growth in the basin/sump. Fluid viscosity must be 100 SSU or less.

B. For Side Stream Installations -- Control of solids in the recirculated cooling water system shall be accomplished via a side-stream flow of not less than 10-30% of the full-stream system flow through a completely assembled separation/filtration package. The package's pump shall provide sufficient pressure for the re-introduction of side-stream fluid back into system flow.

1.02 System Performance Requirements

Testing Requirements – Each unit must be tested by the manufacturer prior to shipment to ensure it conforms to stated operating specifications.

Independent Testing Laboratory – Performance of said products must be verified by published results from an independent and identified testing laboratory. Standard test protocol of upstream injection, downstream capture, and separator purge recovery is allowed with 50-200 mesh particles to enable effective, repeatable results. Single pass test performance must not be less than 95% removal. Model tested must be of same flow-design as specified unit.

2.01 Performance

Flow Capacity -- Unit shall have a flow capacity of 760 US GPM or 172 m³/hr
Pressure Loss – Shall be between 3-12 psi (.2 to .8 bar) remaining constant, varying only when the flow rate changes.

A. Solids Removal Effectiveness

All Systems – In a single pass through the separator, given solids with a specific gravity of 2.6 and water at 1.0, performance is expected to be 98% of 74 microns and larger. Additionally, particles finer in size, heavier by specific gravity and some lighter by specific gravity will also be removed, resulting in an appreciable aggregate removal of particles (up to 75%) as fine as 5 microns.

In Recirculating Systems -- 98% performance is predictable to as fine as 40 microns (given solids with a specific gravity of 2.6), with correspondingly

higher aggregate performance percentages (up to 90%) of solids as fine as 5 microns.

- B. Maximum working pressure: 150 psi (10.3 bar).
Maximum operating temperature: 100° F (38° C).

2.02 Construction

- A. **The separator package** -- Shall provide for initial pre-straining prior to pump suction (except for side-stream applications), followed by direct pumping through a specific centrifugal-action solid-from-liquid separator. Separated solids shall be continuously bled from the separator's collection chamber into the package's integral solids recovery vessel and solids collection bag. Excess liquid shall pass through the bag and return to system flow via piping connected to the package's pump suction line. Alternatively, the separated solids may be purged periodically to desired disposal with an automatic purge valve.
- B. **Strainer** -- Cast-iron housing; manual-cleaning; 9/32-inch (7 mm) minimum mesh rating; stainless steel basket. Not included with TBX and HTX models unless specified as an option.
- C. **Pump** -- End-suction, single stage; TEFC motor; cast iron housing; iron impeller; bronze shaft sleeve; silicon carbide mechanical shaft seal; flooded suction required.
- D. **Separator** -- Centrifugal-action design, incorporating a true tangential inlet and mutually tangential Swirlex internal accelerating slots, employed to promote the proper velocity necessary for the removal of the separable solids. The internal accelerating slots shall be spiral-cut for optimum flow transfer, laminar action and particle influence into the separation barrel. Avoid Dome type or Dumbbell type of Separator construction at the inlet or outlet to prevent the lack of internal method of acceleration. The separator's internal vortex shall allow this process to occur without wear to the accelerating slots. Separated particle matter shall spiral downward along the perimeter of the inner separation barrel, in a manner which does not promote wear of the separation barrel, and into the solids collection chamber, located below the vortex deflector plate. The separator shall be of unishell construction with SA-36, SA-53B or equivalent quality carbon steel, minimum thickness of .25 inches (6.35 mm)
- E. **Vortube** -- To ensure maximum particle removal characteristics at flow rates of 400 U.S. gpm (90 m³/hr) or greater, the separator shall incorporate a vortex-induced pressure relief line (Vortube), drawing specific pressure and fluid from the separator's extended solids collection chamber via the outlet flow's vortex/venturi effect, thereby efficiently encouraging solids into

the collection chamber. System fluid shall exit the separator by following the center vortex in the separation barrel and spiral upward to the separator outlet.

- F. **Automatic Purge Valve** -- In place of the solid's recovery vessel, an electrically-actuated valve shall be programmed at appropriate intervals and duration in order to efficiently and regularly purge solids from the separator's collection chamber. Valve body shall be bronze (optional stainless steel also available). Valve ball shall be stainless steel with sealant seat.
- G. **Inlet and Outlet** -- Shall be grooved/flanged couplings
- H. **Purge Outlet** -- Shall be threaded with a screw-on flange
- I. **Piping** -- Schedule 40 galvanized carbon steel; reinforced rubber hose to solids recovery vessel (in case of SRV only), the inter piping connection of pump & separator should be MS pipes with welding / grooved fittings only.
- J. **Electrical Control** -- IEC starter with overload module; HOA selector switch; NEMA-4x enclosure; re-set/disconnect/trip switch; 120-volt, single phase control voltage; CSA-approved. Power requirement: 380/415-volt, 3 phases.
- K. **Valves** -- Ball valves on purge line for isolation of solids-handling/purging equipment. Optional inlet/outlet valve kit is available.
- L. **Skid Plate** -- Stainless steel, 3/16-inch (5 mm) minimum thickness, structural steel framework on TCI-0825 and larger units.
- M. **Paint Coating** -- Shall be oil-based enamel

2.03 **Purging and Solids Handling**

- A. Evacuation of separated solids may be accomplished automatically, employing a motorized ball valve with integrally-equipped programming for controlling the frequency and duration of solids purging.

AIR HANDLING UNITS

1 **SCOPE**

The Scope of this section comprises the supply, erection, testing and commissioning of double skin Air Handling Units conforming to these Specifications and in accordance with requirements of drawings and schedule of quantities.

2 **TYPE**

The Air Handling Units shall be of floor mounted draw through type having sections such as filter section with pre-filters and Fine filters as required under BOQ ,cooling coil section with suitable chilled water cooling coil, fan section with DIDW fan/EC

Fan, mixing section where required under BOQ, humidification section with centrifugal fan as per schedule of quantities and arrangement shown on the drawings.

3 CAPACITY

The air moving and coil capacities (Air Conditioning Load) shall be as shown in Schedule of equipment and quantities and on drawings.

4 CASING

The housing/ casing of the air handling unit shall be of double skin construction. The housing shall be so made that it can be delivered at site in total/ semi knock down conditions depending upon the conditions. The frame work shall be of extruded aluminium hollow sections with thermal break profile fitted with pre-formed insulated sections. All the members shall be assembled thru mechanical joints to make a sturdy and strong frame work for various sections. Casings should be as per EN 1886.

Double skin panels (each not exceeding 750mm wide) shall be made of 24G pre-coated Galvanised sheet steel and 24G galvanised sheet inside with pressure injected PU foam insulation of 25mm thick X 38 Kg/Cu.M in between, these panels shall be with thermal break barrier also. The panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted together with soft rubber gasket in between to make the joints air tight. Suitable doors with powder coated hinges and latches shall be provided for access to various panels for maintenance.

The fan and the motor arrangement shall be mounted on to the extruded aluminium frame work. The entire housing i.e. The Air Handling Unit shall be mounted on extruded aluminium base channel framework.

Drain pan shall be constructed of 16 SS sheet having 12 mm thick 32 Kq/Cu. XPE insulation. The pan shall have necessary slope to facilitate for fast removal of condensate.

5 MOTOR AND DRIVE

Fan motors shall be 230 \pm 10% volts 50 cycles 3 phase totally enclosed fan cooled with IP-55 rotation and IE 4 type. Motor shall be especially designed for quite operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be

provided through belt drive arrangement. Belts shall be of oil-resistant type. Adjustable sheaves shall be provided.

6 FAN

The fan shall be backward, curved double inlet double width type complete with motor and drive package. The wheel and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with angle iron frame and pillow block heavy duty ball bearings. The fan shall be selected for a speed not exceeding 1000 RPM. The fan outlet velocity shall not be more than 1800 rpm. Fan housing with motor shall be mounted on a common steel base mounted inside the AHU on anti-vibration springs or cushy foot mount. The fan shall be direct driven type. Another fire retardant canvass connection shall be provide at unit outlet to connect the ducts.

7. Cooling Coils :

The cooling coil shall be seamless copper tubes not less than 0.437 mm thick and 12.5 mm O.D. The coil shall have continuous aluminium fins. The tube shall be staggered in the direction of air flow. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube. The coil shall be tested against leaks At a hydraulic pressure of 21kg/m³ for a period of two hours. The water headers shall be of copper pipes to connect all the tubes. The header shall be complete with water In/Out connections, vent plug and drain at the bottom and designed to provide a water velocity between 0.6 to 1.8 m/s (2 to 6 FPS)

8. Filters :

As asked for under Bill of quantities.

9. Electrical Panel :

Each unit shall have its own electric panel consisting of MCCB / fuse switch unit, starter, indicating lamps ,incoming/outgoing internal and external wiring and earthing as per the details in BOQ.

10 Fresh Air Control :

An adjustable damper of GI sheet along with bird screen, air inlet louvers and air filters shall be provided for fresh air entry. The damper shall be sized for 50% of designed air quantity.

11 Limitations :

The air velocity across the cooling coils shall not exceed 500 fpm.

The fan outlet velocity shall not exceed 1800 fps (9m/s) in any case.

The velocity across the filters shall not exceed 500 fpm in any case.

PUMPS

1. **General**

The various items of pump shall be complete in all respect and comply with the specification given below:

2. **Pump Sets**

The chilled water and condenser water pump sets shall be Vertical inline type split coupled Centrifugal type with flanged connections, mounted on drip proof squirrel cage induction motor with suitable starter as specified.

Pumps shall be as per IS:1520-1960, IS:9079, IS:325 and shall be of the following construction:

- | | | |
|----|----------------------|---------------------------------|
| 1. | Casing | Cast Iron/Cast Steel |
| 2. | Impeller | SS/Bronze |
| 3. | Shaft | High Tensile Steel |
| 4. | Shaft sleeve | SS |
| 5. | Bearings | Heavy Duty Ball/Roller bearings |
| 6. | Base Plate | Cast Iron/Fabricated M.S. |
| 7. | Flanges | BIS 1536/1960 |
| 8. | Stuffing Box sealing | Mechanical seal |

9.	Max. Speed	1500 RPM/2900 RPM
10.	Drive	as per BOQ
11.	Starter	See Section "Electrical Switchgears"

- a) Drive ratings shown are only tentative and Tenderers shall select their drivers at least 5% in excess of the maximum BHP of the pump plus transmission losses, if any. Drivers shall be supplied with starters unless otherwise stated.

3. Accessories & Fittings

The following accessories/fittings shall be provided with each pump among other standard accessories/fittings required:

- i) Lubrication fittings and seal piping
- ii) Test and/or air vent cocks
- iii) Steel channel base frame for fixing pump on the concrete foundation
- iv) Suction and discharge pressure gauges not less than 150mm dia. and of the appropriate rating, with gauge cocks, etc.
- v) 25 mm G.I. gland water drain piping.

4. Installation

Pumps shall be installed as per manufacturer's recommendations. Pump set shall be mounted on concrete block which in turn is mounted on machinery isolation cork or any other equivalent vibration isolation fitting.

Concrete foundation will be made by the Contractor as per approved drawings and specifications and the isolation pad foundation bolts, etc., shall also be supplied by the Contractor. Contractor shall ensure that the foundation bolts are correctly embedded.

Pump sets shall preferably be factory aligned whenever necessary, site alignment shall be done by competent persons. Before the foundation bolts are grouted and the coupling bolted, the bed plate levels and alignment results shall be submitted to the Engineer.

5. Insulation

Pumps used for chilled water service shall be insulated so that the dismantling of pumps not affected. Insulation shall be provided in a manner so as to minimize the damage to the insulation in case of maintenance of pumps or other components.

6. Testing

Tenderers shall submit the performance curves of the pumps. They shall also be responsible for the selection of 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 for their discharge head, flow and B.H.P. Test results shall correspond to the performance curves.

Tenderers shall furnish the required testing instruments and arrange for their connection as required.

7. Painting

After complete installation and testing, pumps accessories and fittings shall be given two coats of approved finishing paint.

8. Pumps VFD salient features:

VFDs shall be provided on all pumps and shall have built in AC chokes for line side protection and harmonic reduction, VFDs shall be provided with I/O expander cards for expanding the input / output requirements. they shall have BMS option for integration with IBMS and also shall have pump logic controller for synchronizing the VFDs for pump application.

VFDs shall have pump functions like sleep frequency, wake frequency, dry pump protection, PID controller/built in PLC for performing the pumping functions.

VFDs shall be with 4 line alpha numeric display.

VFDs shall be housed inside sheet steel cubicle panel with associated switchgears like SFU / MCCB/MPCB, contactors, overload relays, indicating lamps, push buttons, selector switches, control transformers, cooling fans along with filters.

The power and control circuit shall be separated to meet the EMI guidelines for the use of VFDs inside the hospital premises.

VFD panel shall be placed near the secondary pumps motor to keep the cable length below 30 m.

Motors used for VFD shall be inverted duty and shall have VPI treatment, insulated bearing housings and IE4 type.

Sheet Metal Work & Air Distribution

1. Scope :

The scope of work shall include supply of factory fabrication of G.I. sheet metal duct and its installation as shown in the relevant duct drawing, testing at site, loading & unloading of G.I. sheet ducts at site, and shifting and other hardware from site stores to exact location inside the office complex. The packing shall be suitable for marine transportation purpose and all other natural disasters and the same shall be transported to respective office warehouses to achieve a guaranteed commercial operation of the same to the entire satisfaction of client.

2. RAW MATERIAL

Galvanizing shall be uniform coating of zinc on both sides (total) of 275gm/sq.m and Lock forming quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

GAUGES, BRACING BY SIZE OF DUCTS

All ducts shall be fabricated from galvanized steel/ aluminum of the following thickness, as indicated as below:

For Rectangular ducts shall with external SP up to 250 Pa (25mm Wg)

Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.

All transverse connectors shall be 4 bolt slip-on flanges system with built-in sealant.

Duct construction shall be slip-on flange in compliance with 1" (250Pa) w.g. static norms as per SMACNA. Important to note is Slip-on flanges system should have 3rd party testing & certification.

FOR SELECTION OF 4 BOLT SLIP-ON FLANGE CLASS AND DUCT GAUGES AT 1200 MM SPACING						
Duct Dimension	Duct Pressure in Inches / (Pascals)					
	1"(250)*⁵	2"(500) *⁴	3"(750) *³	4"(1000)	6"(1500)	10"(2500)
in(mm)	Reinforcement Class – Duct Gauge					

150 – 250	E-26	E-26	E-26	E-26	E-26	E-24
251 – 300	E-26	E-26	E-26	E-26	E-24	E-24
301 – 350	E-26	E-26	E-26	E-26	E-24	E-22
351 – 400	E-26	E-26	E-26	E-26	E-24	E-22
401 – 450	E-26	E-26	E-26	E-26	E-24	F-20
451 – 500	E-26	E-26	E-24	E-24	E-24	F-20
501 – 550	E-26	E-26	E-24	E-24	F-24	H-20
551 – 600	E-26	E-26	E-24	E-24	F-22	H-20
601 – 650	E-26	E-26	E-24	E-24	F-22	H-20
651 – 700	E-26	E-26	E-24	F-24	H-22	H-18
701 – 750	E-26	E-26	E-24	F-24	H-22	I-18
751 – 900*2	E-26	E-24	F-22	H-22	H-20	I-18
901 – 1000	E-26	F-24	H-22	H-20	I-18	J-16
1001 – 1200	E-24	H-22	H-20	I-18	I-18	
1201 – 1300	F-24	H-20	I-18	I-18	J-16	
1301 – 1500	F-24	H-18	I-18	I-16	NOT DESIGNED	
1501 – 1800	H-22	I-18	J-16			
1801 – 2100	I-20	J-18				
2101 – 2400	I-18	J-18				
2401 – 2700	I-18					

Notes:

SMACNA- Sheet Metal and Air conditioning Contractors' National Association Inc-"HVAC Duct Construction Standards-Metal and Flexible"-2005, U.S.A.

For non-critical comfort cooling applications (1" w.g. pressure class), optional "C & S" or "C & SS" cleat joints can be used.

Upto 450 mm duct size use "C & S" cleats.
 451 to 750 mm duct size use "C & SS" cleats.
 Over 750 mm duct size use 4 bolt Slip-on flanges.

FABRICATION STANDARDS & EQUIPMENT

All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

1. A coil (Sheet metal in Roll Form) line to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.
2. All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.
3. All edges to be machine treated using lock formers, flangers and rollers for turning up edges.

4. Kitchen exhaust ducting shall be with 16 G MS suitable access doors shall be provided at every 3 m. Provision shall be made for fire fighting agency to install duct mounted sprinklers at every 3m. Generally exhaust duct shall have slop towards kitchen hood.

DUCT CONSTRUCTION

All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes:

- a) Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section "Insulation" and as indicated in schedule of quantities. Duct dimension shown in the drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.
- b) Ducts shall be straight and smooth on the inside with longitudinal seams shall be air either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.
- c) All ducts up to 75 cms width within conditioned spaces shall have slip and drive (C&S/SS) joints. The internal ends of slip joints shall be in the direction of airflow. Care should be taken ensure that S/SS cleats are mounted on the longer side of the duct and cleats on the shorter side. Ducts more than 75cms width shall have 4 bolt slip-on flanges. Ducts and accessories within the ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint.
- d) Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-vanes shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.
- e) Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall adequately supported and braced where required with standing seams, tees or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.
- f) All sheet metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans, shall be constructed of 18G GSS/16G Aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.

- g) Plenums shall be shop/factory fabricated panel type and assemble at site. Fixing of galvanized angle flanges on the duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.
- h) Self adhesive Polyethylene lining of minimum 4.5mm thickness instead of felt shall be used between duct flanges and between duct supports in all ducting installation.

3. Accessories:

- All dampers, except where shown, shall be louver dampers having multiple opposed blades type or with parallel blades of airfoil construction. The construction of the dampers shall be robust and tight fitting. They should be made from 18 gauge galvanized sheets. The depth should be minimum of 150mm and flanges of 40mm. Blades shall be connected with a suitable linkage for operation by an extending by an extending lever, which shall have a locking quadrant with positions of the damper indicated on it. Dampers and their operating device shall be made robust, easily operable and accessible through suitable access doors in the ducts.
- Dampers shall be provided in ducts at every branch supply or return air duct connections whether or not indicated on the drawings for the proper volume control and balancing the system.
- Where shown, splitter dampers shall be installed. This damper consists of double thickness airfoil blade hinged on the downstream edge. The operating lever shall extend outside the duct and insulation with an airtight hub and locking arrangements. The thickness of the damper blades shall be the same as the duct in which they are installed but not less than 1.5mm thickness.
- Fire dampers shall be motorized / solenoid type wherever specified shall be provide in the ducts to minimize spreading of fire through ducts, i.e. points where duct passes fire (rated 1 ½ hrs. or more) wall or slab. Fire dampers shall be 230mm – deep and face area as required. The outlet casing of the damper shall be fabricated out of 12 gauges M.S. sheet duly epoxy painted with two coats. The louvers shall be provided with smooth pivoted linkage, tripping mechanism of steel bar with heavy-duty spring assembly and provision of motor. The louvers to be arranged to pivot and hold in an open position and can be closed by an electrically operated motor. The damper is used in conjunction with a smoke alarm system. The entire assembly shall be duly epoxy primer of 2 coats (epoxy paint) or aluminum spray painted. The dampers shall be designed for automatic as well as manual tripping.
- Motors shall be rated for fire damper (spring to close power to open) operation and shall be suitable for outdoor installation (IP55). Fire dampers are closed on a signal from the fire control module. Module supply and wiring by fire control contractor.
- Motorised dampers should be single flap dampers with 18 gauge construction with Belimo or Equivalent make spring return type. Opening time should be more than 75secs. And closing time should be 30secs. The power shall be given from the electrical panel and will be routed through the unit.
- 300mm X 300mm access panels with gasket neoprene and stud bolt type shall be provided near lower dampers/ splitters dampers and fire damper. All main ducting

work shall be accessible throughout using tight fitted hinged access doors. Doors shall be cemented sponge rubber gaskets of 6mm thickness. Felt is not acceptable. In the case of insulated ducts with access doors, the same shall be properly insulated, such that it can be operated without damaging the duct insulation and there should be no condensation either on the access doors or on the ducts when the plant is running.

4. Installation Guidelines

- The duct fabrication and installation shall generally conform to IS 655-1963.
- All ducts shall be supported from the concrete slab or beams. Duct supports shall be fixed through the use of two anchor fasteners for each leg. The anchor fasteners shall be of approved make. If ducting is supported from steel structure, Beam Clamps shall be provided. In no case shall the duct be supported from the false ceiling hangers or be permitted to rest on a hung ceiling.
- Transverse joints shall be provided with rubber gaskets (6mm thk.) of nonflammable type. Use of felt shall not be permitted.
- Wherever the ducts are acoustically lined, the duct size shall be increased by the thickness of the duct lining.
- The contractor shall provide and neatly erect all sheet metal work as per the specifications and drawings. This work, in all its parts and details, shall meet with the approval of the Engineer.
- The contractor shall make all necessary allowances and provisions for beams, pipes or other obstructions in the ducting, whether or not the same has been shown in the drawings. Wherever necessary to avoid beams or other structural works, plumbing or other pipes / conduits, the ducts shall be transformed, divided or curved to one side as approved or directed by the Engineer. However the required cross-sectional area shall be maintained.
- All metal work shall be done in dead or furred down spaces so as not to cause any delay to other contractors on the building.
- If a duct cannot be installed as shown in the drawings, the contractor shall install the duct between the required points by any path available subject to the approval of the Engineer and consultants.
- All ducts shall be rigid and shall be adequately supported with standing seams, tees or angles of ample size wherever required to keep the ducts true to shape, prevent buckling, vibration and breathing.
- All duct joints shall be tightly fitted using rubber gasket of nonflammable type and all interior surfaces shall be smooth. Bends shall be made with radius not less than one-half of the width of the duct or with properly designed interior curved vanes. Two vanes shall be spaced such that the aspect ratio of each of the individual elbows formed by the vane will be about five to one.
- All sheet metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans, shall be constructed from 16G galvanised iron thoroughly stiffened with 25mm X 25mm angle iron braces and fitted with all necessary doors as required to give access to all parts of the apparatus. Doors shall not be less than 46 cm X 71cm. Sheet Metal connections to indoor units shall be flexible, double thickness fiberglass cloth or equivalent nonflammable material of 100mm long.

- Where metal ducts or sleeves terminate in woodwork, brick or masonry openings tight joints shall be made by the means of closely fittings heavy flanged collars.
- Resistoflex or similar vibration isolation material of 6mm thickness shall be provided between ducts and duct support.
- Where ductwork is connected to rotating equipment duct such as fans, air handling units (indoor unit of split/package system), the connections shall be made with double thickness nonflammable flexible material, 100mm long.

5. Grilles and Diffusers:

- **Supply Air Side Wall Outlets**

- Wherever specified in the B.O.Q. shall be in Aluminum construction.

- **Double Deflection Grilles:**

- Wherever specified in the B.O.Q. shall be in Aluminum construction. Aluminum double deflection grills for supply air shall be provided with vertical and horizontal adjustable bars and an approved blade damper adjustable from the front face of the grille. The grilles will be powder -coated in a shade as given in the schedule of finishes of this handbook.

- **Fixed Bar Linear Grilles**

Fixed bar grilles will be in extruded aluminum construction. Bars shall be fixed in position using vertical tie bars. Bar spacing shall not exceed 12mm and the grilles shall have 60% free area. Deflection angle of the bars shall be 0. The grilles will be powder coated in a shade as per the owner/ consultants Irrespective of grille finish, vertical tie bars shall be powder coated in Matt black. Supply air outlets shall be provided with volume control dampers to be installed in the duct collar. Dampers shall be in black Matt powder coated finish. Where required by the Consultants, the grilles shall be provided with a margin on all sides. Supply air outlets shall be provided with end closure pieces for the supply portion of the grille. The end closure pieces shall not come to the grille face.

- Continuous grilles shall butt with hairline joints and be provided with interlocking splines.
- All return air grilles shall be similar and equal to the above as determined by consultants.
- All exhaust air grilles shall be similar and equal to the supply air grilles specified above.

6. Ceiling Outlets:

Square / Rectangular Diffusers:

Shall be of aluminum construction wherever specified in the BOQ. Corners of inner and outer cores shall be assembled to provide precise mitered corners. Supply air diffusers shall be provided with multi blade butterfly dampers. Damper flaps shall be provided with a nylon worm gear assembly for ease of operation. Diffusers will be powder -coated in a shade as approved by client/ consultants . Diffuser shall be half step down type.

7. Guidelines for Installation of Grilles/Diffusers

Installation of the grilles/diffusers shall be done by the air conditioning contractor irrespective of the type/model of false ceiling systems. The diffusers will have to be individually suspended from the duct and aligned to match the ceiling line level. In case gypsum or any other false ceiling system, all wooden frames, rectangular or circular for supply/return/exhaust air diffusers will be provided by the Air conditioning contractor.

All air outlets/return air inlets in the same room shall be of the same size unless otherwise specified.

Grilles and diffuser samples must be submitted to the consultants for prior approval before procurement and installation.

Wire Hangers shall be used to suspend all static HVAC services.

Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10) stud, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design. The end fixings and the wire must be of the same manufacturer with several options available. The system should be secured and tensioned with a Hanger self-locking grip at the other end. Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and should not be an integral part of the self-locking grip. Only wire and/or supports supplied and/or approved, shall be used with the system.

- a. Wire Hangers should have been independently tested by Lloyds Register, APAVE, TUV, UL, CSA, Chiltern International fire, ADCAS, Intertek, ECA, and SMACNA, approved by ULC and CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002
- b. The contractor shall select the correct wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

The correct specification of wire Hanger required is determined using the following formula.

Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).

Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer's handbook.

The contractor shall select the correct length of wire rope required to support the service. Lengths from 1-10m lengths. Specials can be made, check with manufacturer. No in-line joints should be made in the rope.

Table. 1

Wire (Gripple) Hanger Safe Working Loads		
size	minimum breaking load of Wire Rope	working load limit (kg/lbs)
No. 1	80kg/176 lbs	0-10 kg / 0-22 lbs
No. 2	260kg/572 lbs	10-45 kg / 23-100 lbs
No. 3	580kg/1276 lbs	45-90 kg / 101-200 lbs
No. 4	1500kg/3300 lbs	90-225 kg / 210-495 lbs
No. 5	2160kg/4752 lbs	225-325 kg / 496-715 lbs
No. 6	2500kg/5500 lbs	325-500 kg / 715-1100 lbs

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless steel wire rope as per the application, the minimum specification is as above and should be manufactured to BS 302 (1987), BSEN12385. **Comply with manufacturer's load ratings and recommended installation procedures.** Note the testing is done to the minimum breaking load of the wire thus giving a minimum safety factor of 5: 1.

Ducting Supports:

All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be. The spacing between supports should be not greater than 2.4 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope using Gripple shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners.

All horizontal ducts shall be adequately secured and supported. In an approved manner, with trapeze Hangers formed of galvanized steel wire rope in a cradle support method (refer to typical drawings) under ducts at no greater than 2000mm centre, for above 2000-2250mm 50x50x5 mm angle should be used under the duct (refer to typical drawings), above 2250mm appropriate size angle should be used with prior approval. All vertical duct work shall be supported by structural members on each floor slab. Duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger wires shall then hang around the ducting. Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services where recommended for by the manufacturer. Rigid support must also be used in conjunction

with wire rope hangers with duct work at each change of direction or connection. Support ducting in accordance with Schedule I at the end of this Section. Any other Grapple solution can be used based on manufacturer's recommendation on site conditions after prior approval. In cases of Spiral ducting the wire can be wrapped directly around the ducting without the need for a spiral ducting clamp for sizes above 1100 a cradle support should be provided refer to manufacturer's recommendations.

Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Construction manager/consultant. In no case shall any duct be supported from false ceiling Hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building. All supports of pipe shall be taken from structural slab/wall by means of fastener.

Piping Supports: Rigid supports may be used in conjunction with grapple hangers to assist with alignment of services as per the Schedule II. These can be at 30m intervals or so depending on the run of the service. Rigid support must also be used in conjunction with grapple hangers with pipe work at each change of direction or connection. For insulated pipe, provide protective sleeve to protect the entire circumference of the pipe insulation. Stainless Steel Supports should be available for food, chemical and High Corrosion areas near coastlines.

Any other grapple solution can be used based on manufacturer's recommendation on site conditions after prior approval. Support piping in accordance with Schedule II at the end of this Section.

Duct Hanger Schedule

For ducts with external SP upto 250 Pa

Maximum Duct Size (mm)	Gauge	Griple Hanger No.
1 - 750	26	2
751-1000	26	2
1001-1200	24	3
1201 - 1500	24	3
1501 - 1800	22	4
1801-2100	20	4
2101-2700	18	4

For ducts with external SP upto 500 Pa

Maximum Duct Size (mm)	Gauge	Griple Hanger No.
1-600 mm	26	2
601-750 mm	26	2
751-1000 mm	24	3
1001-1200 mm	22	4
1201-1300 mm	20	4
1301-1500 mm	18	4
1501-1800 mm	18	4
1801-2100 mm	18	4
2101-2250 mm	18	4
2251-2400 mm	18	4
2401-2700 mm	18	4

Pipe Hanger Schedule

Pipe Size	Weight of pipe + fluid	Weight of pipe + fluid per Rmt	Spacings (pipe + fluid+insulation)	Spacings (pipe + fluid+plaster)	Total Weight of pipe + fluid	Total Weight of pipe + fluid	Gripple Hanger No.	Gripple Hanger No.
(mm)	with insulation (kgs/rmts)	with sand cement plaster (kgs/rmts)	between supports (mts)	between supports (mts)	with insulation (kgs/rmts)	with sand cement plaster (kgs/rmts)	with insulation (kgs/rmts)	with sand cement plaster (kgs/rmts)
12-32	11.73	14	1.5	1.5	18	21	2	2
40-65	11.73	14	2	2	23	28	2	2
80-125	34.73	41.67	2	2	69	83.34	3	3
150-250	112	134	2	1.5	224	201	4	4
300 - 350	180	215	1.5	1.5	270	322.5	5	5
400-500	320	383	1.5	-	480	-	6	-
600-above	as per the manufacturer recommendation and with prior approval.							

Rigid Supports for pipes to be used in conjunction with wire supports:

Pipe size	Rod Size
Upto 12 mm	10 mm
15 to 25 mm	10 mm
30 to 150 mm	10 mm
Over 150 mm	12.5 mm

Pipes & Valves :

1. General

The scope shall comprise the supply, installation of pipe, fittings, valves, etc. and testing/balancing of complete system. Pipe sizes shown on drawing are for the guidance of Contractor and shall not relieve Contractor of responsibility of providing smooth, noiseless circulation of fluid.

2. Pipes

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

All pipes shall be of schedule 40 thick as per ANSI-B-36.1.

All pipes in sizes upto 150mm dia shall be M.S. ERW pipe heavy class as per IS:1239-Part-I (as per latest amendment).

All pipes in sizes 200mm and above shall be M.S. ERW pipe heavy class as per IS:3589 (as per latest amendment).

3. Fittings

The dimensions of the fittings shall conform to I.S. 1239-Part-II (as per latest amendment) unless otherwise indicated in the specifications.

All bends in sizes upto and including 150mm dia. shall be ready made of heavy duty, wrought steel of appropriate class.

All bends in sizes 200mm and larger dia. shall be fabricated from pipes of the same dia. and thickness with a minimum of 4 sections, and having a minimum centre line radius of 1.5 diameter of pipes.

All fittings such as branches, reducers, etc. in all sizes shall be fabricated from pipes of the same dia. and thickness and its length should be at least twice the dia. of the pipe.

The branches may be welded straight to the main line, without making a separate fitting, where specified on drawings or required by Engineer-in-Charge.

Blank ends are to be formed with flanged joints and 6mm thick blank between flange pair for 150mm and over in case where, a future extension is to be made, otherwise blank end discs of 6mm thickness are to be welded on, with additional cross stiffeners from 50mm x 50mm x 5mm heavy angles.

4. Flanges

All flanges shall be of mild steel as per IS:6392/71 and shall be steel slip-on-type, welded to the pipes flanges thickness shall be to suit class-II pressures. Flanges may be tack welded into position, but all final welding shall be done with joints dismounted. 3mm thick gaskets shall be used with all flanged joints. The gaskets shall be fiber reinforced rubber as approved by the Engineer-in-Charge. Special adhesive compound shall be used between flanges of steam, air and gas lines.

Flanges shall be used as used as follows :

Counter flanges for equipment having flanged connections.

Flanged pairs shall be used on all such equipment, which is required to be isolated or removed for service e.g. pumps, refrigeration machines, air handling units, etc.

All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flange connection, for removal of valves from main lines for repair/replacement.

5. Valves

a) Butterfly Valves, Gate Valves, Globe Valves and Check Valves:

All gate valves, globe and check valves upto and including 40mm dia. Shall be of gun metal screwed type, conforming to class 1 of IS:778.

All butterfly valves of 50mm dia. and above shall be flanged type, have cast iron body with black nitrile rubber seat and conforming to class PN-10 of IS:780 (for sizes upto 300mm) and of IS:2906 (for sizes 350mm and above).

All globe and check valve of 50mm dia. and above shall be flanged type in cast iron construction and conforming to class PN-10.

Air valves shall be provided at all higher points in the piping system for venting as per the sizes shown in the BOQ.

All air needle valves shall be of gun metal and tested upto a pressure of class 1 pressure rating. All globe valves of size 50mm and above shall be of rising spindle type.

b) Balancing Valves

All balancing valves of upto and including 50 mm dia. shall be in gun metal screwed type construction. The valves of 65 mm dia. and above shall be in cast iron flanged end construction.

The valve shall have PTFE/SS disc with special erosion/ corrosion proof sealing.

The valves shall be capable of delivering metered quantity of water and subsequently should function as isolating valve. All the valves shall have built in pressure drop measuring facility to ascertain water flow rate. The valves shall have temper proof adjustable and lockable arrangement for required water quantity after commissioning. The valve shall be to the minimum requirement of IS:778 Class-1.

The valves shall be complete with drain cock, pressure test cocks, etc.

c) Miscellaneous Valves

All gauge cocks shall be of gunmetal plug type, complete with siphon (brass chrome plated).

All drain valves shall be of gunmetal with a hose union connection on one end or extended upto the drain pit as the case may be.

All valves on the supply line of fan coil units shall be of gunmetal ball type with integral water strainers, having (BSP) FPT inlet and flare type MPT outlet connection.

All valves on the return line of fan coil units shall be as above but without integral water strainer.

d) Strainers

The strainers shall either be 'pot' type or 'Y' type with cast iron or fabricated steel body, tested to a pressure of 10 kg/sq.cm. applicable for the butterfly valves as shown on the drawings.

The strainers shall have a perforated bronze sheet screen with 3mm perforation, 0.63mm thick.

Pot strainers and Y strainers shall be provided with flanged connections.

The strainers shall be designed to facilitate in easy removal of filter screen for cleaning, without disconnection of pipe line

Pot strainer shall be fabricated out of M.S. sheet and the sizes shall be as under:

Pipe size (mm)	Pot Dia (mm)	Pot HT (mm)	Basket dia (mm)	Basket HT (mm)
50	300	400	200	240
80	350	450	250	250
100	450	500	300	280
125	500	600	330	340
150	540	700	360	390
200	610	815	400	470
250	800	955	550	510
300	1000	1105	750	580
350	1190	1300	895	678
400	1350	1500	1020	785
450	1518	1700	1060	890
500	1690	1800	1100	900

6 Jointing

All pipelines shall be welded type except G.I. piping which shall have screwed connections. Square cut plain ends will be welded to pipe upto and including 100mm dia. All pipes 125mm dia. or larger will be bevelled by 35° for welding.

7. Miscellaneous

- a) Provide all piping, required to make the apparatus connected, complete and ready for regular and safe operation. Unless otherwise noted, connect all apparatus and equipment in accordance with manufacturer's standard details, as approved by Engineer-in-Charge.
Consult drawings and specifications to determine number and requirements of all items of equipment requiring piping, such as bend, drain, relief, etc. wherever equipment is provided with connections for such piping.
- b) Unless otherwise specified, pitch the lines of piping as follows:

All condensation drainage, including air handling unit and fan coil unit shall be pitched in the direction of flow to ensure adequate drainage, with an adequate trap seal to prevent leakage of air due to static pressure developed by air conditioning units. Pitch, 20mm per metre wherever possible, but not less than 10mm. Drains from other equipment shall be pitched similarly without trap seal.
- c) Provide valves and capped connections for all low points in piping system, necessary or required for draining systems. Provide for all risers isolating valves and drain valves to permit repairs without interfering with the rest of the system
- d) During construction, temporarily close, open ends of pipes with sheet metal caps, where necessary, or required to prevent debris from entering piping system.
- e) Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion.
- f) Provide suitable platforms, etc. to facilitate the maintenance-repair and replacement of valves and fittings.
- g) Unions, if used, shall be flanged, as required, wherever indicated and in connections to all equipment, apparatus, and specialities requiring disconnection for repairs or replacement. Locate unions between shut-off valves and equipment, as directed by Engineer-in-Charge.

- h) Provide shut-off valves where indicated and for individual equipment, units at inlet and outlet, to permit unit removal for repairs, without interfering with remaining of the system. Additional shut-off valves shall be provided as required to enable all systems to be fully sectionalised. By-pass and stop valves shall be provided for all automatic control valves as specified
- i) Arrange piping for maximum accessibility for maintenance and repair; locate valves for easy access and operation. No valves shall be installed with handles pointing down, unless unavoidable.
- j) Cut the pipes accurately according to measurements, established at building and work into place without springing or forcing.
- k) Pipe supports shall be adjustable for height and prime coated with rust preventive paint and finish coated with grey paint, both as approved by Engineer-in-Charge. Spacing of pipe supports shall not be more than that as specified below :

Nominal pipe size (MM)	Spacing (Metres)
15	1.25
20 & 25	2.00
32, 40, 50 & 65	2.50
80, 100 & 125	2.50
150 & above	2.50

- l) Extra supports shall be provided at the bends, and at heavy fittings like valves to avoid undue stresses on the pipes. Pipe hangers shall be fixed on walls and ceilings by means of 'Hilti' metallic dash fasteners.
- m) Insulated piping shall be supported in such a manner so as not to put undue pressure on the insulation.
Hangers and supports shall be provided and installed for all piping and tubing wherever indicated, required or otherwise specified. Wherever necessary, additional hangers and supports shall be provided to prevent vibration or excessive deflection of piping and tubing.

All hangers and supports shall be made of steel or other durable and non-combustible materials, galvanised or plated. Wood, wire or perforated strap iron shall not be used as permanent hangers or supports.

Hangers shall be supported from structural steel, concrete inserts and pipe racks, specifically approved.

No hanger/equipment shall be suspended midway, between steel joists and panel points.

Drilling or punching of holes in steel joist members will not be permitted.

All pipes in AC plant room shall be supported from pipes and channels from floor.

9 Sleeves

Where pipes pass through walls, provide galvanised steel pipe sleeves 50mm larger than outside diameter of pipe without any extra cost. Where pipes are insulated, sleeves shall be large enough to have ample clearance for insulation.

Where pipes pass through outside walls or floor slab the space between pipe and sleeve shall be packed with lead wool and oakum.

The centre of pipes shall be in the centre of sleeves and sleeves shall be flush with the finished surface. Floor sleeves shall project 50mm above finished floor level.

10 Expansion or Contraction

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

11 Arrangement and Alignment of Piping

All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the Engineer-in-charge.

Unless otherwise specified, the piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceilings, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angles and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide a maximum head room.

All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult to route, this contractor shall reroute his pipes as required to avoid interference at the discretion of the Engineer-in-Charge.

All piping shall be carefully installed to provide for proper alignment, slope and expansion.

The stresses in pipelines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle.

Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.

Small tubing, gauges, controls or other equipment installed on any apparatus, shall not be coiled or excessive in length, but shall be installed neatly, carefully bent at all changes in direction, secured in place and properly fastened to equipment at intervals to prevent sagging. The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions. All tubing/capillaries shall be provided with PVC sleeves to save it against frictional cuts or damage due to vibration.

12 Testing

In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall piping equipment or appliances be subjected to pressures exceeding their test rating.

The tests shall be completed and approved before any insulation is applied. Testing of segments of pipe work will be permitted, provided all open ends are first closed, by blank-offs or flanges.

After tests have been completed, the system shall be drained and flushed 3 to 4 times and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.

All piping shall be tested to hydraulic test pressure of at least two times the maximum operating pressure but less than 10 kg/sq. cm. for a period of not less than 24 hours. All leaks and defects in the joints revealed during the testing shall be rectified to the satisfaction of the Engineer-in-Charge, without any extra cost.

All the piping systems shall be tested in the presence of the Engineer-in-Charge or their authorised representative. Advance notice of test dates shall be given and all equipments, labour, material required for inspection, and repairs during the test shall be provided by the contractor. A test shall be repeated till the entire system is found satisfactory to the above authority. The tests shall be carried out for a part of work if required by the Engineer-in-Charge in order to avoid hinderance in the work of the insulation contractor.

All water and condensate pipes shall be tested and proven tight under hydrostatic pressure of 10 kg/sq.cm., unless otherwise stated, for a minimum period of 24 hours without drop in pressure.

The Contractor shall make sure that proper noiseless circulation is achieved through all piping systems. If due to poor air bond, proper circulation is not achieved, the contractor shall bear all expenses for carrying out the rectification work including finishing of floors, walls and ceiling damaged in the process of rectification.

The Contractor shall provide all labours and materials to make provision for removing water and throwing it at the proper place during the testing or/and after the testing to avoid damages to employer or other contractors properties. Any damage caused by the contractor to the employer or other contractors properties, shall be borne by the Contractor.

13. Copper Piping

Heavy gauge soft copper tubing, type M, shall be used to make connections to equipment, wherever required or specified by Engineer-in-Charge.

Flare fittings e.g. flare nuts, tees, elbows, reducers, etc. shall all be of brass.

14. Refrigerant Piping

The refrigerant circuit piping shall be of carbon steel seamless, as per ASTM-A-106, grade B or BS-3602 grade 23 and dimensioned as per ANSI B-36.1, schedule 40. The fittings shall be heavy class. The pipes and fittings shall be connected by means of welded joints. The connections to gauges, controls, etc. shall be with flare fittings. The refrigerant valves, required in the circuit shall be as follows:

Valve Size	Valve Material	Type of Connections fittings
Upto 12mm	Brass packless type	Flare
16mm and above	Brass/Steel packed	Brazed/Welded type

Note :-All valves shall be tested against leaks upto 28 kg/sq.cm.

The strainers for the refrigerant liquid line shall be 'Y' type with gun metal body and bronze filter screen of fine mesh. The filter screen shall be easily removable type without dismantling the strainer from the circuit. The moisture indication sight glass in the liquid line shall have leak proof glass on opposite sides to permit easy inspection of the liquid refrigerant. Silencers and moisture drier etc. shall be provided as part of the refrigerant piping.

Bolts wherever used shall be electro-galvanised steel. Brazed joints, in the refrigerant piping, which has leak, shall be opened and re-done. These shall in, no case be repaired by addition of brazing alloy to the joint.

15. Drain Piping

The drain piping shall be medium class galvanized steel as per IS:1239 (as per latest amendment).

The fittings shall be of as per IS:1239 Part-II with screwed connections.

The gate valves shall be of gun metal as described earlier.

Pipe crosses shall be provided at bends, to permit easy cleaning of drain line. The drain line shall be provided upto the nearest drain trap and pitched towards the trap.

Drain lines shall be provided at all the lowest points in the system, as well as at equipments where leakage of water is likely to occur, or to remove condensate and water from pump glands. The drain pipe work shall be carried out with threaded joints only. No welded joint shall be permissible.

16 . Painting

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

All pipes (insulated and non insulated) shall then be given two coats finish paint, of a type and colour as approved by the Engineer-in-Charge.

Duct and Pipe Insulation

Ductwork shall be insulated as per the below specified guidelines.

Painting

Angle iron Flanges, Stiffeners, hangers and supports shall be painted with 2 coats of anti-rust primer and remaining uncovered duct shall be further painted with 2 coats of synthetic enamel paints of black color.

Testing and Balancing

After completion of ducting work, system shall be tested for air leakage. Leakage if any shall be plugged and all the adjustments and balancing are completed. The air quantity readings shall be recorded. All dampers shall be set and locked in position after the final adjustments. All readings made shall be submitted to the consultants for approval.

Ductwork & Piping Insulation Application Guidelines :

Piping and accessory insulation application shall be as follows:

- Pipes shall be thoroughly cleaned with wire brush and rendered free from all rust and grease.
- For insulation of straight pipe slip on method shall be used. For elbows and bends snap off method will be used.
- First 2 coats of specified Insulation adhesive shall be applied then the Insulation shall be fixed tightly on the surface taking care to seal all joints .
- Adequately sized PVC self-adhesive tape shall be provided to seal all joints afterwards Al cladding shall be done as per requirements.

DUCT INSULATION

MATERIAL

- *Insulation material shall be Closed Cell Elastomeric Nitrile Rubber*
- *Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.033 W/(m.K) at mean temperature of 0°C*
- *Insulation material shall have anti-microbial product, which is EPA (Environmental Protection Agency), USA approved, as an integral part of insulation which cannot be washed off or worn off.*
- *It shall give enhanced level of protection against harmful Microbes such as bacteria, mold, mildew and fungi and shall confirm to following standards: Fungi Resistance – ASTM G21 and Bacterial resistance – ASTM G 22 / ASTM 2180.*
- *The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990 as well the National Building code (NBC) of india.*
- *Material shall be FM (Factory Mutual).*
- *Moisture Diffusion Resistance Factor or 'μ' value shall be minimum 10,000.*

The insulation thickness shall be 19 mm on all ducts and 32 mm on pipes as detailed in BOQ.

Pipework Insulation :

All chilled water and drain pipes Insulation shall be as follows.

Closed Cell Elastomeric Nitrile Rubber as per BOQ

Acoustic Insulation

- Interior of duct shall be coated with primer. 25mm thick resin bonded fiberglass Twiga finished with RP tissue shall be fixed to duct using spot hot bitumen. All joints shall be sealed with bitumen. The acoustic lining to be covered with RP tissue and perforated aluminum sheets of 30G thickness. The lining of aluminum sheet facing to be mechanically fastened to the duct with GI bolts/nuts and washers Contractor to ensure a smooth internal finish.
- All plenums, connecting pieces connected to air handling units and return air pieces shall also be acoustically insulated.
- There shall be minimum of 75mm overlap between the acoustical and thermal insulation on ducts.

Controls

1. General :

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

2. Chilling Unit Control:

The Chilling machines controls shall be generally standard as per the selected manufacturer standards.

3. Air Handling Unit and Fan Coil Unit controls:

- 3.1 AHUs thermostats shall be cooling/heating suitable for mounting in the room or the return path as required. The thermostat shall be modulating potentiometer type with an adjustable throttling range and required accuracy.

3.2 2- way motorised Valve for AHUs :

The motorised water valve shall be globe type and consist of CI/gunmetal valve body with SS trim and equal percentage of flow characteristics, modulating motor and linkage. The valve shall be of 3 way mixing type.

- 3.2 The thermostat for Fan coil unit shall be space type for cooling. It shall be snap acting type , line voltage, mercury bulb type with differential of 1.1 C. It shall have minimum three speed control complete with wiring etc.

- 3.3 The water pressure gauges shall be of robust construction 150 mm dial of suitable range and occupancy range.

- 3.4 The thermometers shall be mercury filled industrial stem type with metal casing and threaded fixing arrangement.

Control Panel, Motors and switchgears

1. General

This specification covers the designs, material, construction features, manufacture, inspection and testing at the VENDOR'S/his sub-contractors work, delivery and performance testing of metal-enclosed Medium Voltage Switchgear of voltage not exceeding 1000 V AC.

The switchgears would comprise of Motor Control Centres (MCCs) required for the supply of power to the motors of the plant for medium voltage equipment.

2. Codes & Standards

The design, construction, manufacture and performance of equipment shall conform to latest applicable standards and comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

Equipment shall conform to the latest applicable standards as mentioned. In case of conflict between the standards and this specification, this specification shall govern.

All components shall be of reputed make and subject to Purchaser's approval and as per recommended manufacture.

3 Power Supply System

The incomer power supply shall be 415V, 3 phase, 3 wire, 50 Hz, non-effectively earthed AC system. The fault level for the switchgear shall be 40 KA for 1 sec.

Dynamic - 84 Ka (Peak) - Short time

Variation of voltage and frequency from their rated values are as below :

Variation of voltage	$\pm 10\%$
Variation of frequency	$\pm 5\%$
Combined voltage and frequency	

variation

$\pm 10\%$

4 **Site Conditions**

The following site conditions shall be considered for the design of the MCCs

Reference Temperature	}	Ref :Basis of Design
Relative Humidity	}	
Climatic Conditions	}	

5 **Sheet Metal Work**

The switchgear frame shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness not less than 2 mm.

Frames shall be enclosed by sheet metal of thickness not less than 2 mm cold rolled or 2.5mm hot rolled, smoothly finished, levelled and free from flaws. Doors and covers shall be made of sheet steel of thickness not less than 1.6mm. Cold rolled or 2mm hot rolled. Stiffeners shall be provided wherever necessary.

All panel edges and door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members.

Cut-outs shall be true in shape and devoid of sharp edges.

The complete structure shall be rigid, self-supporting, free from vibration, twists and bends.

6 **Painting**

All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with applicable standards.

Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After phosphating, thorough rinsing shall be carried out with clean water, followed by final rinsing with dilute dichromate solution and oven drying.

Panels shall be dry electrostatic painted (powder coated).

Finished painted appearance of equipment shall present an aesthetically pleasing appearance, free from dents and uneven surfaces.

7 Constructional Features

Switchgear panel shall be :

- a) of the metal enclosed, indoor, floor mounted modular type
- b) Made up of the requisite vertical sections
- c) of dust and vermin proof construction
- d) Provided with a degree of protection of IP-54
- e) Easily extendable on both sides by the addition of vertical sections after removing the ends covers
- f) Provided with a metal frame made of structural steel channel section properly drilled for mounting the Switchgear along with necessary mounting hardware. Hardware shall be zinc plated and passivated
- g) Provided with labels on the front indicating the switchgear designation
- h) Provided with cable entry facilities at top or bottom with 3mm thick removable plates and necessary cable glands. For 1 core cables these plates shall be non-magnetic
- i) of uniform height of not more than 2450 mm
- j) of double front execution
- k) Provided with gaskets all round the perimeter of adjacent panels, panel and base frame, removable covers and doors
- l) Provided with copper busbars running at the top or bottom, as required, all along the length of the switchgear in a separate sheet steel enclosure.

Operating devices shall be incorporated only in the front of the Switchgear.

The Switchgear shall be provided into distinct vertical sections each comprising:

- a) A completely metal enclosed busbar compartment running horizontally.
- b) Individual feeder modules arranged in multi-tier formation. It is essential that the modules are integral multiples of the basic unit size to provide for flexibility in changes, if any, at site.
- c) Enclosed vertical busbars serving all modules in the vertical sections. For safety isolation of the vertical busbars, insulating barrier with cut-outs shall be provided to allow the power stab contacts to engage with vertical busbars.

- d) A vertical cable alley covering the entire height. The cable alley shall be minimum 200mm wide for motor control modules and 500mm wide for circuit breaker controlled modules.
- e) A horizontal separate enclosure for all auxiliary power and control buses, as required, shall be located so as to enable easy identification, maintenance and segregation from the main power buses. Tap-off connections from these buses shall be arranged separately for each vertical section.

Each vertical section shall be equipped with space heaters which may be located in the cable alley as specified in schedule of quantities.

One metal sheet to be provided between two adjacent vertical sections running to the full height of the switchgear except for the horizontal busbar compartment. However, each shipping section shall have metal sheets at both ends.

All equipment associated with a single circuit shall be housed in a separate module compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides and the rear, with the withdrawable units in position or removed, except on the cable alley side. A plate cover with a slot to permit wiring connections shall be provided on the side corresponding to the cable alley. The front of the compartment shall be provided with a hinged door.

For dial out type, modules, only the handles of control and selector switches, push buttons, knobs and cut-outs for lamps and meters shall be arranged on the front doors of the respective compartments to permit operation without opening the door. On circuit breaker controlled circuits, protective relays shall be mounted on the front door of the compartment. All other equipment pertaining to a circuit shall be mounted on the withdrawable chassis. All cut-outs shall be provided with gaskets for the purpose of dust-proofing.

Current transformers shall not be directly mounted on the buses. Current transformers on circuit breaker controlled circuits shall be mounted on the fixed portion of the compartment.

In breaker compartments, suitable barriers shall be placed between circuit breakers and all control, protective and indication circuit equipment including instrument transformers. External cable connections shall be carried out in separate cable compartments for power and control cables.

After isolation of power and control connections of a circuit, it shall be possible to safely carry out maintenance in a compartment with the busbars and adjacent circuits live.

The withdrawal chassis shall move on suitable guides and on suitably plated steel or stainless steel rollers or balls to facilitate easy withdrawal.

Cable alleys shall be provided with suitable hinged doors. It shall be possible to safely carry out maintenance of cable connections to any one circuit with the busbars and adjacent live circuits. Adequate number of slotted cable support arms shall be provided for dressing the cables.

All doors shall be provided with concealed type hinges and captive screws.

The withdrawable chassis housing circuit breakers shall be of the fully drawout type.

The chassis/base plate housing feeder control and motor control equipment not incorporating circuit breakers shall be of the fully-drawout, or fixed type.

a) Fully Drawout Type

In this type of construction it shall be possible to drawout the withdrawable chassis without having to unscrew or unbolt any connections to the equipment mounted on the withdrawable chassis. The power and control drawout type connections shall be of the stab-in or sliding type. All drawout contracts, including the auxiliary and control wiring shall be of self-aligning type.

b) Fixed Type

In this type of construction all power connections to the equipment mounted on the base plate shall be of the bolted type. All control circuit connections to equipment mounted on the base plate shall be carried out through conventional terminal blocks mounted in the respective base plate. It shall be possible to remove the base plate after unbolting/unscrewing all the power and control circuit connections to the equipment mounted on the base plate.

c) Interchangeability

All identical equipment and corresponding parts including chassis of drawout modules of the same size shall be fully interchangeable, without having to carry out modifications. For trouble free interchangeability, the drawout arrangements shall be designed such that normal dimensional variations are taken care of by self-aligning feature of the modules. Components and equipment that are not fully interchangeable will be rejected. **VENDOR** shall replace all such equipment by fully interchangeable equipment at his cost.

Switchgear shall be designed in such a way that all component equipment and bus bars operate satisfactorily without exceeding their respective maximum permissible rise in temperature under ambient temperature conditions prevailing with the switchgear cubicle, with reference ambient temperature outside the switchgear cubicles.

All dummy cubicles necessary to meet the requirements of this specification shall be included in the VENDOR's scope.

No equipment/devices associated with a particular circuit shall be mounted in any other circuit module.

8 Main And Auxiliary Buses

a) Main buses & Tape

Switchgear shall be provided with three phase busbars and neutral.

Busbars shall be of uniform cross section throughout the length of the switchgear.

The busbars shall be made of high conductivity copper alloy of E91E grade.

Busbars shall be provided with at least the minimum clearances in air as per applicable standards for a 500V, 3 phase system.

All bus-bars, bus-taps shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free plastic insulation of high dielectric strength (450 V/mil) to provide a permanent high dielectric non-ageing and non-tracking protection; impervious to water, tropical conditions and fungi. The insulation shall be non-inflammable and self-extinguishing and in fast colours to indicate phase. The joints shall be insulated in such a way as to provide for accessibility of contact bolts for maintenance. The dielectric strength and properties shall hold good for the temperature range of 0 deg.C to 90 deg.C.

Busbars shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents for the associated switchgear. Busbars supports shall be made of Hylam sheets, glass reinforced moulded plastic material, permali wood or cast resin.

Separate supports shall be provided for each phase of the busbars. If a common support is provided for all three phases, antitracking barriers shall be incorporated.

Busbar joints shall be complete with high tensile steel bolts and lock washers and nuts. Busbars shall be thoroughly cleaned at the joint locations and a suitable contact grease shall be applied just before making a joint.

b) Auxiliary Buses

Auxiliary buses for control power supply, space heater power supply or any other specified service shall be provided. These buses shall be insulated, adequately supported and sized to suit specific requirements. The material of control power supply buses shall be electrolytic copper. The material for space heater power supply buses shall be same as that for the main power buses. Supply transformer(s), auxiliary busbars and necessary connections to the supply transformers and associated circuits shall be in the VENDOR's scope.

9 Circuit Breakers

a) Circuit breakers shall be of the airbreak drawout type, mounted along with its operating mechanism on a wheeled carriage moving on guides, designed to align correctly and allow easy movements.

- of the shunt trip type.
- provided with an operating mechanism of the type specified.
- provided with mechanically operated targets to show 'Open', 'Closed', 'Service' and 'Test' positions of the circuit breaker.
- provided with mechanical operated, red 'trip' push button, shrouded to prevent accidental operation.
- provided with locking facilities in the 'Service', 'Test' and 'Isolated', positions. In test position the breaker will be tested without energising the power circuits. The breaker shall remain fully housed inside the compartment in the test position.
- provided with 6 No. and 6NC potential free auxiliary contacts, rated 10A at 240V A.C. and 1A (inductive breaking) at 220 V D.C.
- provided with 'red', 'green' and 'amber' indicating lamps to show 'closed', 'open' and 'auto-trip' conditions of the circuit breaker when breaker operation is controlled by a control switch.

b) Circuit breakers shall be provided with the following interlocks.

It shall not be possible to plug-in a closed circuit breaker, or to drawout a circuit breaker in the closed position.

It shall not be possible to operate a circuit breaker unless it is in the fully plugged-in, test, or fully isolated position.

- c) Circuit breaker closing and trip coils shall be rated for satisfactory operation on a control supply system indicated in Data Sheet-A.
- d) Closing and trip coil shall operate satisfactorily under the following conditions of supply voltage variation:

Closing coils-85% to 110% of rated voltage.

Trip coils-50% to 110% of rated voltage.

The breakers controlling motors shall operate satisfactory under following conditions: -

- i) Direct-on-line starting of the specified motor.
- ii) Breaking no load current of the specified motor.
- e) **Operating Mechanism**

Circuit breaker shall be provided with operating mechanism as specified.

Power operated mechanism shall be of the motor wound spring charging stored energy type.

The closing action of the circuit breaker shall charge the tripping spring ready for tripping.

Speed of closing of contacts shall be independent of the speed with which the handle is operated.

All stored energy mechanisms shall be provided with mechanical indicators to show the 'charged' and 'discharged' conditions of the spring.

Circuit breakers provided with stored energy operating mechanisms shall be provided with the following interlocks.

- i) The circuit breaker shall not close unless the spring is fully charged.
- ii) Shocks, vibrations, or failure of springs shall not operate the breaker or prevent intended tripping.
Power operated mechanism shall be
 - i) Provided with a universal motor suitable for operation on A.C. and D.C. control supplies specified in Annexure-A with voltage variation from 85% to 110% rated voltage.
 - ii) Designed to enable a continuous sequence of closing and opening operation as long as power is available and at least one opening operation on power supply failure.
 - iii) Provided with emergency manual charging facilities.

10. **Moulded Case Circuit Breaker:**

Moulded case circuit breakers shall be made of insulating case and cover made of high strength, heat resistant and frame-retardant thermosetting insulating material.

The switching mechanism shall be made/quick-break type utilizing a trip free toggle mechanism. The handle position shall give positive indication of whether the breaker is ON(top), OFF(down) or tripped (midway). For overload protection, three bimetal magneto-thermal release and electromagnets releases for short circuit protection to be provided. The magneto-thermal release shall be variation and direct acting. All releases shall operate on a common trip bar so that all phases are disconnected in the event when fault occurs even on only one of them.

The contacts shall be made of silver allow and arc chutes shall be made of de-lon plates. These plates shall be housed in a vulcanised fibre casing. The arc chutes shall be capable of quenching the arc rapidly and drawing away the arc from contact tips.

The terminals shall have sufficiently large dimensions to accept links or cable lugs of suitable sizes.

11 **Miniature Circuit Breakers (MCB)**

- a) MCBs shall be hand operated, air break, quick make, quick break type conforming to applicable standards.

- b) MCB shall be provided with overload/short-circuit protective device for protection under overload and short-circuit conditions. The minimum breaking capacity of MCBs shall be 10 KA r.m.s. at 415V/220V D.C.
- c) MCBs shall be provided with locking facility.

12 Air Break Switches

- a) Air break switches shall be of heavy duty, group operated load break, fault make type, complying with the requirements of applicable standards.
- b) The switches shall be capable of withstanding the thermal stresses caused by overloads, locked rotor and short circuit currents of values associated with protective relay settings and the let through current of the associated fuse.
- c) The switches shall be capable of withstanding the mechanical stress caused by the peak short circuit current of value equal of the cut-off current of the associated fuse.
- d) Whenever solid links are used for the connections between switches and fuses, such links shall be fitted with insulated sleeves.
- e) All live parts of the switch shall be shrouded.
- f) Switch operating handles shall be suitable for padlocking in 'OFF' position.
- g) Each switch shall be interlocked with the associated compartment door to achieve the following interlocks.

It shall be possible to open the door only when the switch is in the 'OFF' position.

It shall not be possible to close the switch with the door open.

Suitable means however shall be provided to intentionally release the interlocks specified above for making trip setting adjustments and operation tests.

13 Fuses

Fuses generally shall be of the HRC cartridge fuse-link type having a certified rupturing capacity of not less than 80 KA at 440 V. Fuses upto 63A for distribution systems of medium short circuit levels may be of HRC cartridge screw-cap type, having a certified rupturing capacity of not less than 46KA at 440 V and 16 KA at 250V DC.

Fuses shall be provided with visible indication to show that they have operated.

Fuses shall preferably be mounted on moulded plastic carriers and shall be complete with fuse bases.

Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug in type of bases. In such cases an insulated fuse pulling handle shall be provided for each size of fuse for each switch board.

14 Motor Starters

a) Contactor

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

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

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

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

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

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

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

b) Direct-On-Line Starters

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

c) Reversing Starters

Reversing starters shall comprise forward and reverse contactors, electrically interlocked with each other.

Reversing starters shall be suitable for Class AC 4 duty.

d) Thermal Overload Relays

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

Thermal overload relays shall be hand reset type.

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

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

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

15 Current Transformers

Current transformers shall be of the dry type.

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

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

- a)** Measuring CTs-7.5VA, accuracy class 1.0 and an instrument safety factor of 5.
- b)** Protective CTs - 7.5 VA, accuracy class 5P and an accuracy limit factor of 10.

Notwithstanding the above it shall be the VENDOR'S responsibility to coordinate the current transformer burden with the requirements of relays, instruments and leads associated with that particular current transformer.

Test links shall be provided in both secondary leads of the CTs to easily carry out current and phase angle measurement tests.

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

16 Voltage Transformer

Voltage transformers shall be of dry type.

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

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

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

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

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

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

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

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

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

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

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

17 Relays

The following clauses shall apply to the protective relays.

Relay shall be -

- a)** Enclosed in dust proof flush mounting drawout type cases.
- b)** Accessible for setting and resetting from the front.
- c)** Provided with positive acting hand-reset flag indicators visible from the front.

Access to setting devices shall be possible only after the front covers are removed. Access to resetting devices shall be external to the case.

Auxiliary relays shall be rated to operate satisfactorily between 70% and 110% rated voltage.

Each relay shall be provided with at least two separate voltage from contacts.

Make and type of relays shall be subject to the EIC approval.

18 Indicating Instruments And Meters

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

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

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

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

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

19 Indicating Lamps

Indicating lamps shall be :

- a)** of the filament type and of low watt consumption
- b)** Provided with service resistors
- c)** provided with translucent lamp covers of colours 'Red', 'Green' and 'Amber' as required in the control wiring diagrams.

Bulbs and lenses shall be easily replaceable from the front.

20 Control And Selector Switches

Control and selector switches shall be :

- a)** of the rotary type
- b)** Adequately rated for the purpose intended (Minimum acceptable rating is 10A continuous at 240V AC and 1A inductive break) 220V DC.
- c)** Provided with escutcheon plates clearly marked to show the positions.

Control switches for circuit breakers shall be provided with pistol grip type handles.

Control switches for circuit breaker control shall be provided with

- a)** Contact development and sequencing device.

Selector switches shall be :

a) of the maintained contact stay put type. Switches in ammeter circuits shall have make-before-break type contact.

b) Provided with oval handles.

21 Push Buttons

Push button shall be :

a) of the momentary contact, push to actuate type rated to carry 10A at 240V AC and 1A (inductive breaking) at 220V DC.

b) Fitted with self reset, 2 NO and 2 NC contacts.

c) Provided with integral escutcheon plates marked with its function.

`Start', `Open', 'Close' push buttons shall be green in colour.

`Stop' push buttons shall be red in colour.

All other push buttons shall be black in colour.

`Emergency Stop' push buttons shall be of the lockable in the pushed position type and shall be shrouded to prevent accidental operation. Key shall not be required for the operation of the push button.

22 Space Heaters (if applicable)

Space heaters for switchgear panels shall be :

a) Suitable for operation on a supply system as specified

b) Provided with single pole MCD with overload and short circuit release

c) Provided with thermostats to cut off the heaters at 45 deg.C.

For details for spacing between terminals; clearance between gland plate and first row terminals; and size of gland plate refer Annexure - B, Table-I, II & III.

23 Cable Terminations

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

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

Wire Sizes :

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

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

KW Rating Service	No. of cores x conductor size(mm ²)	approximate overall diameter/mm
Upto 3	3 x 4	18
3.1 - 7.5	3 x 6	19.5
7.6 - 15	3 x 16	24
16 - 25	3 x 35	30
26 - 40	3 x 70	34
41 - 55	3 x 120	40
56 - 70	3 x 185	49
71 - 85	3 x 240	55.5
86 - 110	3 x 400	60
111- 175	3 x 1C x 500	-
Space Heating	2 x 6	19

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

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

24 Internal Wiring

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

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

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

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

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

Spare and unassigned modules shall be complete with internal wiring.

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

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

25 Terminal Blocks

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

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

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

Terminals shall be numbered for identification. Engraved white-on-black labels shall be provided on the terminal blocks, describing the function of the circuit. Where

duplication of a terminal block is necessary it shall be achieved by solid bonding links.

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

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

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

26 Labels

All labels shall comprise white letters on a black background.

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

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

Size of lettering shall be 6mm.

27 Earthing

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

Earth busbars shall be supported at suitable intervals.

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

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

28 Local Push Button Stations

Constructional Features

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

- a)** Metal enclosed, weather-proof suitable for mounting on wall or steel structures. The enclosure shall be die cast aluminium or sheet metal of 2mm thickness.
- b)** Dust and vermin proof.
- c)** Provide a degree of protection of not less than IP:54.
- d)** Metal parts shall be given tropicalising treatment as per standards and painted with one coat of epoxy primer and two coats of light grey epoxy paint.
- e)** Provided with inscription plates of rear engraved perspex with white letters on black background. The letter size shall be 6mm.
- f)** Provided with two earthing terminals suitable for 8 SWG G.I. wire.
- g)** Provided with removable undrilled gland plate and adequate members of cable glands for PVC insulated, armoured cable. The cable entry shall be from the bottom.
- h)** All local push button stations shall have locking facility. The lock switch shall have two positions "locked" and "unlocked". When in unlocked position the switch shall allow individual starting of the equipment. Start/stop push buttons provided for local operation of the equipment shall be provided on the same enclosure and stop push buttons shall be lockable in stop position. The lock switch shall be key operated.

Push Buttons

- a)** The Open/Close/Start push buttons shall be of the momentary contact push to actuate type.
- b)** The stop push buttons shall be stay put type with mushroom knob.
- c)** All push buttons shall be :
- i)** Fitted with two (2) normally open and two (2) normally closed contacts rated to carry and break 6 Amps at 415 Volts. (10A at 240 AC).

- ii) Provided with integral escutcheon plates marked with its function.
- d) 'Open/Close/Start' push buttons shall be green colour.
- e) 'Stop' push button shall be red in colour.

Wiring

The push button stations shall be as follows : Push button station Type-A - Each P.B., station shall comprise three push buttons viz. 'OPEN' 'CLOSE' and 'STOP' for control of reversible motors.

Push button station type B - Each P.B. station shall comprise two push buttons viz. 'START' and 'STOP' for control of non-reversible motors.

Push button station type-C - Each P.B. station shall comprise only one push button i.e. 'STOP' for emergency stop function.

Power - Electricity at specified voltage (415/220V).

29.2 The controls shall be complete with actuators, probes, relays, transformers, wiring, etc.

Safety controls of chilled water unit shall be as under :

- a) Compressor - High/Low pressure stat/manual reset type
high bearing temperature safety.
- b) Chiller thermostat - Manual reset type antifreeze.
- c) Oil pressure - Differential safety switch with manual
reset button. it should have a time delay relay for
start up of the compressor.
- d) Main motor - Thermal relay to avoid overloading of
motor & overheating of winding.

Interlocks for refrigeration unit shall be :

- a) Flow switches in condenser and chiller lines to prevent compressor starting without water flow.
- b) Oil temperature to be maintained at set point.

- c) Condenser and chilled water pumps and cooling tower fans shall be interlocked with chilling units to prevent operation without respective pumps and cooling tower fans running.

30 Tests

Switchgear shall be subjected to following tests :

- a) Temperature rise test on power circuits.
- b) Short time current tests on power circuits.
- c) Mechanical operation test.
- d) High voltage test.
- e) Electrical control interlock and sequential operation tests.
- f) Verification of wiring as per approved schematic.

Type tests and routine tests shall be carried out on all associated equipment as per relevant standards.

Certified copies of all type and routine test certificates shall be submitted for the Engineers approval before dispatch of the switchgear.

31 Drawings And Data

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

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

All drawings and data sheets shall be annotated in English.

Electrical Cabling Works

CABLES:

PVC insulated aluminium conductor Armoured cables shall be used for connecting motors.

CABLE GLANDS:

Heavy duty compression type cable gland alongwith the cable lugs shall be used for termination of cables. The cable glands shall be of cadmium plates brass. For all power cables, crimped type copper cable lugs shall be provided.

The cable trays shall be channel type made out of M.S. sheets (slotted) having a minimum thickness of 2mm duly painted. (Cable trays exposed to atmosphere shall be hot dip galvanised). The Clamps used shall be Aluminium with G.I./Cadmium plated nut-bolts. The size of these trays shall be selected considering the number of cables and leaving minimum 20% spare area. The arrangement of cables in these trays shall be in Single Tier Formation.

Sharp bending of the cables shall be avoided. The radius for bending PVC insulated cable and sheath armoured cable shall not be less than 10D where "D" overall diameter of the cable. Wherever cable rises from concrete trenches, these shall be taken in G.I. pipes of suitable size. The Contractor shall make sure that the 40% area of pipe shall be free after the cable is laid.

WIRE SIZES

Final connection to the equipment shall be through flexible wiring enclosed in galvanised flexible conduit rigidly clamped at both ends. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. P.V.C. insulated single strand hard drawn copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification. All the wires shall be suitably sized for motor duty.

EARTHING

Main power upto the Electrical panels in Plant rooms along with earthing shall be provided by other agency. Each panel shall be earthed to building main earthing. All the motor etc. shall be double earthed to the panel. All three phase motors/equipment shall be earthed with two independent earth conductors as per the requirement of Indian Electricity Rules and Regulation - 1956.

DRAWINGS

Shop drawing for control panel and wiring of equipment showing the route of conduit/cables shall be got approved by the Consultant before starting the fabrication of panel and starting the work. On completion four sets of completion/"As

installed" drawings incorporating all details like conduit routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cable route etc. shall be furnished by the Contractor.

TESTING

Before commissioning of the equipment the entire Electrical Installation shall be tested in accordance with code of Practice IS:732-1963 (Revised) and test report furnished by a qualified and authorised person. The entire electrical installation shall be got approved by Electrical Inspector and certificate from Electrical Inspector shall be submitted. All tests shall be carried out in presence of Consultant.

Painting

All sheet steelwork shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphatising passivating and then sprayed with a high corrosion resistant primer. It shall then be baked in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

Mode of Measurement

1 General

This specification covers measurement of various items/materials at site.

2 Unit Prices in the Schedule of Quantities

The item description in the Schedule of Quantities is in the form of a condensed resume. The unit price shall be held to include every thing necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum of all the individual item prices shall represent the total price of the installation ready to be handed over.

The unit price of the various items shall include the

All equipment, machinery, apparatus and materials required as well as the cost of any tests which the consultant may request in addition to the tests generally required to prove quality and performance of equipment.

All the labour required to supply and install the complete installation in accordance with the specifications.

Use of any tools, equipment, machinery, lifting tackle, scaffolding ladders etc. required by the contractor to carry out his work.

All the necessary measures to prevent the transmission of vibration.

The necessary material to isolate equipment foundations, from the building structure, wherever necessary and suggested by the Engineer.

Storage and insurance of all equipment apparatus and materials.

The Contractor's unit price shall include all equipment, apparatus material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to complete the system even though not specifically shown, described or otherwise referred to.

3 Measurements of Sheet metal ducts, grilles/diffusers, etc.

a) Sheet Metal Ducts

All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars and other fittings. Gaskets, nuts, bolts vibration isolation pads, vanes are included in the basic duct items of the B.O.Q.

The unit of measurements shall be the finished sheet metal surface area in metre squares. No extra shall be allowed for overlaps.

All the guide vanes, deflectors access panels, splitter dampers within the duct work shall be considered as part of the duct and nothing will be paid extra on this account.

The unit duct price shall include all the duct hangers, supports and 'Hilti' metallic fasteners as well as any materials and labour required to complete the duct frame.

b) Box Dampers

Box dampers wherever shown or required in ducts shall be measured as per finished inside cross-sections and paid as per the calculated are in sq.m.

c) Grilles/Diffusers

All measurements of grilles/diffusers shall be the nominal outlet size excluding the outer flanges.

The square or rectangular grilles/diffusers shall be measured in plain sq.m.

All round diffusers shall be measured by their diameters in centimetre.

All linear diffusers shall be measured as per actual length in meters.

4 Measurements of Piping, Fittings, Valves, Fabricated Items

a) Pipe

(Including Water Piping, Oil Piping, L.P. Gas Piping, Air Piping, Vacuum Piping, etc.)

All pipes shall be measured in linear meter (to the nearest Cm.) along the axis of the pipes and rates shall be inclusive of all fittings e.g. tees, bends, reducer, elbows, hanger support bracket, etc. Deduction shall be made for valves in the line.

The rate quoted shall be inclusive of cutting holes, 'Hilti' metallic fasteners and inclusive of all items as specified in specifications and Schedule of Quantities.

Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by the Engineer-in-Charge.

Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowances being made for providing the same.

The length of the pipe for the purpose of payment will be taken through the centre line of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above the fittings. For valves and flanges, section 1.16.3.2 below applies:

b) Valves and Flanges

All the C.I. and G.M. valves shall be measured according to the nominal size in mm and shall be measured by number. Such valves shall not be counted as part of pipe length hence deduction in pipe length, will be made wherever valves occur.

All gate and globe valves shall include two nos. of flanges and two numbers 150 mm long M.S. nipples, with one side threaded matching one of the valves, and other welded to the M.S. slip-on- flanges.

Rate for all valves shall also include the necessary number of bolts, nuts and washers, 3mm thick insertion gasket of required temperature grade companion flanges and all items specified in the specification.

The rates quoted shall be inclusive of making connections to the equipment, tanks, pumps, etc. and the connection made with an installed pipe line shall be included in the rates as per the B.O.Q.

c) Structural Supports

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

d) Copper Connections for Fan Coil Units

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

5 Painting

Painting of all pipes, supports, valves and fittings shall be included with the cost of these items. Nothing extra shall be paid for this work.

Painting of grilles/diffusers, tanks and equipment wherever required shall be in the cost of these items.

6 Insulation

Measurement of insulation for vessels, piping, equipment and ducts shall be made over the bare uninsulated surface area of the metal.

a) Pipes

The measurements for insulation of piping shall be made in linear meters through all valves, flanges, and fittings. Pipes/bends shall be measured along the centre line radius between tangent points. If the outer radius is R_1 and the inner radius is R_2 , the centre line radius shall be measured as $(R_1+R_2)/2$. Measurement of all valves, flanges and fittings shall be taken in running metre of pipe line as if they are also pipe lengths. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured as part of the larger size.

b) Ducts

The measurements for insulation of ducts shall be made in actual square meters of bare uninsulated duct surface.

In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for damper, flanges, fittings shall be for the surface dimension for the connecting duct. Nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

c) Vessels

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

d) Accessories Insulation

The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be of uninsulated area in square meters. In case of curved or irregular surfaces, measurements shall be taken along the curves. The unit insulation price shall include all necessary adhesives, vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.

e) Acoustic Duct Lining

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

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

f) Roof and Wall Insulation and Acoustic Treatment

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

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

g) Acoustic Baffle Boxes (wherever required)

The unit of measurement shall be the exposed inside face of the acoustic baffle boxes in square meters.

The unit price shall include all hold fasts, nuts, bolts connecting the size of wall opening and making it good as well. Any additional materials and labour to fabricate and fix the boxes.

Technical Data Sheet

Contractor shall submit catalogues of the equipment offered by him:

<u>Sr.No.</u>	<u>Equipment description</u>	<u>unit</u>	<u>Condition of service</u>
---------------	------------------------------	-------------	-----------------------------

- | | | | |
|------|--------------------------------|--|--|
| 1. | Chilling Machines | | |
| i. | Capacity at design (TR) | | |
| ii | Chilled water flow lpm/Usqpm | | |
| iii. | Chilled water In Temp (F) | | |
| iv. | Chilled water out temp (F) | | |
| v. | Condenser water flow lpm/Usqpm | | |
| vi. | Condenser water In Temp (F) | | |
| vii. | Condenser water out temp (F) | | |

Condenser:

- | | | | |
|-------|-------------------------------|--|--|
| i. | Manufacturer's name | | |
| ii. | Dia. Of Condenser Shell (mm) | | |
| iii. | Length of condenser tubes (m) | | |
| iv. | No. Of Tubes (Nos.) | | |
| v. | Material of Tube | | |
| vii. | Dia. of tube (mm) | | |
| viii. | No of integral (fins/cm) | | |
| ix. | No. of passes (Nos. | | |
| x. | water velocity (m/s) | | |
| xi. | Pressure drop M) | | |
| xii. | Quantity (Nos.) | | |
| xiii. | Fouling Factor (FPS) | | |

Cooler:

- | | | | |
|-------|---------------------------|--|--|
| i. | Manufacturer's name | | |
| ii. | Dia. Of Shell (mm) | | |
| iii. | Length of tubes (m) | | |
| iv. | No. Of Tubes (Nos. | | |
| v. | Material of Tube | | |
| vi. | Dia. of tube (mm) | | |
| vii. | No .of integral (fins/cm) | | |
| viii. | No. of passes (Nos.) | | |
| ix. | water velocity (m/s) | | |
| x. | Pressure drop (m) | | |
| xi. | Quantity (Nos.) | | |
| xii. | Fouling Factor (FPS Unit) | | |

Signature of bidder with stamp

chilled water Condenser

a.	Manufacturer	
b.	Model No.	
c.	Capacity	USGPM
d.	Head	Meter
e.	Speed	RPM
f.	Motor Rating	KW
g.	Type of motor	

3. Cooling Towers :

a.	Manufacturer	
b.	Type	
c.	Model No.	-----
d.	Overall Dimension	mm
e.	Fan dia/motor rating	mm/HP
f.	Type of motor	-----
g.	Speed of motor	RPM
h.	Type of drive	-----
i.	Capacity	Kcal/Hr (TR)
j.	Wet Bulb (design)	F

4. Air Handling Units :

a.	Manufacturer	-
b.	Casing	-
c.	Coil	-
d.	Blower	-
e.	Type	-
f.	Overall Dimension	-
g.	Unit Weight	-
h.	Air Quantity	-
i.	Fan outlet velocity	-
j.	Design static pressure	-
k.	Fan balancing static/and or Dynamic	
h.	Fan motor output	-
i.	Motor location i.e inside or outside the fan section	-
j.	Type of casing finish	-
k.	Type of drive/vibration Isolators	-

AHU Coil Data :

- a. Cooling Coil Area -
- b. No.of Rows -
- c. No.of fins/cm -
- d. Tube Material -
- e. Tube dia -
- f. Coil Header material -
- g. Thickness of tube -

5. FAN COIL UNITS :

- a. Manufacturer -
- b. Casing -
- c. Blower -
- d. Type -
- e. Overall Dimension -
- f. Unit Weight -
- g. Air Quantity -
- h. Cooling Coil Area -
- i. No. of Rows -
- j. No. of fins/cm -
- k. Tube Material -
- l. Tube dia -
- m. Coil Header material -
- n. Thickness of tube -
- o. Fan motor output -
- p. Impeller dia -
- q. material of Impeller -
- r. No. of fans & Speed -
- s. Capacities (cfm/TR) -
- t. Type & make of Automatic controls -
- u. Type of vibration isolators -

6. Exhaust Fan /Fan section :

- a. Make -
- b. Air Quantity at Operational speed -
- c. Static Pressure -
- d. Diameter/size -

Signature of bidder with stamp

- | | | | |
|----|------------------------------------|---|---|
| e. | Type | - | |
| f. | Current characteristics | - | |
| g. | Motor Rating | | - |
| h. | Type of Motor | - | |
| i. | Fan outlet Speed | - | |
| j. | Fan Speed | - | |
| k. | Motor Speed at the duty conditions | - | |
| | | | |
| l. | Operating Weight | - | |
| m. | Type of vibration isolators | | - |
| o. | Type of bearings | - | |
| p. | Performance curves | | - |
| q. | Motor Efficiency | - | |
| r. | Class of Insulation | - | |

7. Controls

Make and Model of the following :

- | | | | |
|----|-------------------|---|---|
| a. | Flow Switch | - | |
| b. | 2/3 – way Valves | - | |
| c. | Operating Voltage | - | |
| d. | Air Stat | | - |
| e. | Pressure Gauge | - | |
| f. | Thermometer | | - |
| g. | AHU Thermostat | - | |
| h. | FCUs Thermostat | - | |

8. Electrical Accessories :

Make of the following

- | | | | |
|----|----------------------------|---|---|
| a. | Motor Control Centre (MCC) | | - |
| b. | Air Circuit Breaker | - | |
| c. | MCCB | - | |
| d. | MCB | - | |
| e. | Rotary Switch | | - |
| f. | Soft Starter | - | |
| g. | Auto-transformer starter | - | |
| h. | Direct on line starter | | - |
| i. | Contactor | - | |
| j. | Current transformer | | - |

- | | | | |
|-------|--|---------------------|---------------------|
| k. | Single phase preventer | - | |
| l. | Push button/changeover switch | - | |
| m. | Ammeter/Voltmeter | - | |
| n | Relays | - | |
| o | Indicating Lamps | - | |
| p. | Cables/wires | - | |
| 9. | Water Piping ; | | |
| a. | Make of pipes/class of pipes | - | |
| b. | Pipe wall thickness | - | |
| c. | Valves & Strainers | Make | Material |
| i) | Butterfly Valve | | |
| ii) | Balancing Valve | | |
| iii) | Ball Valve | | |
| iv) | Ball valve with strainer | | |
| v) | Pot Strainer | | |
| vi) | Flexible connections | | |
| vii) | Check Valves | | |
| viii) | Gate Valves | | |
| ix) | Globe Valves | | |
| x) | Y-Strainers | | |
| c) | Pressure Gauge | | |
| i) | Make | | |
| ii) | Model | | |
| iii) | Dial | | |
| d) | Thermometer | - Make/Type & Range | |
| 9. | <u>Galvanised Steel Sheets :</u> | | |
| a. | Make | | |
| b. | Gauge/Thickness | | |
| c. | Class of galvanizing | | |
| 10. | <u>Grilles/Diffusers & Dampers/Louvers</u> | - | Make/Material/Guage |
| 11. | <u>Insulation</u> | | |
| a. | Manufacturer | - | |
| b. | Duct Insulation Material/Density | - | |
| c. | Duct Acc. Lining Material/Density | - | |
| d. | Pipe Insulation Material/density | - | |

LIST OF BUREAU OF INDIAN STANDARD CODES

IS:277-1992	-	Galvanized steel Sheet (plain & corrugated)
IS:544-1985	-	Dimension for pipe Threads
(Reaffirmed 1996)		
IS:778	-	Valves (gate/globe/check type)
IS:655-1963	-	Metal Air Ducts
IS:13095-1991	-	Butterfly Valves
IS:659-1964	-	Air-conditioning (safety codes)
IS:1239-1990/92	-	Mild Steel Pipes
IS:325	-	3 phase induction motor
IS:822	-	Code of procedure for inspection of welds
IS:900	-	Code of practice for installation and maintenance of motors
IS:6392	-	Steel Pipe Flanges
IS:1822	-	Motor starters for voltage not exceeding 650 Volts
IEC	-	Relevant Sections
IS:996	-	Single phase small A.C. Motors
IS:4894-1987	-	Centrifugal Fans
IS:1554(I)	-	PVC Insulated (heavy duty)electric cables for working Voltage upto and including 1100 Volts
IS:8623-1993	-	Bus Bar Trunking System
IS:8828-1996	-	Miniature Circuit Breakers
& IEC898-1995		
IS:9537-1981 Part II	-	Rigid steel conduit for electrical wiring
IS:10810-1989	-	Method of Test of Cables
IS:13947-1989	-	Circuit Breakers
IS:13947-1993	-	Switches, disconnectors, fuse combination units
IS:139-1993(Part IV)	-	Contactors & Motor Starters
Duct Fabrication standards	-	SMACNA
ASHRAE Handbooks-		Application 1995
	-	fundamentals 1997
	-	System & equipment 1996
	-	Indoor Air Quality 62-1982

LIST OF APPROVED MAKES FOR HVAC EQUIPMENT AND MATERIALS

Sr.No.	Details of the Items	Approved Manufacturer's name
1.	Chilling Machines	Daikin / Kirloskar / Voltas / Bluesatar / Climaveneta / Carrier / York / Trane / DB
2.	Primary chilled water Pumps Secondary Chilled water Pumps Condenser water Pumps	Armstrong/Grundfoss/XYLEM
2a	VFDs	Danfoss/YASHKAWA
2b	Panel for VFDs	Tricolite/Advance/Zenith Technology
3.	Cooling Towers	Paharpur/MIHIR/DELTA/Eureka Int
4.	Expansion tank, pressurization unit With built in vacuum degasser	Flamco/Spirotech/Caleffi
5.	Air Handling Units & TFA Unit	VTS/ZECO/Edgetech/REVO/Eureka Int.
6.	Ultrasonic Humidifier	Emerald/ Rapid Cool/Eureka Int
7.	Propeller & Ducted Inline fans	Caryaire/Ostberg/Grenheck
8.	Centrifugal fans for AHUs & Fan sections	Nicotra/comefrei /Krugar/VTS
9.	All Electric Motors	ABB/Crompton/Kirloskar/siemens
10.	MS/GI Pipes	Jindal /TATA/SAIL
11.	Factory fabricated ducts GI Sheet for ducts	Zeco/Climecon/Dustech TATA/ ISPAT/Indian Steel/JSW/ESSAR
12.	Butterfly Valves	Advance/Lehri/AIP/Castle/SKS/Emerald
13	Balancing Valves	Advance/Lehri/AIP/Castle/SKS

Signature of bidder with stamp

14.	Check Valve double flanged	Advance/Lehri/AIP/Castle/SKS/Emerald
15.	Ball Valves	Anergy/Rapidcool/Emerald
16.	Ball Valves with Strainers	Anergy/Rapid Cool/Emerald
17.	Y-strainers/Pot Strainers	Advance/Lehri/AIP/Castle/SKS/Emerald
18.	Flexible Pipe Connections	Easyflex/Resistoflex/Dunlope
19.	Gate Valve	Anergy/Rapid Cool Emerald
20.	PID/motorised Valves for AHUs	Fresse/Danfoss/Flowcon
21.	Thermostats for AHUs	Siemens/Honeywell/Danfoss
22.	Pressure Guage	H.Guru/Feibig/Emerald
23.	Thermometer	H.Guru/Feibig/Emerald
24.	Side stream filtration system	Lakos/Winget/Towerflow
24.	Flow Switch	Siemens/Schneider/ Danfoss/Honeywell
25.	Air Purge Vents	Rapidcool/Anergy/Econosto
26.	Grilles/Diffuser	Caryaire/Conaire/Truestar/Airflow
27.	MS Dampers/ Louvers Fire Dampers	Caryaire/Conaire/Truestar/Airflow
28.	Electrical Panel	Tricolite/Advance/Zenith Technology
29.	MCCB	L&T/Schneider/ABB
30.	MCB	L&T/Schneider/ABB

31.	Control Cables	Polycab/Havells/Finolex/Agilon
32.	Power Cable	Polycab/Havells/Finolex/Agilon
33.	DOL/Star Delta starters	L&T/Siemens/Schneider/ABB
34.	Aux.Relay/contactors	L&T/Siemens/Schneider/ABB
35.	Line Type Fuse	L&T/English Electric/Siemens
36.	Timer	L&T/English Electric/Siemens
37.	Terminal Block	Elmex/Siemens/Schneider
38.	Indicating Lamps	L&T/Siemens/Schneider
39.	Selector Switches	L&T/Siemens/Schneider
40.	Duct Insulation	Armaflex/Armacell/K-flex/Supreme
41.	Flexible Duct Connection	Airflow/Pyroguard
42.	Gaskets	Neoprene rubber
43.	Adhesives	Fevicol / Superlon
44.	VIBRATION ISOLATOR	Resistoflex/Dunlope/kanwal
45.	FILTERS	Thermadyne/Anfilco
46.	Inline Fans	Systemaire/Greenheck/Caryaire
47.	Chilled/hot water pipe insulation	A-flex/Armacell/K-flex/Supreme
48.	Adhesives for insulations	Fevicol/superlon
49.	Axial Fans	Airflow/Caryaire/Humidin
50.	Duct Accoustic lining &	Owens corning/Kimmco/UP Twiga

Signature of bidder with stamp

AHU room lining

- | | | |
|-----|------------------------------|---------------------------------------|
| 51. | Duct and pipe Hanging system | Gripple/Mungo/Hilti |
| 52. | Cable Trays | CTM Engg/KEPL/MEM |
| 53. | Cement | Ultratech/Ambuja/JK Super (OPC grade) |

List of HVAC Drawings

Sr.No.	Drawings/Floor Name	Drawing Numbers
1.	HVAC Plant Layout -Basement	HVAC/SBI-LHO/JAI/01
2.	HVAC Schematic drawing (Chilled water and condenser water circuits)	HVAC/SBI/LHO/JAI/02
3.	HVAC layout at Ground Floor	HVAC/SB-LHO/JAI/03
4.	HVAC layout at First Floor	HVAC/SB-LHO/JAI/04
5.	HVAC layout at Second Floor	HVAC/SB-LHO/JAI/05
6.	HVAC layout at Third Floor	HVAC/SB-LHO/JAI/06
7.	HVAC layout at Fourth Floor	HVAC/SB-LHO/JAI/06
8.	HVAC layout at Terrace Floor	HVAC/SB-LHO/JAI/07