CONSTRUCTION/EXTENSION OF GURU RAMDAS LANGAR HALL
AT
SRI HARMANDER SAHIB, AMRITSAR

TENDER DOCUMENT
FOR
HVAC WORKS

Owner : **SHIROMANI GURDWARA PARBANDHAK COMMITTEE**
SRI AMRITSAR.

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1.0 GENERAL CONDITIONS OF CONTRACT

1.1 Scope:

General Conditions of Contract hereinafter specified shall be read in conjuction with Special Conditions of contract Following clauses shall be considered as in extension and not in limitation of the obligations of the Contractor. In case of discrepancy and/or disparity between these General Conditions of Contract and any other section, the more stringent shall apply and the decision of the OWNER/CONSULTANT/PMC/PMC shall be final.

1.2 Definition of Terms:

a) The Owner/Client shall mean **M/s. SHIROMANI GURDWARA PARBANDHAK COMMITTEE, AMRITSAR (SGPC)** or some other person or persons for the time being or from time to time duly appointed by the Owner in writing.

b) The term `Contractor' shall mean the successful Tenderer of the HVAC work whose tender has been accepted by the OWNER/CONSULTANT/PMC and to whom work order has been issued.

c) The `Sub-Contractor' shall mean the firm or persons named in the Contract for any part of the work or any person to whom any part of the work has been sublet with the consent in writing of the OWNER/CONSULTANT/PMC and shall include his heirs, successors and Assigns approved by the Owner.

c) The `Specification' shall mean the specifications annexed to or issued with these Conditions of Contract and any amendments made herein after to carry out the work smoothly.

e) The `Contract' shall mean the agreement between the `Contractor' and the Owner to be entered into under these conditions and shall include these terms and Conditions of contract, specifications, Schedules, BOQ, Drawings, Correspondence, Letter of Intent of the Owner and subsequent amendments if any.

f) The `Site' shall mean the place or places at which the plant is to be delivered or work done by the Contractor and shall include where applicable the lands and buildings upon or in which the works are to be executed and shall also include the place or places at which fabrication and other work will be carried out by the Contractor.

g) `Plant', `Equipment', `Stores', `Work' or `Works' shall mean and include plant and materials to be provided and work to be done by the Contractor.

h) `Tests on completion' shall mean such tests as are prescribed by the specifications or have been mutually agreed to between the Contractor and the OWNER/CONSULTANT/PMC, to be carried out before the plant is taken over by the Owner. In case tests are not possible due to climatic conditions at the time of

completion, the Contractor shall be bound to carry out tests as prescribed hereinafter, at any time subsequent to the date of completion, but before the end of defects liability period.

i) `Commercial use' shall mean that use of the work contemplates or of which it is to be commercially capable.

j) `Writing' shall include any manuscript, typewritten or printed statement under or over signature or seal as the case may be. Words importing `Person' shall include firms, companies, corporations and associations of individuals whether incorporated or not.

1.2.1 Words importing singular shall also include plural and vice versa where context requires.

1.2.2 OWNER

The Owner for the subject work are:

OWNER
SHIROMANI GURDWARA PARBANDHAK COMMITTEE,
AMRIT ASR,PUNJAB

SITE
GURU RAM DAS LANGAR HALL.
SRI HARMINDER SAB,
AMRITSAR
PUNJAB.

1.3 Agreement:

A formal agreement shall be entered into by the Contractor with the Owner for the proper fulfillment of the Contract. In case the agreement is not executed by the Contractor within one month of receipt Intent, Owner may at his option without prejudice to any other claim against the contractor and within seven days after expiry of the said one month and before execution of the agreement by the Contractor and by notice in writing revokes the acceptance of the tender. There upon the Owner shall not be liable to any claim from the Contractor for work already done.

1.4 Completion of Contract :

The Contractor shall provide without any extra charge all items whether specifically mentioned or not but are usual and required to make a complete working plant and to ensure safe and satisfactory operation. All apparatus, appliances, materials or labour which may be necessary to complete the work in accordance with the intent

1.5 Co-ordination:

1.5.1 Work shall be carried out in conformity with the specifications, accompanying drawings and with the requirements of the general architectural and structural plans after approval by the Owner / Consultant. The Contractor shall be responsible for taking actual measurements at site and varying the work in detail if required to meet the site conditions. Such deviations shall, however, be subject to the approval of the Consultant and Owner.

1.5.2 The Contractor shall also co-operate with the Owner's other Contractors, compare plans, specifications and time schedules and so arrange his work that there will be no interference. The Contractor shall forward to the Owner copies of all correspondence and drawings so exchanged. Failure to check plans and conditions will render the Contractor responsible for bearing the cost of any subsequent change found necessary.

1.6 Bye laws:

1.6.1 The Contractor shall comply with all bye-laws and regulations of local and other statutory authorities having jurisdiction over the works and shall be responsible for the payment of all fees and other charges and giving and receiving of all necessary notices and keeping the owner informed of the said compliance with the bye-laws, payments made, notices issued and received.

1.6.2 The Contractor shall indemnify the Owner and Consultant against all claims in respect of patent rights, designs, trade marks or names or other protected rights in respect of any plant, machine, work or material used for or in connection with the works or temporary works and from and against all claims, demands, proceeding, damages, cost, charges and expenses whatsoever in respect thereof or in relating thereto. The Contractor shall defend all actions arising from such claims and shall himself pay all royalties, licenses fees, damages, costs and charges of all and every sort that may be legally incurred in respect thereof.

1.6.3 All drawings required for statutory approvals are to be prepared by the Contractor and approved by the Consultant. The Contractor has to obtain approvals from statutory authorities. However statuary fees will be reimbursed by the Owner on production of original receipts.

1.7 Rates:

1.7.1 Tender shall be on an item rate basis for equipment delivered, tested and commissioned at site. During the contract period prices shall remain firm and free from variations due to rise and fall in the cost of materials, equipment, labour or any other reason whatsoever.

1.7.2 Tender price shall be inclusive of all applicable taxes, duties and other levies such as excise-duty, sales tax, turnover tax, fabrication tax, works contract tax, octroi etc., Any statutory variation in taxes and duties during the contractual/scheduled delivery will be paid by the Owner subject to submission of documentary proof for the actual payment made by the Contractor.

1.7.3 Unit rates for all items of equipment and materials shall remaining valid till the completion of work in all respect and shall be free from variations, due to increase or decrease in the cost of materials, labour, taxes or any other reason whatsoever. Unit rates shall become applicable only to variations in quantities due to changes/modifications in the drawings made by the Owner.

1.8 Owner's Representative:

1.8.1 The Site Engineer deputed by the Owner shall be representative of the Owner and Consultant. The duties of the Owner's representative are to watch and supervise the works and to test any materials, equipment, plant etc., to be used to workmanship employed in connection with the works. He shall have no authority to relieve the Contractor of any of his duties or obligations under the Contract, or, except any expressly provided hereunder, to order any work involving delay or any extra payment by the Owner or any variation of or in the works.

1.8.2 The Contractor shall afford the Owner's representative every facility and assistance for examining, checking and measuring materials and works. The Owner's representative without the written order of the Owner. shall not to revoke, alter, enlarge or relax any requirements of this Contract, or to sanction any-day work, additions, alterations, deviations or omissions.

1.8.3 The Owner's/Consultants representative shall have power to give notice to the Contractor or his representative about the non-approval of any work or materials or equipment and such works shall be suspended or the use of such materials, equipment should be discontinued until the decision of the Owner is obtained. The work will, from time to time be examined by the Consultant or the Owner's representative, but such examination shall not be in any way exonerate the Contractor from the obligation to remedy any defects which may found to exist at any stage of the work or after the same is completed. Subject to the limitations of this clause, the Contractor shall take instructions only from the Owner.

1.9 Date of Commencement and Completion:

1.9.1 The date of letter of acceptance of Tender issued to the Contractor shall be regarded as the date of commencement for the purpose of this Contract. The work shall be Proceeded in accordance with the programme of work approved by the OWNER/CONSULTANT/PMC and shall be completed in all respect within 2 (two) months.
However, OWNER/CONSULTANT/PMC reserves the right to indicate commencement/ mobilization date.

1.10 Delays:

1.10.1 The Contractor shall not be entitled to any compensation for any loss suffered by him on account of delays in commencing or executing the work, whatever the cause for such delays may be, including delays in procuring government controlled or other materials. The Contractor shall, however, merit extension of time as herein after mentioned.

1.10 Rejection of Defective Plant:

1.11.1 If the completed plant or any portion thereof before it is taken over be found defective or fails to fulfill the intent of this specification, the Contractor shall on receipt of notice from the Consultant/Owner forthwith make the defective plant/equipment good.

1.11.2 Should he fail to do so within a time considered reasonable by the Consultant/Owner, the Owner may reject and replace at the risk and expense of the Contractor the whole or any portion of the plant/equipment/installation which is defective or fails to fulfill the requirements of the Contract.

1.11.3 The OWNER/CONSULTANT/PMC shall have the right to operate installation/equipment if in operating condition whether or not such equipment have been accepted as complete and satisfactory. Repairs and alterations shall be made at such times and as directed by the Consultant.

1.12 Taking Over:

1.12.1 The works when satisfactorily completed at site shall be deemed to have been taken over by the Owner when the Consultant will have certified in writing that the plant has fulfilled the Contract conditions.

1.13 Extension of Time:

1.13.1 If the Contract is delayed in the progress and completion of work by changes Ordered or by any which the OWNER/CONSULTANT/PMC shall decide to justify the delay, then the time of completion shall be extended by mutually agreed time. No such extension shall be allowed unless requests for extension are made in writing by the Contractor to the OWNER/CONSULTANT/PMC within 15 days from the date of occurrence of the delay.

1.14 Liquidated Damages:

1.14.1 For all delays which do not merit an extension of time the Contractor shall pay to the Owner liquidated damages 1/2 % per week, or part thereof, for delay in the completion of work, subject to a maximum of 10% of the contract value. The amount of liquidated damages shall be recoverable from the payments due to the Contractor on this or any other contract with the Owner.

1.14.2 The deduction of liquidated damages shall not absolve the Contractor of his responsibility and obligations under the Contract to complete the work in its entirety and shall also be without rejudice to action by the Owner under clause: `Termination of the Contract by the Owner.

1.15 Security Deposit:

1.15.1 Contractor shall furnish a EMD as security deposit for an amount Equivalent to 1% of the contract value, while submission of tender. Earnest money and 50% of the total security deposit shall be refunded after the completion of work. Balance amount will be refunded after the expiry of defects liability period laid down.

1.16 General:

1.16.1 Every tenderer is excepted before quoting his rates to inspect the site of the proposed Work. The materials must strictly comply with the relevant specifications attached. Samples of the materials as required by the Consultants in all cases shall be sumitted for their approval before the supply to site of work begins. In absence of any specification of any material or workmanship the same shall have to be to the entire satisfaction of the Consultants/Owner.

1.16.1 If on check differences are found between the rates given by the Contractor in words and figures or in the amounts worked out by him, the following procedures shall be followed :-

a) Where there is a difference between the rates in figures and in words, the rates which correspond to the amounts worked out by the Contractor shall be taken as correct.

b) Where the amount of an item is not worked out by the Contractor or it does not correspond with the rate written either in figure or in words, then the rate quoted by the Contractor in words shall be taken as correct.

d) Where the rate quoted by the Contractor in figures in word tallies but the amountis not worked out correctly, the rate quoted by the Contractor shall be taken as correct and not the amount.

1.16.3 No execs as regards want to information on any particular point will be considered after the tender has been received. No advice of any charge in rate or conditions after the opening of tender shall be entertained.

1.16.4 The Contractor shall nor in any case after acceptance of a contract rate be paid any extra charges for lead involved in transport of materials to site of work, erection, and hire of T & P sheds for materials, royalty for designs equipment etc., of for any other reason in case the Contractor is found later on to have misjudged the materials available.
All taxes including octori, toll and sales tax/works contract etc shall be payable by the Contractor and any claim whatsoever in this respect shall not be entertained .

1.16.5 No alteration which is made by the tenderer in the Notice of Tender, instructions to the Contractors, the contract Form, the Conditions of Contract, accompanying the same shall be recognised, an if any such alterations are made or any special conditions are attached, the tender is liable to be rejected.

1.17 Termination of Contract by the Owner:

1.17.1 The Owner in Consultation with the OWNER/CONSULTANT/PMC may, not withstanding any previous waiver and after giving seven days notice in writing to the Contractor and under the provisions of this clause, terminate the contract on the occurrence of any or all of the following:

a.) If the Contractor

i) commits any `act of Insolvency'

ii) shall be adjudged as `Insolvent'

iii) shall have an order for compulsory winding up made against him.

iv) pass effective resolution for winding up voluntarily.

v) shall suffer any payment under this Contract to be attached by on behalf of any of The radiators of the contractor.

vii) shall assign the Contractor without the prior consent in writing of the Owner/ Consultant.

vi) shall charge or encumber this contract or any payment due or may become due.

b.) If OWNER/CONSULTANT/PMC shall certify in writing to the Owner that the Contractor:

i) has abandoned the contract.

ii) has failed to commence the works, or has without any lawful excuse under these conditions suspended the progress of the works seven days after receiving from the owner written notice to proceed.

iii) has failed to proceed with the work with such due diligence and failed to achieve such due progress as would enable the works to be completed in accordance with the approved programme of work.

iv) has failed to remove materials from the site or to pull down and replace works for seven days after receiving from the Architect/ Consultant under these conditions.

v) has neglected or failed persistently to observe and perform all or any of the acts, matters or things by this contract to be observed and performed by the contractor for even days after written notice shall have been given to the Contractor requiring the contractor to observe or perform the same.

vi) has to detriment of good workmanship or in defiance of the OWNER/CONSULTANT/PMC's instruction to the contrary sublet any part of the Contract. The termination of the contract shall be without prejudice to the powers of the OWNER/CONSULTANT/PMC or the obligations and liabilities of the contract, the whole of which continue to be in force as if the contractor has not been so determined and as if the work subsequently executed has been executed by and/or on behalf of the Contractor.

1.17.2 After the issue of such notice, the Contractor shall not be at liberty to remove from site any plant, tools and materials belonging to him which shall have been placed there on for the purpose of the works and the Owner shall have lien upon such plant, tools or materials to subsist from the date of such notice and until the notice shall have been complied with.

1.17.3 If the Contractor shall fail to comply with the requirements of said notice for seven days after such notice has been given, the Owner shall have the power to enter upon and take possession of the works and site and all plants, tools and materials thereon, and to engage any other person, firm or agency to complete the works, utilizing the plant, tools and materials to the extend possible. The Owner shall not in any way be responsible for damage or loss of the tools, equipment and materials and the Contractor shall not have any compensation whatsoever.

1.17.4 Upon completion of the works, the OWNER/CONSULTANT/PMC/PMC shall certify the amount of expenditure properly incurred consequent on and incidental to the default of the contractor as aforesaid and such amount shall be deducted from the payments due to the Contractor, including the security Deposit. If the said amount exceeds the payment due to the contractor, the Owner shall be at liberty to dispose of any of the Contractor's materials tools or plant and apply the proceeds For the payments due from the Contractor and recover the balance by due process of law.

1.17.5 After the works have been completed and the amounts due from the Contractor have been fully recovered from the Contractor, the OWNER/CONSULTANT/PMC shall give notice in writing to the Contractor to remove the surplus plant and material from site. If such plant and materials are not removed within a period of 14 days after such notice, the Owner shall have the power to remove and sell the same holding the proceeds less the cost of removal and sale to the credit of the Contractor. The Owner shall not be responsible for any loss sustained by the contractor from the sale of the plant.

1.18 Clean up of Work Site

1.18.1 During erection the contractor shall at all times keep the working and storage areas free from waste or rubbish. On completion of erection, he shall remove all structures, debris and leave the premises in a satisfactory condition under intimation to site incharge.

1.19 Terms of Payments:

1.19.1 The Owner shall pay to the Contractor in the following manner the contract price unless agreed upon otherwise between the contractor and the Owner.

a) For Supply installation Testing & Commissioning of Local Equipment and installation Testing & Commissioning of Imported Equipment.

i) 10% mobilization advance on acceptance of order along with Bank Guarantee of equal amount from National Bank only, valid upto contract period.

ii) 40% prorata against safe receipt of material at site.

iii) 15% after satisfactory erection, subject to approval by the owner.

iv) Balance 35% after testing and commissioning and handing over of project. 5% as security deducted from every running bills and will be refunded after the expiry of defect liability period.

1.20 Construction of Contract:

1.20.1 The contract shall in all respects be constructed and operate as Indian Contract and in conformity with Indian Laws and all payments there under shall be made in Rupee money. The marginal notes here to shall not effect the construction here of.

1.21 Proceedings:

1.21.1 All proceedings relating to this work, if any, shall be instituted at Amritsar only.

1.22 Arbitration:

1.22.1 All disputes and differences of any kind whatever arising out of or in connection

with the contract or the carrying out of the works (whether during the progress of the works or after their completion and or breach of the contract) shall be referred to and settled by the OWNER/CONSULTANT/PMC who shall state his decision in writing. Such decision may be in the form of final certificate or otherwise. The decision of the OWNER/CONSULTANT/PMCs with respect to any of the excepted matters shall be final and without any appeal as stated in this section. But if either the owner or the Contractor be dissatisfied with the decision of the Owner / Consultant on any matter, question or dispute of any kind (except on any excepted matters) or as to the with-holding by the 0wner / Consultant of any certificate to which the contractor may claim to be entitled, then and in any such case either party (the Owner or the Contractor) may within 28 days after receiving notice of such decision give a written notice to the other party through the OWNER/CONSULTANT/PMC requiring that such matters in dispute be arbitrated upon. Such written notices shall specify the matters which are in dispute and such dispute or difference of which such written notice has been given and no other shall be referred to the arbitration. Final decision of single Arbitrator being a member of the Institution of Engineer (India) to be agreed upon and appointed by both the parties or in case of disagreement as the appointment of single arbitrator to the arbitration of two arbitrators being both members of Institution of Engineers (India) one to be appointed by each party. Such arbitrators shall before taking upon themselves the burden of Reference, appoint an umpire.

1.22.2 The Arbitrator/Arbitrators or the umpire shall have power to open up review and revise any certificate, opinion, decision, requisition or notice save in regards to the excepted matters in dispute which shall be submitted to him or them and of which notice shall have been given as aforesaid.

1.22.3 Upon every or any such reference, the cost of and incidental to the reference and award respectively shall be at the discretion of the arbitrator/arbitrators or the umpire who may determine the amount thereof or direct the same to be shared as between attorney and the client or as between party and shall direct by whom to whom and in what manner the same shall be borne and paid. This submission shall be deemed to be a sub-mission to arbitration with the meaning of the Indian arbitration Act 1940 or any statutory modification thereof. The award of the arbitrator/ arbitrators or umpire shall be final and binding on the parties.

1.22.4 Such Reference except as the with holding by the Owner of any certificate under clause 1.11, 1.14 / 1.17 to which the contractor claims to be entitled shall not be opened or entered upon until the completion or alleged completion of the works or until after the practical cessation of the works arising from any cause unless with the written consent of the owner or and the contractor provided always that the owner shall not with hold the payment of Interim Certificate nor the contractor except with the consent in writing of the architects in any way delay the carrying out the works by reason of any such matter, question or dispute being referred to arbitration but shall proceed with the work with all due diligence and shall until the decision of the arbitrator or arbitrators or the umpire be given abide by the decision of Consultants and no award of Arbitrator or Arbitrators or umpire shall relieve the contractor of his obligations to adhere strictly to the Architect's instructions with regard to the actual carrying out the works.

2.0 SPECIAL CONDITIONS OF CONTRACT:

2.1. **GENERAL**

These special condition of contract shall be read in conjunction with the other documents forming part of the contract. In case of any variance, these conditions shall supersedes any other conditions mentioned in any contract document.

The materials, design and workmanship shall satisfy the specifications contained herein and Codes Referred to. Where the technical specifications stipulate the requirement in addition to those contained in the Standard Codes and specifications those additional requirements shall also be satisfied. In the absence of any Standard/ Specifications covering any part of the work covered in this tender document, the instructions/directions of Consultant will be binding on the contractor.

The scope of this section is to describe materials and systems for HVAC installations of building which form together with the project documents, a complete volume of work and quality description.

All HVAC installations shall be of high quality, complete and fully operational including all necessary items and accessories whether or not specified herein. All HVAC work shall be completed in accordance with the regulations and standards to the satisfaction of the Consultants/ Architect. The general provisions, special provisions and general requirements apply to the entire installation.

The work shall be carried out simultaneously with building work and shall be continued till it is completed satisfactorily along with the completion of essential portions of the building works. All installed HVAC works shall be protected till the end - by the HVAC contractor.

2.2 SCOPE OF WORK:

2.2.1 Contractor shall furnish all labour, materials, factory supplied new equipment, transportation and incidentals necessary for supply, installation, testing & commissioning of complete HVAC system as described in these documents & drawings. In general, the entire work shall be carried out as follows:

Contractor shall submit all the calculations i.e. Cooling load, Heating load and pressure drop etc.

2.3 EXCLUSIONS:

2.3.1 P.C.C. foundation for Machines, Cooling Towers, Pumps and Fan, etc.

2.3.2 Plant Rooms and false ceiling work.

2.4. RATES:

2.4.1 The rates quoted shall be deemed to allow for all minor extras and constructional details which are not specifically shown on drawings or given in the specifications but are essential in the opinion of the Owner / Consultants for the execution of works to con-form to good workmanship and sound engineering practice. The Owner / Consultants reserve the right to make any minor changes during the execution without any extra payment.

2.4.2 The Consultants decision to clarify any item under minor changes, minor extras and constructional details shall be final, conclusive and binding on the Contractor.

2.4.3 The rates quoted by the Contractor shall be net so as to include all the requirements described in the contract agreement and no claim whatsoever due to fluctuations in the price of material and labour will be entertained.

2.4.4 The rates quoted by the Contractor shall include for supplying materials and labour necessary for completing the work in the best and most workmanship like manner to the satisfaction of the Architect /Consultants and which in the opinion of the Consultants cannot be made better. The rates shall be complete in all respects including cost of materials, erection, fabrication, labour, supervision, tools and plant, transport, sales and other taxes, royalties, duties and materials, contingencies, breakage, wastage, sundries, scaffoldings, etc on the basis of works contract. The rates quoted shall include all taxes, duties, transport, insurance, octroi, or any other levies applicable under the statute.

2.4.5 In case the rates of identical items under different sub-heads/parts are different, the lowest of these will be taken for the purpose of making the payments.

2.4.6 The rates for different items are for all heights, depths, widths and positions, unless otherwise specified against the item. No claim in respect of any leads/lifts for any item specified in the Schedule of Quantities, for which separate items for lead/lift do not exist in that schedule, will be entertained.

2.4.7 The work shall be executed as per the programme drawn or approved by the Architects and it shall be so arranged as to have full co-ordination with any other agency employed at site. No claim for idle labour shall be entertained nor shall any claim on account of delay in the completion of the work be tenable except extension of time secured by the contractor on request to be submitted to the Architects.

2.4.8 The Contractor shall permit free access and afford normal facilities and usual convenience to other agencies or departmental workmen to carry out connected work or other services under separate arrangements. The Contractor will not be allowed any extra payment on this account.

2.4.9 The contractor shall provide all equipments, instruments, labour and such other assistance required by the OWNER/CONSULTANTPMCs for measurement of the works, materials etc.

2.4.10 Even though the payment shall be effected under different items in the schedule of quantities, the various items in the schedule of quantities shall be deemed to cover all aspects of the work for the completion of the work as per drawings, from excavation to the finishing not withstanding any space adjustment possible omission in the description of the item and specifications thereof regarding incidental items of work, without which the whole work cannot be deemed to have been included under the scope of the different items of the schedule of quantities. The Contractor is advised to keep this in mind while quoting rates as no claims in this regard shall be entertained.

2.4.11 **Electricity shall be supplied at one point at site** and the contractor shall be responsible for providing the kilo watt hour meter and draw electricity from this point. The cost of meter, cabling, distribution etc. shall be borne by the contractor. Also the cost of electricity consumed will be charged from the contractor at the same rate as of the electricity authority. The owner, however, does not guarantee continuity and sufficiency of power at all times. If Power is not available, than contractor have to arrange his own D.G. set to complete the work in time.

2.5 AWARENESS OF SITE CONDITIONS AND CARRYING OUT OF SITE INSPECTION PRIOR TO TENDER SUBMISSION

2.5.1 Prior to the preparation and submission of his Tender, the Contractor shall make visits to the site and carry out all the necessary inspections and investigations in order to obtain all information and to make his own assessment of the conditions and constraints at site, including the means of access to it. The Contractor shall make himself aware of all the features of the site and the working conditions and space and shall, in general, be responsible for obtaining all the necessary and requisite information needed for him to prepare and submit his Tender.

2.5.2 Should the Contractor require any clarifications he shall seek these in writing from the Owner/ Consultant before submitting his Tender. At no stage will any extra claims be entertained or allowed on any matter or for any reason arising from or as a consequence of the Contractor's failure to comply with all the requirements stipulated in this Clause.

2.6 WORK AND WORKMANSHIP

2.6.1 To determine the acceptable standard of workmanship, the Architect /Consultant may order the Contractor to execute certain portions of works and services under the close supervision of the Architect / Consultant. On approval, these items shall be labelled by them as guiding samples so that further works are executed to conform to these samples.

2.7 CO-ORDINATION WITH OTHER CONTRACTORS AND AGENCIES

2.7.1 The Contractor during the execution of the Works shall co-ordinate with other Contractors, and other Agencies associated with the Project and shall work in harmony with them without causing any hindrance or obstruction or impeding the progress of their work in any way.

2.7.2 In respect of the work of other Contractors and Agencies, where the commencement or progress of such work of any other Contractor, or Agency is dependent upon the completion of particular portions of the Contractor's Works or generally upon the Contractor maintaining progress in accordance with the approved coordinated construction programme, it shall be the responsibility of the Contractor to complete such portions and maintain such progress.

2.7.3 Should any differences arise between the Contractor and the other Contractors, and Agencies, these shall immediately be brought to the attention of the Architect / Consultants who after reviewing the matters causing the differences will give their decision which shall be final and binding on the Contractor.

2.7.4 Co-ordination with Fire Alarm & Fire Protection System Contractor

Co-ordinate with fire alarm contractor to get the Complete information regarding the interference of Fire Alarm /Fire Protection System cable routes/piping routes, with HVAC ducting/piping layouts.

2.7.5 Co-ordination with Civil Contractors

To prepare detailed shop drawings for related HVAC works in accordance with the civil construction drawings.

To provide all pipes, boxes, sleeves, HVAC insert plates, supports, openings etc., necessary for the installation in compliance with construction programme.

To co-ordinate with the civil work contractor, for provision of drain channels, trenches etc.

2.7.6 Co-ordination with Plumbing Contractor

To co-ordinate Plumbing & Sanitary system pipelines crossing with pipes & ducts of HVAC System.

2.7.7 Co-ordination with Electrical works Contractor:

To co-ordinate the requirement of electrical power for various HVAC works equipments.
To co-ordinate bus duct crossing of pipes/ducts.
To co-ordinate HVAC pipes & ducts routing with regard to electrical works, cabling/conducting routes.

2.7.8 Co-ordination with Owner

To Coordinate with Owner for equipment \ material supplied by the Owner.

2.8 VARIATION IN QUANTITIES & TENDER DRAWINGS:

2.8.1 The quantities for ancillary works given in the schedule and/or in drawings are for the guidance of the tenderer. The contractor shall be paid on the basis of actual quantities of works carried out. However the contractor shall check these quantities before quoting and will bring to the notice of Consultants for any major variation. HVAC drawings issued with the tender are diagramatic only and indicate the general arrangement only. The data given in the drawings and specifications is as exact as could be secured, but its accuracy is not guaranteed. Contractor shall carry out his own computations and provide all such equipment, as required to achieve the specified conditions.

2.9 ADDITIONAL WORKS:

2.9.1 If required the Contractor shall have to execute additional works within the project site to the extent of 25% (Twenty five percent) of the total accepted contract sum. No adjustment of rates shall be made up to this limit and the terms and conditions of the contract shall remain unaltered.

2.10 RESTRICTED AREA:

2.10.1 For all purposes of this contract the site is considered as a Restricted Area. The Contractor shall ensure that he obtains entry passes for all his workmen and employees. The Contractor shall obtain special permission in writing from the Owner if he desires to continue working beyond office hours or on Holidays. The Contractor shall also observe and abide by the security regulations applicable during the currency of the contract.

2.11 PROTECTION OF OTHER CONTRACTOR'S WORKS AND SAFETY OF PERSONNEL AT SITE

2.11.1 Since many other contractors and agencies will be engaged on site and working simultaneously, the Contractor shall ensure at all times that during the execution of his work or during the operations and movements of equipments and supply vehicles and machinery, no damage or injury is caused to the work or property or personnel of other contractors and agencies.

2.11.2 In case of any such loss or damage the Contractor shall take full responsibility for same and shall bear all cost and expenses thereof. Also, the Contractor shall be responsible and liable for all delays caused due to such damage and or injury and for the consequences which the other Contractors and Agencies may have to face or to which they may be subjected to or be accountable for as a result of such delays.

2.12 SAFETY OF MATERIALS

The contractor shall provide proper and adequate storage facilities to protect all the materials and equipment including those issued by the owner against damage from any cause whatsoever.

2.13 MATERIALS SUPPLIED BY THE OWNER

The Contractor shall conduct all checks and carry out all tests and obtain test certificates necessary to ascertain and ensure that the Owner supplied materials are in conformity with the requirements stipulated in the Contract Documents. Should any of the Owner supplied materials obtained from any supplier not be in conformity with the requirements stipulated in the Contract Documents then the Contractor shall not take acceptance of such materials and he shall not incorporate them in the Works unless so specifically authorised by the Owner / Consultants and it shall be the Contractor's responsibility to bring this matter to the immediate attention of the Architect / Consultants and seek his instructions in respect of the disposal of such materials. Should the Contractor fail to comply with this procedure then all costs and/or delays which are a result and consequence thereof shall be to the account of the Contractor.

With respect to reconciliation of Owner supplied materials, the quantities of such materials allowed towards consumption for the Works by the Contractor shall be the theoretical requirement plus permissible wastage. The theoretical requirement shall be determined by measurements made in accordance with the dimensions shown on the Drawings to which the Works shall be executed. Owner supplied materials used due to any reason whatsoever for replacement and/or rectification work shall not be deemed to be theoretical requirement, and the costs in respect of these materials used for such work shall be borne by the Contractor.

2.14 TOOLS, TACKLES, EQUIPMENTS & SCAFFOLDING

All tools, tackles & equipments necessary for the HVAC installation and testing shall be provided by the contractor. The quoted rates shall take into account for providing any such equipment, which may not form part of the installation, but are necessary for the execution of the job. Contractor shall be responsible to make his own arrangement to provide scaffolding/ supports etc., necessary for his work. However the contractor may use the civil contractors scaffoldings if available with prior understanding with the civil contractors.

2.15 ACTUAL ROUTE OF PIPE LINES/DUCTS:

The location of the HVAC pipe lines/Ducts indicated in the drawing is only indicative. The actual route of pipe lines/ ducts may differ from the plans according to the details of the building construction and the conditions of executions of the installations.

The contractor shall supply and install at his expense all secondary materials and special fittings found necessary to overcome the interference and to supply the modifications on the route of HVAC pipe lines/ducts that are found necessary during the work, to the complete satisfaction of the Owner /Consultants.

2.16 DRILLING/CUTTING

The contractor shall have to do all drilling and cutting of walls or other elements of the building for the complete and proper installation of the pipe lines/ducts and other equipments by using electrically operated tools. Manual drilling or chiseling shall be permitted on special request only.

Beams, girders and other principal structural members shall not be cut or drilled unless prior permission has been granted by the Architect /Consultants.

If such drilling and cutting are made on finished surfaces, any marring of the surfaces shall be made good by repair at the HVAC Contractor's expense.

2.17 PLASTERING OF WALL CHASES/OPENING ETC.,

All chases and openings made by the contractor for his pipe lines/ducts shall be filled/covered over with cement plaster in reasonable manner, to be finished by the HVAC contractor.

Before rough plastering on the pipe surfaces the concealed pipes shall be secured to the wall by using proper supports /clamps.

2.18 MANUFACTURERS

Where manufacturers have furnished specific instructions relating to the materials used in this job, covering points not specifically mentioned in these documents, these instructions shall be followed in all cases.

Where manufacturer's names and/or catalogue numbers are given, this is an indication of the quality, standards and performance required.

For items not covered under the `List of Approved Makes', contractor shall offer items of first class quality, standards and performance and obtain the approval of Architect /Consultants before procuring them.

Where interfacing occurs, equipment shall be mutually compatible in all respects.

2.19 RATING

Rating of all items shall be appropriate for the conditions on the particular site on which the item will be used. All the equipment shall be fit for continuous work under the most severe conditions of site.

2.20 TESTING:

All types of routine and other/tests shall be carried out at the works of the Contractor or the manufacturers of the components. The Consultants shall be free to witness any or all tests, if they so desire.

On the completion of the installation the Contractor shall arrange to carry out various initial tests as detailed below, in the presence of and to the complete satisfaction of the Consultants or his representative, any defects or short, comings found during the tests shall be speedily rectified or made good by the Contractor at his own expense. The initial tests shall include, but not be limited to the following:.

2.20.1 To operate and check the proper functioning of all electrically operated components viz. Compressor motor, pumps, air washer fan air handling units etc as well as other electrical motors.

2.20.2 To test and check the proper functioning of electrical switch gears, safety and other controls to ensure their proper functioning.

2.20.3 To check the air distribution system and to provide design air flow in all areas by adjusting the grilles, diffusers and dampers for air conditioning.

2.20.4 To check & balance/adjust the water flow in the water circuits for smooth and noiseless flow.

2.20.5 To check the systems against leaks in different circuits, alignment of motor, `V' belt adjustments, control setting and all such other tests which are essential for smooth functioning of the plant.

2.20.6 On the satisfactory completion of all `Initial' tests the plant should be considered to the `Virtually Complete' for the purpose of taking over by the employer.

2.20.7 In addition to the `Initial' test the Contractor shall also give two or three continuous running tests of the plant, each of (3) three days duration, and each one during the full specified outside conditions (when the ambient conditions are close to the specified ambient conditions). The first running test may be taken on the completion of the initial test, provided the ambient temperature and humidity are near their peak.

2.20.8 The Contractor shall provide all necessary tools, instruments, gauges, flow meter, anemometer, etc as may be required for conducting the various tests. He shall also provide necessary lubricant etc and required personnel for the tests.

2.21 SHOP DRAWINGS & SAMPLES:

2.21.0 On the award of the work, the Contractor shall immediately proceed with the preparation of detailed working drawing showing the detail of the equipment that are to be installed and the ancillary works that are to be carried out.

2.21.2 Three sets of all such working drawings along with soft copy shall be submitted to the Consultants for approval to ensure that the works will be carried out in accordance with the specifications and drawings, including such changes as may have been mutually agreed upon. All the drawings shall be received by the Consultants for approval within 3 weeks of the award of work. The approval of the drawings by the Consultants shall in no way relieve the Contractor from his obligations to provide a complete and satisfactory plant installation, testing and commissioning as per intent and purpose as laid down in the specifications.

2.21.2 Any omissions and/or errors shall be made good or rectified whether or not the drawings are approved. Contractor shall obtain written approval for samples (like grilles/diffusers, valves & controls) and other materials before placing the order. Contractor shall guarantee the specified

Inside conditions at specified outside conditions. Prior to the completion of the work, the contractor shall furnish to the employer (4) four sets of a comprehensive manual, describing all components furnishing a list of spare parts and setting forth in details the instructions for the operation and maintenance of the plant.

2.21.3 The Contractor shall also fix in the plant room, neatly typed and framed, instructions in details, for the starting and running of the plant. All equipment shall be suitable for power supply of 415/220 volts, 3 phase, 50 cycles A/C power supply.

2.21.4 Any special tools required for the operation or the maintenance of the plant shall be supplied free with the plant including consumables for a period of 6 months from the date of commissioning.

2.22 "AS BUILT" DRAWINGS”

At the completion of work and before issuance of certificate of virtual completion the contractor shall submit Three (3) sets to the Owner /Consultants, layout drawing drawn at appropriate scale indicating the complete HVAC system "as installed" also soft copy on CD.

2.23 INSTRUCTION/MAINTENANCE MANUAL

The Contractor shall prepare and produce instruction, operation and maintenance manuals in English for the use, operation and the maintenance of the supplied equipment and installations, and submit to the Owner / Consultants in (4) copies along with soft copy at the time of handing over. The manual shall generally consist of the following:

a) Description of the project.
b) Operating instructions.
c) Maintenance instructions including procedures for preventive maintenance.
d) Manufacturers catalogues.
e) Spare parts list.
f) Trouble shooting charts.
g) Drawings.
h) Type and routine test certificates of major items.
i) One (1) set of reproducible `as built' drawings.

2.24 COMPLETION CERTIFICATE

On completion of the HVAC installation a certificate shall be furnished by the contractor countersigned by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local supply authority.

2.25 GUARANTEE

At the close of the work and before issuance of final certificate of virtual completion by the Owner/ Consultants, the contractor shall furnish written guarantee indemnifying the owner against defective materials and workmanship for a period of **two year after completion** (Defect liability period). The contractor shall hold himself fully responsible for reinstallation or replacement, free of cost to owner, the following:

2.25.1 Any defective work or material supplied by the Contractor.

2.25.2 Any material or equipment supplied by the owner which is damaged or destroyed as a result of defective workmanship by the contractor.

2.25.3 Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor.

2.26 RATE ANALYSIS

At anytime and at the request of the Owner /Consultants the contractor shall provide details or breakdown of costs and prices of any part or parts of the works.

2.27 STAFF

The contractor shall employ competent fully licensed qualified, full time Mechanical/Electrical engineers to direct the work of HVAC installation in accordance with the drawings and specifications.

The engineers shall be available at all times at site to receive instructions from the Owner/ Consultant, in the day to day activities throughout the duration of contract. The engineer shall correlate the progress of the work in conjunction with all the relevant requirement of the supply authority.

2.28 WATER AND POWER:

The contractor will make his own arrangement for water and electricity. If arranged by the Owner the same shall be supplied at one point only and contractor shall be required to make his own arrangement for distribution lines required for the work. Recovery for the same shall be made at the prevailing rates based on the meter readings to be installed by the contractor at the source point. Contractor shall arrange at his own cost the fuel oil/or other consumables required for testing the systems.

2.29 SAFETY BARRIERS AND CONSTRUCTION SAFETY

The Contractor shall at his own cost provide for the protection and safety of the persons working in the area, safety barriers around all openings in every location and at the periphery and edges of all slabs, staircases and stairwells, lift shafts, ducts etc., all to the approval and satisfaction of the Owner. However contractor shall take appropriate safety precautions suitable for specific locations/ situations and as instructed by the Owner.

The Contractor shall, in general, be fully responsible for all matters with regard to every form of safety during construction and in connection with the execution of the Works, and the Contractor shall take all necessary precautions and provide at his cost everything necessary to ensure such safety at all times. Should any accidents occur due to the Contractor's failure to comply with such safety requirements and to take all other safety measures necessary, the Contractor shall be fully responsible for all such accidents and he shall bear and pay for all costs and damages in connection therewith and as a consequence thereof. The Contractor shall indemnify the Owner from and against all claims in this regard.

The Owner shall have powers to withhold amounts from payment certificates in case of Contractor's persistent non compliance with provisions of this clause. Also the Owner is empowered to employ another agency at Contractor's cost after one week's notice to implement this Clause in case of Contractor's non compliance with provisions of this Clause.

2.30 DISPOSAL OF RUBBISH FROM THE WORKS AND THE SITE AND PROVISION OF SAFETY NETTING/SCREENS BY CONTRACTOR

The Contractor shall at all times keep the Works and the site in clean, neat and tidy condition. All rubbish from the Works and the site shall be collected and deposited in large bins provided on the site for such purpose by the Contractor at his own cost. The rubbish from such bins shall be regularly carted away by the Contractor to rubbish tips and dump yards beyond the site.

At no time or stage shall any rubbish be thrown over the edges of slabs or through any openings or shafts or ducts or stairwells.

The Contractor shall, at his own cost and to the approval and satisfaction of the Architect, provide safety netting/screens at the periphery of all slabs and at all openings, shafts, ducts and stairwells and/or canopies to prevent any rubbish or material falling over or into such areas and endangering the safety of the persons working below. Should the Contractor fail to provide such safety measures and to take other necessary precautions in accidents that may occur, he shall bear all costs and damages as decided by Owner in connection therewith and as a consequence thereof. The Contractor shall indemnify the owner from and against all claims in this regard.

The Owner shall have powers to withhold amounts from payment certificates in case of Contractor's persistent non compliance with provisions of this clause. Also the Owner is empowered to employ another agency at Contractor's cost after one week's notice to implement this Clause in case of Contractor's non compliance with provisions of this Clause.

2.31.1 SPACE FOR CONTRACTOR'S CONSTRUCTION YARD, STORES, LABOUR CAMPS ETC.,

The owner shall provide adequate storage/office space to the contractor for his use. The space has to be main tained/constructed by the contractor as per his usage requirements.
All spaces allotted to the contractor, as described above shall be vacated and all structures removed from site at any time as and when required and directed by the relevant authorities or by the Owner, unconditionally and without any reservation. The authorities or the Owner will not be obliged to give any reason for such removal. Upon receiving instructions to vacate the space, the contractor shall immediately remove all his structures, materials, etc., from the sources and clear and clean-up the site to the satisfaction of the Architect.

It shall be the specific responsibility of the Contractor to safeguard the site and ensure that no illegal encroachments are made by outside elements within the area allotted to the Contractor. Upon completion of the work or earlier as required by Owner/Authorities, the Contractor shall vacate the land totally without any reservations. Necessary Bond to this effect on a stamp paper shall be signed by the contractor in a prescribed form.

The Performance Bond and/or guarantees towards retention amount furnished by the Contractor shall not be released until the spaces allotted to the contractor are fully vacated and handed over to the owner as per the instructions of the Owner.

2.32 FENCING AND SECURITY

The Contractor will arrange to erect, at his cost, barbed wire or other appropriate fence around the infrastructure site, with entry/exit gates at suitable points. The Contractor shall, at his own cost, provide and erect suitable fencing around the spaces allotted to him at the infrastructure sites to ensure the security of his men, materials and equipment within the sites and in relation to other contractors who will also be allotted spaces at above sites.
The security of workmen, materials, equipment stores, etc., within the area allotted to the contractor shall be the responsibility of the contractor.

2.33 CARRYING OUT WORK BEYOND NORMAL WORKING HOURS OR IN SHIFTS

In order to achieve the milestone and completion dates and to keep pace with the approved construction programme, the Contractor shall be permitted to carry out his work beyond the normal working hours or in shifts. The Contractor shall be responsible for obtaining any necessary permissions from the relevant authorities that may be required for him to carry out the work beyond the normal working hours or in shifts. Also, the Contractor shall give prior notice to and make arrangements with the Owner for the supervision of work carried out beyond the normal working hours or in shifts. The Contractor shall make his own arrangements in respect of the provision of adequate lighting and any other facilities that may be required for carrying out the work beyond the normal working hours or in shifts. No extra payments shall be made to the Contractor for or in connection with any such overtime or shift work. The Contractor will not be required to bear the overtime expenses of the Architect in respect of the supervision of such overtime or shift work of the Contractor.

2.34 USE OF CIVIL CONTRACTOR'S ESTABLISHED/AVAILABLE FACILITIES AT SITE BY SPECIALIST AND SERVICES CONTRACTORS/ NOMINATED SUB-CONTRACTORS

The civil contractor at his discretion may allow the use of his established/available facilities at site such as storage, scaffolding, lifting and hoisting, other plant and machinery, means of access, water, power, labour camp etc to the Contractor subject to prior arrangements being made by the contractor with the civil work Contractor.

2.35 PERIOD AND TIME LIMIT FOR VIRTUAL COMPLETION OF WORKS

The period and time limit for Virtual Completion of the Works shall be _____ Calendar Months from the date of issue of Work Order to commence works or handing over of site in respect of the award of Contract. This time period shall be inclusive of the mobilisation period and monsoon period.

2.36 PROFESSIONAL INTEGRITY AND TEAM SPIRIT

It is the intent of the Owner, Architect and Architect that this project will be executed in a spirit of team and full professional integrity. Contractor is expected to cooperate with all the agencies involved in the project to fulfill this objective.

2.37 MALPRACTICES

The Contractor shall not try to influence in any manner the employees, staff or anyone else of the Owner, Consultants and Architect by offering undue favours, monetary gains, or any such illegal gratifications for any reason whatsoever. If it is established that the Contractor has indulged in such activity, the Owner reserves the right to terminate the Contract forthwith.

2.38 LIST OF APPROVED MAKES:

The Contractor shall quote for the first make of materials from the list of approved makes. In case of deviations from the same alternate makes with subsequent price reduction to the client shall be quoted by the contractor. The contractor shall clearly indicate the list of materials proposed to be used by him & enclose the same with the tender.

2.39 APPROVAL OF EQUIPMENT/MODEL/SUB-VENDORS:

HVAC contractor shall obtain prior approval from Owner /consultant for selected equipment/samples/model including selection of sub-vendors before bringing at site for execution.

2.40 TO SPECIAL CONDITIONS SUBMITTALS TO BE MADE BY THE CONTRACTOR DURING THE EXECUTION OF THE WORK

1. Weekly progress report including number of men employed under each trade, Equipments at site etc.

2. Fortnightly progress report-showing progress against programme.

3. Programme of work for the forth-coming week.

4. Labour and Equipment Deployed at site - programmed requirement VS actual deployed -- weekly.

5. Updated approved monthly PERT Chart along with monthly progress chart -- weekly.

6. Construction Materials by Contractor: status and mobilisation programme - Fortnightly.

7. Owner supplied Materials for the coming (next) month - monthly.

8. Reconciliation of owner supplied materials -- Monthly.

9. Value of work anticipated to be done in the forth coming month including value of any materials / equipment of large value -- Monthly.

2.41 SAFETY REQUIREMENT/GENERAL PRECAUTIONS

1. All workmen to be dressed in approved uniform.

2. All workers to be shaved or trimmed and to be in good neat appearance.

3. No smoking and tobacco chewing permitted within the premises.

4. All workers to have photo ID card with the following prominently displayed:

   i) Name of client

   ii) Name, address and contact number of contractor

   iii) Name of worker

   iv) Designation

   v) Address of worker

   vi) Worker code number

   All the ID cards to be submitted to security department of the Hotel. Subsequently on approval, all cards to be laminated and chained by the contractor.

5. All workers to keep I-Card in visible portion. Card to hung prominently on all working time inside the hotel premises.

6. All workers are subject to security check

7. All contractors to make schedule of entry and exit of all workman. Proper record book to be maintained at site. The record book to be accessible to the Consultant and Hotel Authorities.

8. All tools and plants and refundable material to be noted and verified by the hotel security.

9. All tools and plants to be labeled by the contractor for identification.

10. Insurances/Safeties:

i) The contractor shall at this own cost provide for the protection and safety of the persons working in the area. The contractor shall be fully responsible for all matters with regard to every form of safety during construction. Should any accidents occur due to the contractors failure to comply with safety requirements, the contractor shall be fully responsible for all such accidents and he shall bear and pay for all the costs and damages. Rs. 1,00,000/- in each accident at each job site & & to a limit of Rs. 5,00,000/- for all accidents at all job site.

ii) Workman compensation.

iii) Contractor all risks policy.

3.0 BASIS OF DESIGN

3.1.0 INTRODUCTION :

Air conditioning system is designed as per relevant National standards to provide year round air-condoning of the Langar Hall, Kitchen, Stores and other areas.

3.1.1 The basis of design for central air conditioning is as given below:-

A) Outside Weather Data:

Location		-	Amritsar, Punjab, India.
a)	Latitude (^{o}N)	-	31.37 N
b)	HT above MSL	-	234 M

B) Out Door Design Conditions:

Dry Bulb	**Summer**	**Monsoon**	**Winter**
Deg. F	110.0	95.0	45.0
Deg. C	43.33	35.0	7.2
Wet Bulb			
Deg. F	75.0	83.0	41.0
Deg. C	23.9	28.3	5.0

3.1.2 Inside Design Conditions of AC Areas:

Dry Bulb	**Summer**	**Monsoon**	**Winter**
Deg. F	77.0	77.0	70.0
Deg. C	25.0	25.0	7.2
RH	Not exceeding	60%	

3.1.3 Lighting Load of AC areas - 1.0 Watt/Sq.Ft.

3.1.3 Fresh Air of AC areas - 5.0 CFM /Persion

3.1.5 Mechanical Ventilation - @ 15-30 air changes per hr

3.1.7 <u>INSULATION:</u>

Roof shall be insulated with 50 mm thick PUF or equivalent.

Window Glass shall be double insulated reflective type to minimize energy consumption.

3.2.0 BUILDING

3.2.1 Building Consisting of following:

- Basement : Plant Room ,Substation and Stores.
- Ground Floor : Langar Hall, Tea Langar Hall,Cooking Area & Washing Areas
- First Floor : Langar Halls, Cooking Area and Washing Area.
- Second Floor : Cooking Area, Sewa Area, and Washing Area.
- Terrace : VRV Outdoor units, Cooling Towers, Air Washers & Ex. Fans
- Terrace(MS Structure) : Exhaust Fans

3.2.2 For AC loads and room internal loads refer Table 1

3.3.0 SYSTEM DESCRIPTION:

3.3.1 Air conditioning Load.

a) Connected peak AC load works out to be as follows:
   i) Summer : 683.6 TR.
   ii) Monsoon : 761.7 TR.

3.3.2 AC System Description:

Air conditioning system has been designed to provide year round air conditioning for proposed Lennar Halls with VRV System. The system will provide cooling in summer and monsoon seasons.

Air conditioning system includes VRV air cooled outdoor units, Air handling units and interconnected refrigerant piping work. Energy conservation oriented air conditioning system shall be designed to achieve energy conservation for various areas. Each area shall be provided with independent air handling units connected to the outdoor units. Each AHU will be provided with thermostat and when the indoor specified conditions are achieved, The speed of Outdoor unit will reduced or turned off to save the energy.

Each VRV System shall consist of following important equipment to conserve energy:

a) VRV Out Door Heat Pumps.
b) Ceiling Suspended or Floor Mounted AHUs.
c) Inter connecting refrigerant piping and cabling.
d) Thermostat.
e) Control Panel
f) EEV Kit
g) Electrical Panel

All the areas shall be provided with battery of AHUs. Each ceiling hung AHU shall be accessible through the access panel in the false ceiling.

Supply air will be fed to the conditioned space through supply air duct and return air will be brought back to the AHU through the void space above the false ceiling. It is proposed to insulate supply air ducts. AHUs are provided with metallic prefilters having 90% efficiency as per ASHRAE Standards. These filters are non flammable and washable type.

TFA AHUs will be provided to provide the Spot cooling in the Cooking/Working areas apart from ventilated air from the air-washers to make working area comfortable.

3.3.3 Ventilation and Exhaust System :

Exhaust System is proposed for all the Cooking and Washing areas. Exhaust Hoods shall be provided over the various Cooking devices. (To be supplied by other Contractor) Exhaust will be taken to the terrace through MS Ducts. On terrace exhaust ducts will be connected to the exhaust fans and exhaust will be released to the atmosphere.
Fresh air to the various areas will be supplied through Air-washers provided on the terrace. Air-washers will filtered and cool the air. This air will keep the temperature lower in summer.
Some of the Air-washes will be provided with Cooling coils and Chilled water will be available from the 2 Nos.700 KW Each Heat Pumps provided in the Basement by another contractor.
Free Cooling of 155 TR Each will be available.
Chilled Water Supply Temperature will be 5 ^{0}C (44.6 ^{0}F)
Chilled Water Return Temperature will be 12 ^{0}C (53.6 ^{0}F)

Plant room area & other non air conditioned areas will be mechanically ventilated.

Stores in the Basement will be provided with Ventilation system.

3.3.4 FIRE SAFTY:

Smoke/Fire dampers shall be provided in accordance with ASHRAE/NFPA Standards within supply and return air ducts at AHU room crossings to prevent spread of smoke/fire to the adjoining areas. Smoke/Fire dampers shall be motorized operated, actuated by smoke sensor.

3.3.5 CONDENSER WATER SYSTEM:

Cooling Towers shall be located at Terrace floor. Water through condenser of Cold Stores shall be pumped by the condenser water pumps and after picking up the heat, the same shall be discharged to cooling tower.

MS class C pipes shall be used interconnecting cooling towers & condenser of the Cold Stores. Water, after dissipating the heat to ambient through cooling towers, shall be re-circulated to the condensers. Makeup soft water supply shall be provided to each of the two nos. cooling towers.

3.3.6 NOISE CRITERION:

All air conditioning equipment and materials (like pumps, chillers, motors, ducts, grilles, acoustic lining etc) will be selected, designed and installed in such a manner that the inside noise criterion for all conditioned spaces will be in the range NC-35 to NC-40.

3.4.0 DESIGN PARAMETERS:

3.4.1 Design Parameters for selection of air handling unit and its components shall be:

Maximum face velocity across prefilter	- 350-400 Ft/Min = 105 – 120 M/Min
Maximum face velocity across coils	- 500 – 550 Ft/Min = 150 – 168 Mtrs/Min
Maximum fan outlet velocity	- 1800 Ft/Min = 550Mtrs/Min
Maximum fan speed	- 1000 RPM
Maximum fan motor speed	- 1500 RPM

3.4.2 Piping shall be sized for the following design parameter

Maximum flow velocity:	- 8 Ft/Sec = 2.5Mtrs/Sec
Maximum friction	- 5 Ft per 100Ft. run.

3.5 Following Tables to be referred:

i) Schedule of Requirements and Room Internal loads are given the Table –1

ii) Detail of Ventilation & Exhaust System are given in Table – 2

iii) Detail of AC System is given in Table – 3

iv) Schedule of AHU's is given in Table – 4

v) Schedule of Air-washers is given in Table – 5

vi) Schedule of Exhaust Fans is given in Table – 6

I4) TECHNICAL SPECIFICATIONS:

A) VARIABLE REFRIGERANT FLOW SYSTEM:

1.0 SCOPE

The scope of this Section comprises the supply, erection testing and commissioning of the air-conditioning system confirming to these specifications and in accordance with the requirements given in Schedule of Equipments.

2.0 General

i) The scope of this section comprises the design, supply erection, testing and commissioning of inverter technology based D.C Twin Rotary / Scroll VRF type system of air conditioning conforming to these specification/ Explanatory Note and in accordance with the requirements of Drawing and Schedule of Quantities. The prices quoted shall include all the equipment ancillary material as specified and all such items whatsoever and which may be required to fulfill the intent and purpose as laid down in the specification and the approved drawings. The contractor shall calculate equipment capacity based upon design parameters specified for the system design & verify all the quantities and sizes of refrigerant pipe, fitting, cables, control cable, pipes, insulation, indoor units, and outdoor units etc. before installation to avoid any shortfall or surplus. The tenderer shall also include all necessary civil work MS frame work for installation of outdoor and indoor units in VRF based air condition system. The cost quoted by tenderer shall also include the refrigerant gas R-410A & its charging for proper & specified functioning of air conditioning system.

ii) The scope in the tender schedule also covers detailed designing of complete air-conditioning system BMSed on inverter technology BMSed D.C Twin Rotary / Scroll / Scroll /Scroll VRF air conditioner with air cooled outdoor units system capable of cooling and heating (reverse cycle) as per individual or season requirement suitable for operation on 415 V, 3 Phase, 50 Hz AC electric supply.

The outdoor units shall have both cooling & heat pump mode, consisting of one/ multiple outdoor unit with single circuit of refrigerant piping and multiple in door units of various types. Each indoor unit should have capability to cool or heat as per seasonal weather changes and as per Bill of Quantity.

iii) The tendered shall quote only makes for which he has satisfactorily executed the job and shall also furnish certificate to the effect that the such equipment has performed satisfactorily under Indian weather conditions at least for a period of one year from its commissioning. The performance certificate from the end user shall also be enclosed with the tender documents.

The firm should comply with the parameters as specified in the terms & conditions.

iv) The project of air-conditioning is required to be executed in time bound and professional manner. The equipments involved in air-conditioning are complex in nature comprising of instrumentation, control and central management system. The job, therefore calls for highest order of technical expertise and also requirement of experience of air-conditioning installation with proven performance. This consent shall also covers aspects of desired assistance in the field of design, development, testing, execution, completion & maintenance/ maintenance spares of the air-conditioning system.

v) Notwithstanding the technical details as specified in the tender, the manufacturers may offer/ indicate systems and necessary design & features applicable for the offered products at the tendering stage.

2.0 OUTDOOR UNIT

i. The outdoor unit shall be factory assembled, weather proof casing (Material of construction of casing shall be vendor's standard design), constructed from heavy gauge GI sheets steel panels and coated with baked enamel finish. The outdoor unit shall be completely factory wired, tested with all necessary controls & filled with first charge of refrigerant before delivering at site The Unit should have a minimum of 4.5 C.O.P at 50% part load. All the vendors shall provide an O.E.M letter from the manufacturer for the C.O.P.

ii. The inverter technology BMSed D.C Twin Rotary / Scroll VRF equipment should be capable so that refrigerant piping between indoor units and outdoor unit shall be Extendable up to 150m with maximum height difference between outdoor & indoor unit of 50m & level difference between two indoor units shall be maximum up to 15m.

iii. The outdoor unit shall be factory tested and filled with first charge of refrigerant R-410A before delivering at site.

iv. It should also be provided with duty cycling for D.C inverter Twin Rotary / Scroll compressors capable of changing the rotating speed of compressor by inverter controller to follow variation in cooling & heating loads & switching starting sequence for better stability and prolonging equipment life or similar features if available in D.C Twin Rotary / Scroll will also be accepted.

v. The unit shall be provided with its own microprocessor control panel with provision for integration with the building management system for Air-conditioning system.

vi. The machine must have a sub cool feature to use coil surface more effectively through proper circuit/ bridge so that it prevents the flushing of

refrigerant from long piping due to this effect thereby achieving energy savings.

vii. The outdoor unit should be fitted with low noise level and should not be more than 67 db (A) at normal operation when measured at 1.5m distance from ground level.

viii. The outdoor unit should be fitted with low noise aero spiral design fan with aero fitting grill for spiral discharge airflow to reduce pressure loss and should be fixed with DC fan motor for better efficiency.

ix. In case of trouble occurs in an indoor units (s), the continuous operation of system should be possible.

x. The unit shall be designed in such as way that cleaning of drain Pan should be easy & inspection/ replacement of compressor should be easy.

xi. The condensing unit shall be designed to operate safely whey connected to multiple fan coil units.

2.1 Compressor

i. The compressor in inverter based D.C Twin Rotary / Scroll System shall be highly efficient. The system should response efficiently in accordance to the variation in cooling or heating load requirement.

ii. All outdoor units shall have multiple steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated stock. Forced lubrication may also be employed.

2.2 Oil Recovery system

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigeration piping lengths.

The system must be provided with oil balancing circuit to avoid poor lubrication.

2.3 Refrigerant Circuit

The refrigerant circuit shall include liquid and gas shut-off valves and a solenoid valves at condenser end.

The equipment must have inbuilt refrigerant stabilization control for proper refrigerant distribution.

All necessary safety devices shall be provided to ensure the safe operation of the system.

2.4 Heat Exchange

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fin coil.

The aluminium fins shall be covered by anti-corrosion resin film.

The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical discharge. Each fan shall have a safety guard.

2.5 Safety Devices

All necessary safety devices shall be provided to ensure safe operation of the system.

Following safety devices shall be part of outdoor unit: - high pressure switch, fuse, fan drive overload protector, fusible plug, crankcase heater, over load relay, overload protection for inverter.

2.6 The outdoor roof mounted units shall be provided in such a fashion that these do not affect the overall aesthetics and ambience of the building. If required these units shall be suitably camouflaged to give good aesthetic look. These provisions, however, shall be discussed, if required, at a later date and the prices for the same shall be worked out separately as extra item.

2.7 Noise levels for outdoor units shall not be more than 67 db (measured at a point 1 meter in front of the unit at a height of 1.5 meters.

3.0 INDOOR UNITS

All indoor units as specified shall have; in general, noise levels should be low. For critical applications noise levels below these limits may, however, be specified during design stage.

i. Each unit shall have electronic control valve to control refrigerant flow rate respond to load variation of the room.

ii. The address of the indoor unit shall be set automatically in case of individual and group control.

iii. In case of centralized control system, it shall be possible to set the address of individual indoor unit through a liquid crystal remote controller.

iv. The fan shall be dual suction, aerodynamically designed, Turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free

operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having support from housing.

v. Indoor unit shall have cleanable type filter fixed to an integrally moulded/ moulded plastic frame. The filter shall be slide in and neatly insertable type. It shall be possible to clean the filters either with compressed air or water.

vi. Each unit shall have Electronic control expansion valve for variable refrigerant Flow Effect.

vii. Each indoor Cassette unit shall be with wired remote controllers as standard features. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self diagnostic features for each and quick maintenance and service. The controller shall be able to change fan speed and 4 way supply air grilles on sides and return grilles in centre as per requirement.

4.0 Y-Joint/ Ref. net séparation

Supply & installation of the Y-Joint/ Ref-net separation refrigeration pipe joints and headers in the appropriate orientation to enable correct distribution of refrigerant. The Distribution Joints should be factory insulated with pre-formed sections of Expanded Polystyrene/Equivalent

5.0 REFRIGERANT COPPER PIPING:

5.1 Refrigerant Piping

Refrigerant piping for the air-conditioning system shall be upto 19.1 mm dia of soft seamless copper tubes & for above 19.1 mm dia the pipe material shall be of hard seamless copper tubes with pipes material being hard drawn copper pipe. Forged copper fittings shall be used for the refrigerant piping. The refrigerant piping arrangements shall be in accordance with good engineering practices as applicable to the air-conditioning industry, and shall include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits except Y joint/separation tubes.

The thickness of refrigerant circuit piping shall be as per detail given below:

Outer Dia(mm)	Minimum wall thickness (mm)
6.35 mm	0.80 mm
9.5 mm	0.80mm
12.7 mm	0.80 mm
15.9 mm	1.00 mm
19.1 mm	1.00 mm

22.2 mm	1.00 mm
28.6 mm	1.00 mm
34.9 mm	1.10 mm
41.3 mm	1.25 mm

5.2 Before jointing any copper pipe or fittings, its internals shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently it shall be thoroughly blown out using nitrogen gas.

5.3 After completion of installation of the refrigerant piping, the refrigerant piping system shall be pressure tested using nitrogen gas at a suitable pressure as specified by OEM (Original Equipment Manufacturer). Pressure shall be maintained in the system for 48 hours. The system shall then be evacuated to vacuum of not less than 700 mm Hg and held for 24 hours.

5.4 The supplier of air-conditioning system shall choose sizes as designed and erect proper interconnections of the complete refrigerant circuit.

5.5 The suction line pipe size and the liquid line pipe sizes shall be selected according to the manufacturer's specified diameter. All refrigerant pipes shall be properly supported and anchored to the building/structure using steel hangers, fasteners, brackets and supports which shall be fixed to the building/structure by means of inserts or expansion shields or anchor fasteners of adequate size and number to support the load imposed thereon.

5.6 Entire liquid and suction refrigerant pipe lines including all fittings, valves and strainer bodies, etc. shall be insulated with 13mm thick nitrile rubber upto pipe size of 15.9mm dia and above that with 19mm thick nitrile rubber as specified in BOQ.

6.0 REFRIGERANT PIPE INSULATION :

6.1 All suction pipes and low temperature / pressure liquid pipes of the refrigerant pipe work shall be insulated with slip on closed cell crossed link fire retardant pipe insulation having a wall thickness of not less than 13 mm for soft pipe / 19mm for hard pipe.

6.2 The thermal conductivity of the insulation material shall not exceed 0.032 W/m K at 0 deg C. mean temperature. The density of the insulation material shall not be less than 33+/- Kg/ cum.

6.3 All joints of the insulation shall be sealed with 100 mm width x 3 mm thick self adhesive tapes of the same material as insulation and shall be of the same make as the BMSis insulation material.

7.0 ACCESSORIES:

Unit shall be complete with the accessories including but not restricted to the following:

7.1 One power supply will be made available by the electrical contractor near the outdoor units. AC contractor to make necessary provision to feed two outdoor units by providing suitable MCBs in weather proof enclose.

7.2 Power Supply will be made available near each indoor unit and Out door unit. Starter panel/MCB/MCCB& ELCB and from there all work to be carried out by AC contractor.

7.3 Inter connection wiring and refrigerant piping along with insulation to be provided.

7.4 MS frame as required at site to install indoor and Self leveling type ODU body coloured powder coated MS stand for outdoor units including vibration isolators and painting to complete the installation.

B) AIR HANDLING UNITS:

1.0 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of air handling units, conforming to these specifications and in accordance with requirement of drawings and of the Schedule of Quantities.

I) DOUBLE SKIN

1.1 TYPE:

The air handling units shall be double skin construction of approved make with filter section & filter, DX cooling coil, with insulated condensate drain pan, centrifugal fan and volume control dampers. Units shall be of the arrangement shown on the Drawings and mentioned in Schedule of Quantities.

1.2 CAPACITY:

The air moving capacities and maximum motor horse power shall be as shown on Drawings and in Schedule of Quantities.

1.3 HOUSING/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 locations. The Frame work shall be of Extruded Aluminum hollow sections filled with preformed insulation section duly mill finish/powder coat painted/anodized. The entire frame shall be assembled using mechanical joints to make a sturdy & strong frame work for various sections.

Double skin panels shall be made of 0.62 mm galvanized pre-plasticized/powder coated sheet on outside and 0.62mm GI sheet inside with 25/46 mm thick P.U.F foam of 38 Kg/m^3 (Min.) density insulation in between. These panels shall be bolted from inside on to the frame work with soft rubber gasket in between to make the joints air tight.

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

Drain Pan shall be constructed of 22G SS sheet with necessary slope to facilitate fast removal of condensate. Necessary supports will be provided to slide the coil in the drain pan. Outlet shall be provided on both the sided of drain pan.

Opposed blade double skin aero foil aluminium damper shall be provided on the outlet of the AHU.

1.4 MIXING BOX :

AHU'S requiring mixing box shall be complete with fresh Damper and return air damper. Dampers shall be opposed blade type. Blades shall be made of double skinned aerofoil aluminium extruded aluminium alley frame. Manual dampers shall be provided with a bakelite knob for locking the damper blades in position. Linkages shall be extended wherever specified for motorised operation. Damper frames shall be sectional to minimize blade wrapping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure.

2.0 DAMPER:

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

3.0 MOTOR AND DRIVE:

Fan motors shall be 415 ± 6% volts, 50 cycles three phase AC supply squirrel cage, totally enclosed fan cooled motors. Motors shall be specially designed for quiet operation and motor speed shall not exceed 1450 RPM. Fan motors shall be mounted inside the AHU casing on side rails for easy belt tensioning. Drive to fan shall be provided through belt-drive with a standard belt guard housing the bolt and adjustable motor sheave. Belts shall be of the oil-resistent type.

4.0 FAN:

Fan wheel and housing shall be fabricated from heavy gauge steel. Fan wheels shall be of the double width, double inlet backward-curve for double skin AHU's and forward curve for single skin AHU's, multi-blade type enclosed in a housing and mounted on a common shaft. Fan housing shall be made of die-formed steel sheets with stream lined inlets and guide vanes to ensure smooth air flow into the fans. Bearings shall be mounted externally for servicing without dismantling of the unit. All rotating parts shall be statically and dynamically balanced. Fan speed shall not exceed 1000 RPM and maximum fan outlet velocity shall be 550 meters per minute (1800 FPM). The fan housing with motor shall be mounted on a common aluminium frame work mounted in side the air handling housing on anti-vibration mounts.

The fan outlet shall be connected to the casing with the help of fire retardant double flexible connection mounted on aluminium extruded channels.

5.0 COOLING COILS:

Cooling/Hot water coils shall have 12.5 to 15 mm dia tubes min. 27 gauge thick with aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame cooling/heating coil shall be integrally finned type. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21 Kg./Sqcm. air pressure while submerged in water. Tube shall be mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 fins per inch. (4 -5 FINS/CM.).

6.0 ISOLATOR:

Vibration isolators shall be provided in all floor mounted air handling units and AHU mounted within the ceiling space shall be hunged through vibration isolation suspensions.

7.0 FRESH AIR INTAKES:

Galvanised sheet steel fresh air louvers with bird screen, filter and dampers shall be provided in the clear openings in masonry walls of the air handling unit rooms having atleast one external wall louvers, damper, fresh air ducts shall be shown on drawings and in schedule of quantities. Fresh air dampers shall be of the interlocking opposed blade louver type. Blades shall be made of not less than 18 gauge galvanised sheet steel, edges covered with felt to provide air tight closure and shall be rattle-free. Dampers shall be similar to those specified for air distribution. Fresh air intakes shall be as shown on the drawings.

8.0 ACCESSORIES:

Each air handling unit shall be provided with the following accessories make the system functional. The detailed specifications are given in individual sections, and quantities separately in Schedule of Quantities.

a) AHU Connection Kit comprise of Expansion Valves, Electronic Interface with wired Sensors.
b) Control Box
c) Corded Remote.
d) Suitable Electrical Starter Panel with DOL starters and provision of Auto/Manual change over switch. And can be interlock with fire signal.

C) AIR WASHERS

1.0 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of Air washers conforming to these specification and in accordance with requirement of drawings and of the schedule of quantities.

2.0 CASING

Double skin same as Double Skin AHU

3.0 TANK

Air washer casing shall be made out of 3mm (1/8") sheet steel with 300 mm heigh to maintain water level of 250mm. The tanks shall be painted black from inside and Aluminium from out side with 20 mm dia make up connection (with float valve and ball valve). 50 mm dia drain connection with drain valve 12 mesh brass suction screen with G.I. frame.

4.0 WASHER SECTION

Celdek fill with cross fluted configuration assembled in self supporting pads made of cellulose paper impregnated with insoluble Anti-rot salts, rigidifying sat rants and wetting agents, with built in eliminators. Max face velocity across the pads shall be 500 FPM

5.0 FAN

Forward curved dynamically balanced heavy duty centrifugal blower with 18G. scroll mounted on hollow shaft and self-aligning ball bearings. Outlet velocity shall not exceed 1800 FPM and 1200RPM.

6.0 MOTOR & DRIVE

Totally enclosed 3 phase 440 volts motor with belt driven arrangement of adjustable type.

7.0 DISTRIBUTION SYSTEM

25 MM g.i. 'b' class perforated pipe imping on ½ cut 100mm dia G.I. pipe to distribute on the 50 mm distribution pad of similar construction as that of celdex to get even wetting of media. Bled off arrangement with 6 mm wheel valve shall be provided to adjust the requisites rate. All internal and external interconnecting G.I. 'B' class piping including 'Y' strainer on the suction of the pump. With necessary valves.

8.0 FILTER

50 mm thick, 5 layer wire mesh viscous type filters with G.I frame shall be provided, max. velocity across the filters shall be 400 FPM.

9.0 ISOLATORS

Vibration isolators shall be provided for Air washers and pumps.

10.0 PAINTING

Shop Coats of paints that have become marred during shipment or erection shall be cleaned off with mineral sprits, wire brushes and spot primed over that affected areas, then coated with aluminium paints.

11.0 TESTING

Air washer shall be computed from measurements of air flow, dry and wet bulb temperature of air leaving the air washer, The efficiency of air washer shall not be less than 90%.

D) FANS:

1.0 SCOPE:

Scope of this section comprises of supplying, erection, testing and commissioning of following type of fans.

a) Centrifugal Fans SISW/DIDW
b) Inline fans (Vane axial/Tube axial)
c) Propeller fans

The above fans shall be as indicated on drawings and mentioned in schedule of quantities.

2.0 CENTRIFUGAL FANS:

2.1 Scroll:

Casing shall be welded construction fabricated with 14 gauge M.S. sheet with spray galvanization. Minimum zinc deposition shall conform to class III of IS:277.

The minimum thickness of casing shall not be less than 2 mm. The fan scroll shall be attached to the side plate by means of continuous lock seam.

18 gauge galvanized wire mesh inlet screens of 25 mm sieves shall be provided on both inlets if fan is without enclosure. Housing shall be provided with standard cleanout, safety screen, and door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.

2.2 Impeller:

The impeller shall have die-formed, forward/backward curved blades, welded to the rim and back plates to have a non-over loading characteristic of the fan. Rim shall be spun to have a smooth contour. If required, intermediate stiffening rings shall be provided. Shaft sleeves shall be furnished wherever required. The impeller, pulley and housing shall be statically and dynamically balanced. Fan velocity shall not exceed 2000 FPM at a maximum fan speed of 1000 RPM. However higher velocities shall be acceptable for applications of higher static pressures.

2.3 Shaft:

Shaft shall be constructed of SAE 1040 steel turned, ground and polished. Shaft shall not pass through first critical speed through the full range or specified fan speeds.

2.4 Bearings:

The bearing shall be self-aligning, heavy duty ball, roller or sleeve bearings. Bearing shall be selected for quiet operation and shall be grease pack, pillow block type.

2.5 Inlet guard:

Inlet guard shall be spun to have a smooth contour. Inlet screen if provided shall be of galvanized wire mesh of 25 mm square.

2.6 Base Plate/Base Frame:

Base frame shall be provided for each fan. Base frame for both fans and motor shall be built as an integral part and shall be mounted on a concrete foundation through metallistik vibration isolators. The concrete foundation shall be at least 150 mm above the finished floor level and shall be further isolated from structural floor through 25 mm thick layers of sand all around & sandwiched ribbed rubber pads.

2.7 Motor:

Fan motor shall be of squirrel cage type totally enclosed fan cooled motor, suitable for 415/220± 10% volts, 50 Hz, 3 phase. Horse power indicated on the name plate of motor shall be more than brake horse power by at least 10%. Motor R.P.M. shall not exceed 1500 RPM. The fan motor combination selected for the particular requirement shall be of the most efficient type (i.e smallest horse power) so that power consumption and noise level may be minimized.

2.8 Drive:

The fan shall be provided with oil resistant type V-belts. All belts shall be selected for 150% rated HP. V-belts shall be supplied with removable belt guards that do not impede the air flow to the fan inlet. There shall be a minimum of two belts per drive.

2.9 Vibration Isolation :

Fan with motor(or housing) shall be mounted on a concrete foundation through metallistik vibration isolation cushy foot mountings.

3.0 IN-LINE FANS;

In-line fans shall be Centrifugal type direct/belt driven complete with motor, belt guard, motor mount and vibration isolation type suspension arrangement mounted within/end of duct.

3.1 Casing: (Tube Axial Fan)

Shall be constructed of 14 gauge sheet steel. Fan casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting plate shall be minimum 20 mm. thick and machined to receive motor flange. Casing shall be provided with two Nos. wide hinged doors which open easily. Inspection doors with handle and neoprene gasket shall also be provided. Casing shall have flanged connections on both ends for ducted applications. Support brackets for ceilings suspensions shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed and finish coated with enamel paint.

3.2 Rotor:

Hub and blades shall be cast aluminum construction. Blades shall be die formed Aerofoil section for maximum efficiency and shall vary in twist and width from hub to top to effect equal air distribution along the blade length. Fan blades mounting on the hub shall be statically and dynamically balanced. Maximum clearance between blade tip and fan housing at the specified duty blade setting shall be 5 mm. Rotor blades shall be whirl tested to speed of 25% above the design operating speed and certification of the test shall be provided by the manufacturer. Extended grease leads for external lubrication shall be provided. Rotor shall be statically and dynamically balanced. The fan pitch control shall be manually readjusted at site upon installation for obtaining actual air flow values as specified and quoted. The impeller blade shall be of adjustable type blade.

3.3 Motor:

Shall be squirrel cage, totally enclosed, fan cooled standard round frame, constant speed, continuous duty, single winding, suitable for 415/220 +/- 10% volts, 50 cycles, 3/1 phase power supply, provided with class "B" insulation. Motor nameplate horsepower shall be more than brake horsepower by a minimum of 10%. Motors shall be specially designed for quiet operation and motor speed shall not exceed 1500 RPM. For maximum efficiency or minimum horsepower . Motor conduit box shall be mounted on exterior of a casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

3.4 Drive:

The fan shall be provided with direct/belt drive within housing.

3.5 Vibration Isolation:

The assembly of fan and motor shall be suspended from the ceiling by spring type vibration isolators.

3.6 Accessories;

The following accessories shall be provided with all fans:

i. Outlet cone for static pressure regain.
ii. Inlet cone.
iii. Fan silencers if required.

Fan shall be factory assembled and shipped with all accessories factory-mounted.

4.0 PROPELLER FANS;

Propeller fans shall be approved make direct-drive, three or four blade type mounted on a steel mounting plate with orifice ring.

4.1 Mounting Plate:

Shall be steel construction, square with streamlined venturi inlet (reversed for supply applications) coated with baked enamel finish, the mounting plates shall be of standard size, constructed of 12 to 16 gauge sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

4.2 Fan Blades:

Shall be constructed of cast aluminum or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades shall be quiet in operation and shall be statically and dynamically balanced at the factory.

4.3 Shaft;

Shall be of steel, accurately ground and shall be of ample size for the load transmitted, and shall not pass through first critical speed through the full range of specified fan speeds.

4.4 Motor:

Shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with prelubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 900 RPM for fans of 380 mm. dia or larger and 1450 RPM for fans 300 mm dia or smaller. Motors for fans 600 mm dia and larger shall be suitable for 415/220 +/- 10% volts, 50 cycles, 3/1 phase supply, and for fans less than 60 cms. dia shall be suitable for 230 +/- 6% volts, 50 cycles,

single phase power supply, and shall be suitable for either horizontal or vertical service, as indicated on drawings and in schedule of quantities.

4.5 Accessories;

The following accessories may be required and provided with propeller fans as indicated in BOQ. :

i. Wire guard on inlet side, and bird screen at the outlet.

ii. Oscillating louvered anodized aluminum cover with bird screen.

ii. Regulators for controlling fan speed for single phase fan motors.

5.0 PERFORMANCE DATA;

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

6.0 TESTING;

Capacity of all fans shall be measured by Velometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

E) COOLING TOWERS:

1.0 SCOPE:

The scope of this section comprises the supply, erection, testing and commissioning of cooling towers conforming to these specification in accordance with requirements of drawings and of the schedule of quantities, including steel supporting structure along with the foundation. If the structure has to be extended for supporting on beams/columns, extra payment shall be made.

2.0 TYPE:

Cooling towers shall be FRP, induced draft type or in accordance with requirements of drawings and of the Schedule of Quantities.

3.0 FRP INDUCED DRAFT COOLING TOWERS:

Fiber reinforced plastic cooling towers shall be of approved equal make, suitable for outdoor use. Tower shall be vertical, induced draft, counter flow type, fibre reinforced plastic construction, cross in square or rectangular shape, complete with fan, motor, surface and spray sections, eliminators, automatic controls and sound attenuation equipment where called for in Schedule of Quantities.

3.1 Capacity:

The cooling tower capacities shall be as per the Drawings and Schedule of Quantities.

3.2 Side Casing:

This shall be made out of FRP with both side smooth surface for minimum resistance to air flow. It shall have sufficient structural strength to adequately withstand high wind velocities and vibration. The casing shall be installed on the fiber glass reinforced BMSin. The tower supporting structure shall be made out of hot dipped galvanized steel frame.

A hot dip galvanized expanded metal mesh screen shall protect the air intake. Sufficient clearance between casing and water BMSin shall be provided to enable servicing and periodically cleaning.

3.3 Cold Water BMSin:

Cold Water BMSin shall be of fiberglass reinforced plastic deep sump on which cooling tower super structure shall be supported. Suction tank with easily removable double brass strainers shall be provided with this tank, if separately specified in schedule of quantities.

BMSin fittings shall include the following:

i. Bottom outlet.
ii. Suction screen assembly bolted to the casing.

iii. Drain connection at under side of suction side.

iv. Overflow connection bolted to inside of casing side.
v. Built in bleed off attached to inlet header discharge through PVC tube into overflow pipe.
vi. Ball type automatic make up water valve.
vii. Quick fill connection to inside of casing side.
viii. Equalising connection.

3.4 **Distribution System:**

Hot water distribution shall be by sprinkler system consisting of PVC/brass sprinkler and mounted on brass top of the vertical pipe installed centrally in the tower.

3.5 **Filling:**

Filling shall be made of corrosion proof and rigid PVC fill in honeycomb design and arranged in circular form to facilitate easy replacement. They shall be arranged in such a manner to ensure negligible resistance to air flow and to eliminate back water spots and prevent fouling through scales that may form. In order to reduce carry over losses through entrainment of moisture drops in air streams, multiple rotary drift eliminator shall be installed.

3.6 **Mechanical Equipments:**

Fan shall be of the propeller type, cast aluminium, flow weight rotor fitted with multiple aerofoil blades. The entire fan assembly shall be statically and dynamically balanced. Fan shall be directly driven by a 415 ± 6% volts, 3 phase, 50 cycles AC supply electric motor. Fan motor shall be of totally enclosed, fan cooled weather proof construction, designed and selected to operate in humid air stream. Fan shall be protected by fan guard & shall be easily accessible for inspection and maintenance. A spray galvanised service ladder shall also be provided for maintenance. The mechanical equipment assembly shall be adequately supported on a rigid steel BMSe welded to tubular support assuring vibration free support.

4.0 PAINTING:

The exterior steel surfaces of all towers shall be given two coats of paint of approved finish. If these shop coats become marred during shipment or erection, the affected areas shall be cleaned of with mineral spirits, wire brushed and spot primed then coated with enamel paints of matching shades.

5.0 PERFORMANCE DATA:

Complete performance ratings and power consumption at varying loads and outdoor wet bulb temperatures, shall be submitted with the tender and verified at the time of testing and commissioning of the installation.

F) PUMPS:

1.0 SCOPE:

The scope of this section comprises the supply, erection, testing and commissioning of water pumps conforming to these specifications and in accordance with requirements of schedule of quantities.

1.1 TYPE:

All condenser water, for air conditioning applications shall be of approved make or equal.The equipment shall be capable of developing the required total head at rated capacity. The pumps shall run smooth without undue noise and vibration. The magnitude of peak to peak vibration at shop shall be limited to 75 microns at the bearing housing. After installation at site the magnitude of vibration shall be limited to 50 micron.

2.1 HORIZONTAL SPLIT CASING CENTRIFUGAL PUMPS:

a) Casing:
Pump casing shall be close-grained cast iron of heavy section, horizontal split-casing making possible complete servicing of rotating parts without breaking piping or motor connection. Motor to pump connection shall be done with flexible coupling. Suction passages shall be of volute form promoting smooth entry to impeller and increased efficiency.

b) Impeller:
Impeller shall be of bronze or gunmetal, double suction, enclosed type and hydraulically balanced so as not to cause any vibration during operation. Impeller shall be securely keyed to the shaft. Means shall be provided to prevent loosening during operation including rotation in reverse direction. Impeller fastening nuts (if provided) shall be of cap type and shall tighten in the direction of normal rotation.

c) Wearing Rings:
Wearing rings shall be of renewable type. These shall be held in place by screwing against rotation, press fit and locked with pins, flanged and screwed.

d) Shaft:
Shaft shall be made of steel, protected by gun metal sleeves. It shall be finished to close tolerance at the impeller, coupling pulley and bearing diameters. The impellers, pulley and shaft sleeves shall be firmly secured to the shaft by key/nuts.

The shafts size shall be calculated on the maximum combined shear stress. This shear stress shall not exceed 30 per cent of the elastic limit in tension or 18 percent of ultimate tensile strength whichever is lower.

e) Shaft Sleeves:
Shaft sleeves shall be of gun metal, provided to protect the shaft where, it passes through stuffing boxes. Unless the pump is equipped with mechanical seals, in which case sleeves are preferred but not essential, shaft sleeves shall be securely locked or keyed to the shaft to prevent loosening. Rotating shaft and shaft sleeves shall be machined and assembled for concentric rotation.

f) Bearings:

i. The bearings may be ball, roller or sleeves type provision shall be made to take axial and radial loads. Oil level indicators shall be provided in oil baths.

ii. Where there is a possibility of liquid entering the bearing, the pump shall be provided with suitable preventive arrangement such as water deflectors.

iii. Bearings shall be easily accessible without disturbing the alignment of the pump.

g) Stuffing boxes shall be of such design that can be repacked, without removing any part other than the gland and lantern ring. Stuffing boxes shall be so designed by 3rows of packings and shall be easily removable. Lantern ring shall be of axially split types.

h) Couplings:
Pumps shall be furnished complete with an approved type of flexible couplings. Spacer type couplings shall be provided, when required, to permit disassembling, or without disturbing pump driver, coupling guards, shall be made of expanded metal and bolted to the BMSe plate, shall be furnished for all coupled pumps.

i) BMSe Plates:
The common BMSe plate for pump and motor shall be in one place and it shall be made of cast iron or welded steel construction. Suitable holes shall be provided for grouting and they shall be so located that the BMSe can be grouted in place without disturbing the pump and motor. All pumps and motors shall be properly aligned bolted and doweled to the BMSe plates by contractor. Adequate space shall be provided between pump drain connections and BMSe plate for installation of minimum 15mm drain piping. Pumps shall be supplied with suitable drain pans or drain rim type BMSe plates with trapped drain connections.

j) Installations:

The pump shall be installed on a concrete foundation as shown in approved for construction shop drawings.

2.2 COUPLED CENTRIFUGAL PUMPS:

a. Pump:
Pump shall be monobloc end-suction design directly coupled or connected to motor. The pump casing shall be of cast iron. Impeller shall be of bronze hydraulically balanced and keyed to shaft, stuffing boxes with mechanical seal shall be integral with casing and water sealed. Shaft sleeve shall be of gun metal extending through stuffing boxes.

b. Motors:
Motor shall be of a size suitable for the pump. BMSe shall be cast iron, TEFC designed as integral part of pump. Motor shall be suitable for 415 +/- 6% volts, 3 phase 50 cycles AC power supply.

c. Installation:
The pump shall be mounted on a concrete foundation as shown on approved construction shop drawings.

2.3 LUBRICATION:

Upon installation of the complete system and before testing, the pump shall be lubricated in strict accordance with the manufacturer's instructions.

2.4 PUMP ALIGNMENT:

All pumps prior to testing shall be aligned with a dial indicator within 0.05mm.

2.5 PAINTING:

All pumps, motors and BMSes shall be supplied with approved finish. Shop coat of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the adjoining areas.

2.6 PERFORMANCE DATA:

Pump performance curves and power consumption with operating points clearly indicated shall be submitted, and verified at the time of testing and commissioning of the installation.

G) AIR DISTRIBUTION SYSTEM:

1.0 GENERAL:

Supply, fabrication, installation and testing of all sheet metal/aluminium ducts & supply, installation, testing and balancing of all grilles, registers and diffusers, in accordance with these specifications and the general arrangement shown on the drawings.

Duct work shall mean all ducts, casings, dampers, access doors, joints, vanes, stiffeners, hangers and supports etc.

All ducts shall be fabricated from sheets of the following thickness as indicated in schedule of quantities & as described in the IS : 655 with latest edition.

‘ 2.0 DUCT MATERIAL:

2.1 Galvanised Sheets:

Sheet metal ducts shall be fabricated out of galvanized steel sheets conforming to IS -277, IS -737. Sheet used shall be produced by Hot Dip process and galvanizing shall be class –VIII minimum average coating 120gm/sq.m and Lock Forming Quality prime material with mill test certificate. In addition, if deemed necessary, sample 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.

2.2 Stainless Steel sheets shall conform to IS 6911.

2.3 Steel products shall conform to IS 2062.

2.4 The Steel Jointing Flanges shall conform to IS 2062.

2.5 Bolts and nuts shall conform to IS 1363 (Part-1) and IS 1363 (Part-3) respectively.

2.6 Steel bars for the supports shall conform to IS 2062.

2.7 High density self adhesive Gasket of neoprene rubber/UV resistant PVC foam lining 5mm thick gasket. Size should be confirming to flange manufacturer’s specifications. Single length of Gasket on the centre of flanges shall be provided. The end of the stip of Gasket must be overlap by 6mm.

2.8 Sealing Material for seams at duct corners shall be the material employing silicone rubber, nitryl rubber and butyl rubber and chloroprene or modified silicone rubber as the BMSe or Sealant shall be used as per the duct manufacturer recommendations.

2.9 All the transverse duct connectors (flanges/cleats) and accessories related hardware such as support system shall be zinc coated galvanized.

2.10 All related accessories of duct to be supplied by manufacturer i.e., Carriage bolt, Gasket, Corners, Cleats, W bracket, threaded rods etc.

3.0 SHEETS THICKNESS OF DUCTS:

The thickness of sheet shall be chosen BMSed on the internal pressure of the duct.
The thickness of sheet of short side of rectangular duct shall be the same as that of long side.

3.1 Thickness of Sheet for Rectangular Galvanized Steel Sheet Duct:

Classification of Duct By Pressure (1)	Low Pressure Duct (Upto ± 500 Pa) (2)	Medium Pressure Duct and High Pressure Duct (± 500 to 1000 Pa & ± 1000 to 2500 Pa) (3)	Thickness of Sheet, Min mm (4)
Long Side of Duct	$l \leq 450$	-	0.6
	$450 < l \leq 750$	-	0.6
	$750 < l \leq 1500$	$l \leq 450$	0.8
	$1500 < l \leq 2200$	$450 < l \leq 1\,200$	1.0
	$2\,200 < l$	$1\,200 < l$	1.2

3.3 Thickness of Sheet for Rectangular Stainless Steel Sheet Duct:

Classification of Duct By Pressure (1)	Low Pressure Duct (2)	Medium Pressure Duct and High Pressure Duct (3)	Thickness of Sheet, Min mm (4)
Long Side of Duct	$l \leq 750$	-	0.6
	$750 < l \leq 1500$	-	0.6
	$1500 < l \leq 2200$	$l \leq 450$	0.8
	$2200 < l$	$450 < l \leq 1\,200$	1.0
	-	$1\,200 < l$	1.2

3.3 Thickness of Sheet for Circular Galvanized Steel Sheet Duct and Stainless Steel Sheet Duct:

Classification of Duct By Pressure (1)	Low Pressure Duct (2)	Medium Pressure Duct and High Pressure Duct (3)	Thickness of Sheet, Min mm (4)
Internal Diameter of duct (d), mm	$d \leq 500$	-	0.6
	$500 < d \leq 630$	-	0.6
	-	$d \leq 450$	0.8
	-	$450 < d \leq 630$	1.0

3.4 Thickness of Sheet for Circular Spiral Galvanized Steel Sheet Duct:

Classification of Duct By Pressure (1)	Low Pressure Duct (2)	Medium Pressure Duct and High Pressure Duct (3)	Thickness of Sheet, Min mm (4)
Internal Diameter of duct (d), mm	d ≤ 450	d ≤ 200	0.6
	450< d ≤ 710	200 < d ≤ 560	0.6
	710< d ≤ 1000	560 < d ≤ 1000	0.8
	1000 < d	800 < d ≤ 1000	1.0
	-	1000 < d	1.2

3.5 Thickness of Sheet for Circular Spiral Stainless Steel Sheet Duct:

Classification of Duct By Pressure (1)	Low Pressure Duct (2)	Medium Pressure Duct and High Pressure Duct (3)	Thickness of Sheet, Min mm (4)
Internal Diameter of duct (d), mm	d ≤ 560	d ≤ 250	0.6
	560 < d ≤ 800	250 < d ≤ 560	0.6
	800 < d ≤ 1000	560 < d ≤ 800	0.8
	1000 < d	800 < d ≤ 1000	1.0
	-	1 000 < d	1.2

3.6 For Aluminium ducts, sheet shall be of one gauge higher than G.I sheet with 22 gauge as minimum.

3.7 All air duct from Kitchen Exhaust Hoods shall be fabricated from 1.37mm thick carbon steel. All longitudinal and transressor joints shall be welded. Hinged access doors shall be provided at intervals of not more than 5 meters for purpose of cleaning. All exhaust ducts shall be laid to fall towards the hoods.

4.0 <u>DUCT DIMENTION & TOLERANCES:</u>

4.1 The size of duct refers to the internal dimensions of duct.

4.2 Tolerance for rectangular duct on both long side and short side shall be -0, +4mm.

4.3 Tolerance for circular and spiral duct shall be as per IS: 655.

5.0 CONSTUCTION OF JOINTS (Rectangular Ducts) :

5.1 DUCT OF ANGLE FLANGE TECHNIQUE:

i) In the angle flange technique, connection of ducts shall be carried out by tightening the angle flanges attached to both ends of ducts using bolts and nuts. Gasket shall be inserted between the joining faces of angle to keep air tightness.

ii) The angle flange shall be made in such a way that corners of four angles are welded at outside, so assembled that contacting surface of flange is flat and smooth with necessary drilling.

iii) The end fold of duct shall be at least 6mm.

iv) Joint materials for low pressure duct, shall be as given in Table -1, and for medium and high pressure ducts shall be as per Table -2.

Table 1: **Material for Joint of Low Pressure Duct by Angle Flange Technique (Upto ± 500 Pa.)**

Long side of Duct (*l*) mm	Joint Flange		Flange Mounting Rivet		Connecting Bolt		
	Angle Minimum Size mm	Maximum Spacing mm	Minimum Nominal Diameter mm	Maximum spacing of Rivets mm	Minimum Nominal Diameter mm	Maximum Spacing	
						Corner mm	Other Than Corner mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$l \leq 750$	25 x 25 x 3	3 000	4.5	65	M8	100	150
$750 < l \leq 1500$	30 x 30 x 3	2 730	4.5	65	M8	100	150
$1500 < l \leq 2200$	40 x 40 x 3	1820	4.5	65	M8	100	150
$2\,200 < l$	40 x 40 x 5	1 820	4.5	65	M8	100	150

Notes: i) The bolts shall be located symmetrically at the central portion of flange.

ii) Electrical spot welding may be employed other than riveting. The spacing shall be within 100mm.

iii) The diameter of connecting bolt shall not exceed a certain diameter which ensures enough edge distance of flange.

Table 2: **Material for Joint of Medium Pressure Duct (± 500 Pa to 1000 Pa) by Angle Flange Technique**

Long side of Duct (*l*) mm	Joint Flange		Flange Mounting Rivet		Connecting Bolt		
	Angle Minimum Size mm	Maximum Spacing mm	Minimum Nominal Diameter mm	Maximum spacing of Rivets mm	Minimum Nominal Diameter mm	Maximum Spacing	
						Corner mm	Other Than Corner mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$l \leq 750$	25 x 25 x 3	1820	4.5	65	M8	100	100
$750 < l \leq 1500$	30 x 30 x 3	1820	4.5	65	M8	100	100
$1500 < l \leq 22($	40 x 40 x 3	1820	4.5	65	M8	100	100
2 200 < *l*	40 x 40 x 5	1820	4.5	65	M8	100	100

Notes:

1. The bolts shall be located symmetrically at the central portion of flange.

2. Electrical spot welding may be employed other than riveting. The spacing shall be within 100mm.

3. The diameter of connecting bolt shall not exceed a certain diameter which ensure enough edge distance of flange.

5.2 DUCT OF SAME SHEET FLANGE TECHNIQUE:

i) In the same sheet flange technique, the joint is carried out by using corner metal fittings, corner bolts, same sheet flange produced by bending process of the same sheet, flange presser metal fitting (clips or the like) and gasket (see Table-3).

ii) Joint materials shall be in given in Table 4.

iii) The same sheet flange shall be formed by bending the end of duct and shall have the same thickness of sheet as that of duct.

iv) In addition to the bolts, the flanges shall be tightened with flange presser metal fittings (clip or the like). The flange may be reinforced with mounting fittings with bolts.

v) The flange presser metal fittings shall have a width of 150mm or more, be located within 150mm from the duct edge and the spacing between metal fittings shall be within 200mm.

vi) The height and width of flange, the thickness of sheet of corner metal fittings and flange presser metal fittings, etc, shall be as given in Table 4.

Table 4 : Material for Joint by Same Sheet Flange Technique:

Long Side of Duct (*l*)	Minimum Size of Same Sheet Flange mm				Minimum Size of Same Sheet Flange mm			Minimum Thickness of Sheet of Flange Pressure Metal Fittings mm		Maximum Spacing of Joints mm	
	Height	Width	Thickness of sheet (Thickness of Duct Sheet)		Thickness of sheet		Nominal Diameter of Bolt				
			Low Pressure	High Pressure, Medium Pressure	Low Pressure	High Pressure, Medium Pressure		Low Pressure	High Pressure, Medium Pressure	Low Pressure	High PressureMedium Pressure
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$l \leq 450$	30	10	0.5	0.8	1.2	1.6	M8	1.0	1.2	3480	2610

450< *l* ≤ 750	30	10	0.6	1.0	1.2	1.6	M8	1.0	1.2	3480	1740
750< *l* ≤ 1200	30	10	0.8	1.0	1.2	1.6	M8	1.0	1.2	2610	1740
1200 < *l* ≤ 1	30	10	0.8	1.2	1.6	1.6	M8	1.0	1.2	2610	1740
1500 < *l* ≤ 2200	30	10	1.0	1.2	1.6	1.6	M8	1.2	1.2	1740	1740

Note: The diameter of bolts for corner metal fitting shall not exceed a certain diameter which ensure enough edge distance of flange.

5.3 DUCT OF SLIDE – ON FLANGE TECHNIQUE:

i) In the slide –on flange technique, the joint is carried out by using corner metal fittings, corner bolts, sliding type flange, flange pressure metal fittings (nuts, clamps, etc) and Gasket.

ii) The Flange shall be double folded and formed steel sheet, the thickness of sheet shall be at least 0.6mm, the height of flange shall be 19mm, 20mm, 30mm or 40mm and the flange shall be as given in Table -5.

iii) The thickness of sheet of corner metal fittings shall be adequate to the material to be used for the flange. The thickness of sheet shall be as given Table -6.

Table 5: **Joint Flange of Slide- on Flange Technique**:

Long Side of Duct (*l*) mm	**Minimum Size of Joint Flange**						**Maximum Spacing**
	Low Pressure Duct		**Medium Pressure Duct**		**High Pressure Duct**		
	Height mm	**Thickness of Sheet mm**	**Height mm**	**Thickness of Sheet mm**	**Height mm**	**Thickness of Sheet mm**	
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
l ≤ 450	19	0.6	20	0.9	30	1.2	3000
450< *l* ≤ 750	20	0.9	20	0.9	30	1.2	3000

750< *l* ≤ 1500	20	0.9	30	1.2	30	1.2	2760
1500 < *l* ≤ 2	30	1.2	30	1.2	40	1.5	1840
2 200 < *l*	30	1.2	40	0.5	40	1.5	1840

Table 6: **Minimum Values of Thickness of Sheet for Corner Metal Fittings and Diameter of Bolt**

Long Side of Duct (*l*) mm	**Low Pressure Duct**		**Medium Pressure Duct**		**High Pressure Duct**	
	Thickness of Sheet mm	**Nominal Diameter of Bolt mm**	**Thickness of Sheet mm**	**Nominal Diameter of Bolt mm**	**Thickness of Sheet mm**	**Nominal Diameter of Bolt mm**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
l ≤ 450	2.0	M8	2.3	M8	3.2	M10
450< *l* ≤ 750	2.3	M8	2.3	M8	3.2	M10
750< *l* ≤ 1500	2.3	M8	3.2	M10	3.2	M10
1500 < *l* ≤ 220	3.2	M10	3.2	M10	4.0	M12
2200 < *l*	3.2	M10	3.2	M12	4.0	M12

Note: i) The diameter of bolts for corner metal fitting shall not exceed certain diameter, which ensures enough edge distance of flange.

ii) In addition to the bolts, flanges shall be fixed with flange pressure metal fittings (nuts, clamps etc). The fixing spacing and number of fittings shall be as given Table -7:

iii.) The flange shall be mounted to the duct by electric spot welding. Spacing of spot welding shall be within 100mm.

Table 7: **Fixing Spacing and Number of Flange Pressure Metal Fittings (with Bolt) size of Joint Flange**

Long Side of Duct (*l*) mm (1)	Low Pressure Duct		Medium Pressure Duct		High Pressure Duct	
	Number of Pieces (2)	Maximum Spacing mm (3)	Number of Pieces (4)	Maximum Spacing mm (5)	Number of Pieces (6)	Maximum Spacing mm (7)
$l \leq 450$	0	-	0	-	0	-
50< $l \leq$ (	0	-	1	700	1	650
00< $l \leq$ 1	1	1 000	1	700	1	650
1300 < 1400	1	1 000	1	700	2	670
1400 < 2 000	1	1 000	2	700	2	670
2 000 <	2	1 000	3	800	3	700

5.4 KITCHEN EXHAUST DUCTS:

The installation and construction of ducts used for the removal of smoke or grease laden vapors from cooking equipment should be in accordance with NFPA standard 96 and SMACNA's rectangular and round industrial duct construction standards. Kitchen exhaust ducts must be constructed from carbon steel with minimum thickness of 1.463 mm (0.0575 inch)or stainless steel sheet with a minimum thickness of 1.14mm. All longitudinal seams and transverse joints shall be continuously welded. Ducts shall be installed without dips or traps that may collect residues. Necessary access windows to be provided for cleaning of ducts.

3.6 REINFORCEMENT OF GALVANIZED SHEET DUCTS:

The direction of reinforcement made perpendicular to longitudinal direction of duct is called lateral direction, and that made parallel to longitudinal direction of duct is called longitudinal direction, provided that the circular spiral duct is exempted from the reinforcement.

3.6.1 Reinforcement of Low Pressure Galvanized Steel Ducts:

a) Lateral Reinforcement

The spacing of lateral reinforcement depending on joint technique is given in Table 8. The flange junction made in duct of angle flange technique, duct of same sheet flange technique and duct of slide –on flange technique is considered as the lateral reinforcement. Longitudinal Reinforcement

For ducts of the sizes given in Table -9 in addition the lateral reinforcement given in Table -8 is performed and longitudinal reinforcement shall also be carried out.

Table 8: Lateral Reinforcement of Low Pressure Duct:

Long Side of Duct (*l*) mm (1)	Type and Spacing of Reinforcement			
	Minimum Size of Steel Angle Reinforcement mm (2)	Maximum Spacing		
		Angle Flange Technique mm (3)	Slide – on Flange Technique mm (4)	Same Sheet Flange Technique mm (5)
250< *l* ≤ 750	25 x 25x 3	1840	1840	1840
750 < *l* ≤ 1500	30 x 30x 3	925	925	925
1500 < *l* ≤ 2200	40 x 40x 3	925	925	925 + Tie rod
2200	40 x 40 x 5 (3)	925	925 + Tie rod	-

Note: The value given in parenthesis shows that when the rods are also used.

Table 9: Longitudinal Reinforcement of Low Pressure Duct

Long Side of Duct (*l*) mm (1)	Minimum Size of Steel Angle mm (2)	Position of Reinforcement (3)
1500 < *l* ≤ 2200	40 x 40 x 3	One Point or more
2200 < *l*	40 x 40 x 5 (3)	Two Points or more

Note:

1. The value given in parenthesis shows that when tie rods are also used.

2. Angle reinforcement may be outside or inside of the duct.

3.6.2 Reinforcement of Medium and High Pressure :

Lateral reinforcement**:**

The spacing of lateral reinforcement shall be as given in Table -10. The flange junction made in duct of angle flange technique, duct of same sheet flange technique and duct of slide- on flange technique is considered as the lateral reinforcement.

Longitudinal reinforcement:

For ducts of the sizes in Table -11, in addition to the lateral reinforcement given in table, longitudinal reinforcement shall also be carried out.

Table 10: Lateral Reinforcement of Medium and High Pressure Duct:

Long Side of Duct (*l*) mm (1)	Spacing of Reinforcement			
	Minimum Size of Steel Angle Reinforcement mm (2)	Maximum Spacing		
		Angle Flange Technique mm (3)	Slide – on Flange Technique mm (4)	Same Sheet Flange Technique mm (5)
250< *l* ≤ 750	25 x 25 x 3	925	925	925
750 < *l* ≤ 1500	30 x 30 x 3	925	925	925
1500 < *l* ≤ 2200	40 x 40 x 3	925	925 + Tie rod	925 + Tie rod
2200 < *l*	40 x 40 x 5 (3)	925	925 + Tie rod	-

Note: The value given in parenthesis shows that when tie rods are also used.

Table 11: Longitudinal Reinforcement of Medium and High Pressure Duct:

Long Side of Duct (*l*) mm (1)	**Minimum Size of Steel Angle mm (2)**	**Position of Reinforcement (3)**
1200 < *l* ≤ 2200	40 x 40 x 3	One Point or more
2200 < *l*	40 x 40 x 5 (3)	Two Points or more

Note: The value given in parenthesis shows that when tie rods are also used.

The mounting of steel angle shall be made by rivets of nominal diameter not less than 4.5mm or electrical spot welding and the spacing between welding shall not exceed 100mm.

For ducts not thermally insulated with a long side exceeding 450mm,diamond brake or reinforcement rib with a pitch not exceeding 300mm shall be mounted.

The longitudinal reinforcement shall be evenly spaced on the side of ducts so that the specified number of reinforcements is obtained.

Angle reinforcement may be outside or inside of the duct.

3.7 REINFORCEMENT BY TIE ROD:

3.7.1 When both of steel angle and tie rod is used in a rectangular duct the following requirements shall be satisfied.

3.7.2 For ducts of slide- on flange technique or of same sheet flange technique having a length of side as given in Tables 12 &13, reinforcement shall be made by means of both of steel angle and tie rod.

3.7.3 The tie rod shall be located at a position where the lateral reinforcement and the longitudinal reinforcement intersect or in the vicinity thereof.

3.7.4 The nominal diameter of tie rod shall be minimum 9mm when the rod is one in each side, and 12mm minimum when the rods are two or more in one or both sides.

3.7.5 In the case of the long side of duct of slide – on flange technique utilizing tie rod and steel angle exceeds 2200mm, the size of steel angle 40 mm x 40 mm x 5 mm may be replaced by 40 mm x 40 mm x 3mm.

Table 12: Mounting position and nominal Diameter of Tie Rod in Low pressure Duct (Common to Slide –on Flange Technique and Same Sheet Flange Technique):

Title of Figure	Dimension of Duct		Spacing of Tie Rod Mounting	Minimum Nominal Diameter of Steel Bar for Tie Rod mm
	Dimension A mm	Dimension B mm		
(1)	(2)	(3)	(4)	(5)
1)	$1500 < A_1 \leq 2200$	$1500 \geq B_1$	One centre of side A_1	9
2)	$1500 < A_2 \leq 2200$	$1500 < B_2 \leq 2200$	One in each side (two in total)	9
3)	$2200 < A_3$	$1500 \geq B_3$	a: 1 100, Max	12
4)	$2200 < A_4$	$2200 < B_4$	a: 1 100, Max b: 1 100, Max	12

Table 13: Intermediate Reinforcement by Tie Rod and Its Size in Medium Pressure Duct or High Pressure Duct (Common to Slide –on Flange Technique and Same Sheet Flange Technique):

Title of Figure	Dimension of Duct		Spacing of Tie Rod Mounting	Minimum Nominal Diameter of Steel Bar for Tie Rod mm
	Dimension A mm	Dimension B mm		
(1)	(2)	(3)	(4)	(5)
1)	$1200 < A_1 \leq 1800$	$1200 \geq B_1$	One centre of side A_1	12
2)	$1200 < A_2 \leq 1800$	$1200 < B_2 \leq 1800$	One in each side (two in total)	12
3)	$1800 < A_3$	$1200 \geq B_3$	a: 900, Max	12
4)	$1800 < A_4$	$1800 < B_4$	a: 900, Max b: 900, Max	12

3.7 HANGERS AND SUPPORT SYSTEM:

3.8.1 Ducts shall be installed with support system indicated in the Table 14. Ducts shall be installed as required to maintain alignment. Horizontal ducts shall have support with in 600mm of each elbow and within 1200mm of each branch intersection.

3.8.2 Hangers shall be securely fixed to the concrete structure with approved fasteners and with the duct work truly isolated free from noise and vibration in the proper manner.

3.8.3 All hangers and supports shall be provided with anti- rust paint.

Table 14:

Duct Size (mm)	Spacing (M)	Size of MS angle (mm x mm)	Size of rod dia (mm)
Upto 750	2.5	40 x 3	10
751 to 1500	2.0	40 x 3	12
1501 to 2250	2.0	50 x 3	15
2251 to above	2.0	50 x 3	15

3.9 DUCT SEALING:

3.9.1 Duct must be sufficiently air tight to ensure economical and quiet performance of the system. It is recommended that all duct constructed for the 1 inch (250 Pa) and ½ inch (125 Pa) pressure class meet seal class C. seal class detail are as given in Table – 15.

Table 15: DUCT SEALING:

Seal Class	Sealing Requirements	Applicable Static Pressure Construction Class
A	Class A: All Transverse joints, longitudinal Seams, and duct wall penetrations	4 in. wg and up (1000 Pa)
B	Class B: All Transverse joints and longitudinal Seams only	3 in. wg and up (750 Pa)
C	Class C: Transverse joints only	2 in. wg and up (500 Pa)

3.10 FABRICATION:

All ducts shall be fabricated and installed in workman like manner, conforming to IS 655. Round exposed ducts shall be die formed for achieving perfect circle configuration. For details not available in IS: 685 then SMACNA of latest edition to be followed:-

a) Ducts so identified on the drawings shall be acoustically lined with thermal insulation as described in the section 'Insulation' and as indicated in schedule of quantities. Duct dimensions shown on drawings are overall sheet metal dimensions inclusive of the acoustic lining, where required and indicated in schedule of quantities.

b) Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made air tight.

c) All exposed ducts within conditioned spaces shall have slip joints - no flanged joints. The internal ends of slip joints shall be made in the direction of air flow.

Exposed ducts, where required or as indicated in Schedule of quantities, shall be painted with two coats, of enamel paint of approved colour. Ducts and accessories within 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. Curved elbows, unless otherwise indicated, shall have a centre line radius equal to one and a half times the width of the duct. Air turns shall be installed in all vanes, arranged to permit the airto make the turn without appreciable turbulence. Suitable vanes shall be provided in duct collar to have uniform/ proper air distribution.

e) Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles of sample size to keep the ducts true to shape and to prevent bulking, vibration or breathing.

f) All sheet metal connections, partitions and plenums required to confine the flow of air to and through 18g GI/16 gauge aluminium, thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary 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) All ducts shall be factory fabricated except to – suit prices.

i) Factory Fabricated ducts shall be of either duct of same sheet flange Technique or duct of slide - on flange technique. which shall necessarily complying the following for 1200mm long transverse joints:-

   i) Duct construction shall be in compliance with 1" (250 Pa) Wg. static pressure norms as per SMACNA. If pressure is not specified. (Except Kitchen Ducts).

   ii) To reduce leakage sealant shall be used.

   iii) Transverse connectors shall be conforming to 1inch (250 Pa/Wg. static pressure).

   iv) All related accessories of ducts should be supplied by the duct manufacturer i.e., carriage bolts, Gasket, corners, cleats, W bracket, treaded rods etc.

   v) All duct to be boxed from factor by manufacturer, except planums, No. 'L' sections to be accepted at rit.

   iv) All the ductwork including straight sections, tapers, elbows, branches, shoe pieces, collars, terminal boxes and other transformation pieces shall be factory-fabricated. Equivalency will require fabrication by utilizing the following machines and process to provide the requisite quality of ducts and speed of supply.

Coil Lines to ensure location of longitudinal seams at corners/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any side of the ducts.

All ducts, transformation pieces and fittings shall be made on CNC profile cutters for required accuracy of dimension, location and dimensions of notches at the folding lines.

All edges shall be machines treated using lock- formers and rollers for furning up edges.

v) Each duct pieces shall be identified by coded sticker, which shall indicate specific part numbers, job name, drawing number, duct sizes and gauge.

vi) Ducts shall be straight and smooth on the inside. Longitudinal seams shall be airtight and at corners, which shall be either Pittsburgh or snap Button Punch as per SMACNA practice, to ensure air tightness.

vii) Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7) Turing vanes to air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

viii) Turning vanes to be provided as per SMACNA Standards.

3.11 INSTALLATION:

All ducts shall be installed generally as per the drawings and in strict accordance with approved shop drawings to be prepared by the Contractor.

i. The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent, of these specifications and drawings. The work shall meet with the approval of Owner's site representative in all its parts and details.

ii. All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and/or conduits, the ducts shall be transformed, divided or curved to one side, the required area being maintained, all as per the site requirements.

iii. If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available, in

accordance with other services and as per approval of Owners site representatives.

iv. All duct work shall be independently supported from building structure. All horizontal ducts shall be rigidly and securely supported, in approved manner with trapeze hangers formed of MS rods and angle iron under ducts at not greater than 2 meter centres. All vertical duct work shall be supported by structural members at each floor. Air conditioning contractor shall supply and install 50mm cube MS boxes with 10mm dia steel rod passing through box, all given two coats of redoxide paint, the MS rod tied with reinforcement bar at point of suspension shall be neatly exposed and opening subsequently filled with plastic compound after duct hangers are installed.

If duct is passing through in such areas where space between ceiling slab to false ceiling is more than 1500 mm than duct should be supported by wall mounted brackets of 40 x 40 x 3 mm angle.

v. Ducting over furred ceiling shall be supported from the slab above, or from beams, after obtaining approval of Owner's site representative. In no case shall any duct by 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 contractors on the building.

vi. Where metal ducts or sleeves terminate in wood work, tight joints shall be made by means of closely fitted heavy flanged collars. Where ducts pass through brick or masonry opening and wooden frame work shall be provided within the opening and crossing ducts provided with heavy flanged collars on each side of wooden frame work, so that duct crossing is made leak-proof.

vii. All ducts shall be totally free from vibration under all conditions of operation. Whenever duct work is connected to fans, air handling units or blower coil units that may cause vibrations in the ducts, ducts shall be provided of closely woven, rubber impregnated double layer asbestos/canvas or neoprene coated fibre glass fire resistant flexible connection. The flexible connections located close to the unit, in mutually perpendicular directions. The flexible sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both ends. The flexible connection shall be suitable for pressures at the point of installation.

viii. Air conditioning unit and exhaust fans shall be connected to duct work by inserting at air inlet and air outlet a double canvass sleeve. Each sleeve shall minimum 150 mm securely bolted to duct and the connecting duct work rigidly held in line with unit inlet or outlet.

ix. Test points shall be provided at the suction and discharge of each an Air handling unit/fan and at each individual zone of the duct work system. Test points shall consist of 25mm diameter sockets fitted with sealing plugs which can be removed for the fitting of measuring devices. Test points shall be insulated as for the duct work and shall be provided with identification labels.

x. All duct surfaces behind diffusers, registers and grilles shall be painted matt black internally.

xi. Run outs to diffusers shall be medium pressure rated externally insulated, spiral wound, flexible duct with a maximum length of 2.4 m (8 Ft.)

xii. External shall be minimum 450 mm above the finish level of the roof to permit servicing of the roof. Area.

xiii. Provide steps over the duct work for access to roof area and roof mounted systems

3.12 SPLITTERS AND DAMPERS:

All dampers shall be opposed blade type dampers of robust construction and tight fitting. They shall be made of G.S. sheet minimum 16 g thick and shall have brass bushes. The design, method of handling, and control shall be suitable for the location and service required.

Dampers shall be provided with suitable links, levers and quadrants as required for their proper operation control or setting devices shall be made robust, easily operatable and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times. Handles will be provided with extended arms to account for insulation thickness.

Dampers shall be placed in ducts and at every branch supply or return air duct connection, whether or not indicated on the drawings, for the proper volume control and balancing of the system.

3.13 FLEXIBLE DUCT CONNECTION :

The Flexible Connection should be made of imported fabric of fibreglass weave having silicone rubber coating shall be Air Tight and Water Proof and withstand for high temperature application, Non flammable type and does not support combustion. At the both ends, there shall be aluminium Extruded Angle frame for Connection.

3.14 MOTORISED COMBINATION SMOKE & FIRE DAMPER :

All supply/return air duct or path at AHU room wall or slab crossing shall be provided Motorised combined smoke and fire damper. The fire rating shall be of 90 minutes fire damper blades and outer frame shall be formed of 1.6mm galvanised sheet steel.
The damper blade shall be privoted spindles in self lubricated bronze bushes, stop seals shall be provided on top and bottom of the damper housing made of 16g galvanised sheet
steel. Side seal shall be provided to preventing fine leakages. Fire damper shall be kept open during normal mode with the help of 230 V operated electric actuators (spring return) to providing maximum air passage without creating any noise or actuated either through electric actuator or through UL stamped electro-thermal link. The actuator shall be energized with the help of a single from smoke detector installed in AHU room / RA duct/damper. The fire damper shall also close due to temp rise in SA.
Ducts through the electric temp sensor factoy set at 165 deg F, micro switches with bakelite BMSe will be provided to stop fan motor & give open & close signal at remote panel in case of motorised damper. Incase of power failure the damper shall closed and automatically open (with spring) in case of power is 'ON'.

3.15 SUPPLY AND RETURN AIR GRILLES:

Supply and return air grilles shall be M.S. or anodized extruded aluminium construction with individually adjustable bars as shown on drawings and indicated in schedule of quantities. Supply air grilles shall be generally double deflection type, with removable key operated volume control dampers. Return air grilles shall be generally double deflection type similar to supply air grilles but without dampers. All supply and return air grilles behind wooden grilles shall be single deflection type with one way bars only, the supply air grilles being provided with removable key operated volume control dampers. Mild steel supply and return air grilles shall be factory coated with rust resistant primer and shall be finished with two coats of paint as per client's choice. Aluminium supply and return grilles shall be powder coated and to have colour of client's choice or extruded aluminium as per bill of quantities.

3.16 SUPPLY AND RETURN AIR DIFFUSERS:

Supply and return air diffusers shall be shown on the drawings and indicated in schedule of quantities. The supply air diffuser shall be provided with removable key operative volume control dampers. Mild steel diffusers/dampers shall be factory coated with rust resistant primer. These shall be finished with two coats of paint as per client's choice. Aluminium supply and return air diffusers shall be powder coated and to have colour of client's choice or shall be extruded aluminium.

i. **Round or Rectangular Diffusers:**

Supply/return air linear diffuser shall be M.S. or Extruded aluminium construction, square, rectangular, or round diffusers with flush fixed pattern or adjustable flow pattern. Diffusers for different spaces shall be selected in consultation with the Architect/Consultants. Supply air diffusers may be equipped with fixed air-distribution grids, removable key-operated volume control dampers, and antismudge rings as per requirements of schedule of quantities.

ii. **Linear Supply air/ Return Air Grilles:**

This shall be extruded aluminium construction with fixed horizontal bars at 15 dig inclination and flangeaon both side. The thickness of fixed bar louvers shall be at least 5.5mm & angle shall be 20mm/30mm inside . The grilles shall be suitable for concealed fixing volume control damper of extruded. Aluminium construction with black anodised finised shall be provided in SA duct collars.

3.17 LINEAR DIFFUSER :

Liner diffuser shall be extruded aluminium construction multislot type with air patern controlled provided in each slot. Supply air diffusion shall be provided with volume damper in each slot of the supply air diffuser. Plenum shall be provided for each supply air diffuser.

The Material of Grilles shall be as follows:

i. All grilles shall be selected in consultation with the Client/Architect/Consultant. Different spaces shall require horizontal or vertical face bars, and different width of margin frames.

ii All grilles shall have a soft, continuous rubber gasket between the periphery of the registers and the surface on which it has to be mounted. The effective area of the registers shall not be less than 75 percent.

iii. Grilles shall be adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to 100 deg horizontal arc and upto 30 deg C deflection up or down. Bars shall hold deflection settings under all conditions of velocity and pressure. Extruded aluminium grilles shall have fixed bars.

iv. Bars longer than 45cm shall be reinforced by set-back vertical members of approved thickness.

The material thickness of grills, diffuser,damper shall be as follows :

	Diffuser	MS	Aluminium
a)	Frame	20 gauge	18 gauge
b)	Louvers	20 gauge	18 gauge
	Grills :		
a)	Frame	20 gauge	18 gauge
b)	Louvers	26 gauge	24 gauge
	V.C. Damper :		
a)	Frame	20 gauge	18 gauge
b)	Louver	26 gauge	24 gauge

iv. **Fresh air intake and extract louvers:**

All the louvers shall be rain protection type and shall be fabricated from extruded aluminium section. The louvers shall additionally be provided with heavy duty expanded metal (aluminium –alloy) bird screed.

3.18 Design parameters for duct design shall be:

Maximum flow velocity (Air conditioning system)	- 1500 Ft/Min = 7.6 Mtrs/Se.
Maximum flow velocity (Vent. & Exhaust system)	- 2000 Ft/Min = 10.0 Mtrs/Se.
Maximum flow velocity (Collers)	- 800 Ft/Min = 4.0 Mtrs/Se.
Maximum friction drop	0.1 inch WG per 100Ft run. = 1cm WG per 100Mtrs run
Maximum velocity at supply air outlet Heating system	- 500 Ft/Min = 150Mtrs/Min
Maximum velocity at supply air diffuser	= 500-1000Ft/Min. = 150-300 Mt/Min.

3.19 Testing & Balancing:

After the installation of the entire air distribution system is completed in all respects, all ducts shall be tested for air leaks before painting the interiors of conditioned spaces air distribution system shall be allowed to run continuously for 48 hours for driving away any dust or foreign material logged within ducts during installation.

Commissioning of all building systems as defined by Sheet Metal and Air Conditioning Contractors National Association (SMACNA) and including required equipment pre-start and start-up checklists and verification checklists. Additional document including air test and balance report, operating &maintenance manuals, highlighted cut sheets, record As- Build" Documents in pdf format and warranties on all equipments.

K) PIPING & VALVES:

1.0 SCOPE:

The scope of this section comprises the supply and laying of pipes, pipe fittings and valves, testing and balancing of all water and refrigerant piping required for the complete installation as shown on the drawings. All piping inclusive of fittings and valves shall follow the applicable Indian Standards.

2.0 CONDENSER WATER PIPING:

2.1 All Condenser water pipes and fittings shall be of , MS class 'C' (heavy class) conforming to BIS 1239 for pipe size upto 150mm dia and for pipe size 200mm dia and above shall be as per BIS 3589 having minimum 6mm thickness. All jointing in the pipe system shall generally be by welding, unless otherwise mentioned, or directed at site. All welding shall be done by qualified welders and shall strictly conform to Indian Standards code of procedure for manual metalarc welding of Mild steel as per BIS 823.

2.2 All pipes and their steel supports shall be thoroughly cleaned and given one primary coat of red oxide paint before being installed. All chilled water piping will rest on treated teakwood blocks neatly machined to the radius of pipes and seated MS angles/channel. All welded piping shall be subjected to the approval at site.

2.3 Fittings shall be malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of the weldable type.

2.4 Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.

2.5 Ball valve, Butterfly valves, globe valve, conforming to the following specifications, shall be provided as shown on drawings:

Size	Construction	Ends
15 to 40 mm	Gun metal	Screwed
50 mm and above	Body cast iron spindle and valve seat of Bronze or Gun metal or Nitrile rubber. (in case of butterfly valve)	Flanged

2.6 All valves shall be heavy duty conforming to BIS 5155, BIS 5152, BIS 780. Valves shall have nonrising spindles unless otherwise specified and shall be suitable for not less than 10 Kg. per sq.cm. gauge working pressure.

Butterfly valve shall be perform the function of isolating valves, Butterfly valves shall have cast iron body with black wtrile seat. All Butterfly valves shall be provided with locking devices valves above 250 mm dia shall be gear driven.

All AHU's shall be provided with balancing/ control valves with built in pressure drop measuring facility.

2.7 Flanges shall be of slip on raised face type. The supply of flanges shall also include supply of bolts and nuts and suitable asbestos/fibre rubber insertion gaskets (minimum 3mm thick).

2.8 Non-return (check) valves shall be provided as shown on the drawings, conforming to BIS 778 and IS 5312 (Part I) and in accordance with the following specifications.

Size	**Construction**	**Ends**
10 to 40 mm	Gun metal	Screwed
50 mm and 150	Cast Iron/Gun Metal	Flanged plate
200mm to 450 mm	Body casting iron,plate	Flanged carbon steel with 13% chrom overlay

The spring and hinge/stop pin shall be SS 304 and bearing fire material. Valves shall suitable for not less than 10 Kg per Sqcm gauge working pan.

Non-return valves shall be of approved equal. Swing check valves shall normally be used in all water services. Lift type valves may be used in horizontal runs. Valves shall be suitable for not less than 10 Kg per sq.cm. gauge working pressure.

Non-Return Valves of dual plate (wafer type) shall be used in horizontal/vertical r uns.

2.9 Strainers shall be of approved equal 'Y' type or pot strainers as shown on the drawings, with cast bodies designed for the test pressure specified for the gate valves. Strainers shall have bronze screen with 3mm perforations. Screen shall be removable and replaceable without disturbing of the main pipes. All strainers shall be provided with equal size isolating gate valves with non rising spindel so that the strainer may be cleaned without draining the system. Strainers shall be provided on the inlet side (at suction) of each pump, and where shown on the drawing.

2.10 Pot strainers shall be fabricated out of MS sheet.

Pot strainer shall be fabricated out of MS plate upto 100mm dia pipes shall be fabricated of 6mm thick MS sheet, 125 to 300 mm dia pipes of 8mm thick and 3508 above of 12m thick.

2.11 All chilled water piping and fitting shall be pressure tested, then insulated as described under the section "Insulation".

2.12 After all chilled/condenser water piping has been installed, The pressure testing run for at least three days of eight hours each. The piping, fittings & supports shall be painted with one coat of red oxide paint & two finish coats of 3 mils each of approved color of synthetic enamel paint conforming to IS 2379 (Incase the chilled water piping, the paint shall be done after insulation of the pipes). The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows.

2.13 Auto Air vent/drain valve of suitable size shall be provided in the chilled/condenser water piping at highest point and at lowest points in the risers respectively.

3.0 COLD WATER AND DRAIN PIPING:

3.1 All pipes to be used for cold water (makeup), drain, and condensate drain shall be approved make and fittings as per BIS 4736 or galvanized steel class B (medium class) conforming to relevant BIS codes.

3.2 All jointing in the pipe system shall be by screwed fittings using non-hardening lubricant as sealing material and/or by screwed flanges using 3mm 3 ply rubber gaksets. Pipe threads and flanges shall be as per BS 534 and BS 4504.

3.3 All pipe supports shall be mild steel, thoroughly cleaned and given on primary coat of red oxide paint before being installed.

3.4 Fittings shall be galvanized steel 'Medium Class' malleable casting of pressure rating suitable for the piping system. Flanges shall be of approved make. Supply of flanges shall include bolts, washers, gaskets as required. Sufficient number of flanges and unions shall be provided for future cleaning and servicing of piping. Tee-off connections shall be through equal or reducing tees. All equipment and valve connections, or connections to any other mating pipe shall be through unions/screwed flanges upto 50 mm dia and through screwed flanges for larger diameters, or as required for the mating connections.

3.5 Ball Valves, Butterfly Valves, check valves and strainers shall be similar to those specified for chilled, condensing water piping, except that the smaller valves upto 15mm dia may have screwed female ends.

3.6 All condensate drain piping shall be insulated as per the section 'Insulation'. Cold water piping within the building may also be insulated.

3.7 After the piping has been installed, tested and run for atleast three days of eight hours each, all piping and pipe supports shall be painted with one coat of red

oxide paint & two finish coats of 3 mils each of approved color of synthetic enamel paint conforming to IS 2379.

3.8 The direction of flow of fluid in the pipes shall be visibly marked with identifying arrow.
OR

3.9 PVC Pipe of 6 Kg./Cm^2 with 6mm thick Closed cell crossed linked insulation shall be provided.

4.0 PIPING INSTALLATION:

4.1 Tender drawings indicate schematically the size and location of pipes. The contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air auto vent valves, and all pipe supports. He must keep in view the specific openings in buildings and other structures through which pipes are designed to pass.

4.2 Piping shall be properly supported on, or suspended from, stands, clamps, hangers as specified and as required. The contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers, and be responsible for their structural sufficiency.

4.3 Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated black. Where pipe and clamps are of dissimilar materials, a gasket shall be provided in between spacing of pipe supports shall not exceed the following:

Pipe Size	**Spacing between supports**
Upto 12mm	1.5 meter
15 to 25mm	2.0 meter
30 to 150mm	2.0 meter
Over 150mm	2.5 meter

4.4 Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 15mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lowest point and air vent at the highest point.

4.5 Pipe sleeves, 50mm larger diameter than pipes, shall be provided wherever pipes pass through walls and slabs, and annular space filled with fiberglass and finished with retainer rings.

4.6 Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 14 gage metal sheets shall be provided between the insulation and the clamp, saddle or roller, extending atleast 15cm on both sides of the clamp, saddles or roller.

4.7 All pipe work shall be carried out in workmen like manner, causing minimum disturbance to the existing services, buildings, rods and structure. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipe supports, pipe and pressure testing for each area shall be carried out in one stretch.

4.8 Cut-outs in the floor slab for installing the various pipes are indicated in the drawings. Contractor shall carefully examine the cut-outs provided and clearly point out where ever the cut- outs shown in the drawings, do not meet with the requirements.

4.9 The contractor shall make sure that the clamps, brackets, clamps saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes, and include expansion Loop where required.

4.10 All pipes shall be accurately cut to the required sizes in accordance with IS 554 and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.

4.11 Flanged inspection pieces 1.5 meters long, with bolted flanges on both ends, shall be provided no more than 30 meters centres wherever shown in approved for construction to facilitate future cleaning of all welded pipes.

4.12 All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, then wrapped with three layers of fibreglass tissue, each layer laid in bitumen.

4.13 Insulated buried pipes shall be cleaned, derusted, then coated with epoxy primer. Insulation shall be applied as per the section 'Insulation' wrapped with GI wire and covered with polythene sheet. Two coats (each 6mm thick) of cement plaster shall be applied over chicken wire mesh lath. Where indicated in schedule of quantities, buried insulated pipes shall be water proofed using coat of shalibond, or approved adhesive, over the plastered surface; wrapping one layer of fibreglass RP tissue and one layer of roofing tarfelt with sufficient overlaps, set and sealed with the adhesive, held in position by 16 gage GI wire tied at 15cm intervals.

4.14 Auto Manual air vent valves shall be provided at all high points in the piping system for venting. All valves shall be minimum of 15mm pipe size and shall be associated with an equal size gate valve.

Discharge from the air valves shall be piped through an equal sized mild steel or galvanised steel pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

4.15 Pressure gauges as specified under section "Automatic Controls and Instruments", shall be provided at the suction and discharge of chilled water/condenser water pumps supply and return at air handling units, at chillers and at condensers, as shown on the drawings and included in schedule of quantities. Care shall be taken to protect pressure gauges during pressure testing.

4.16 Temperature gauge as specified under section "Automatic Controls and Instruments" shall be provided at each Air handling unit's Supply / Return Chilled water line, at chillers, and condensers, as shown on drawings and included in schedule of quantities.

5.0 TESTING & BALANCING:

5.1 All piping shall be tested to hydrostatic test pressure of atleast two and half times the maximum operating pressure, but not less than 10 Kg per sq.cm. gage for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified and gotten approved at site.

5.2 Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.

5.3 System may be tested in sections and such sections shall be securely capped, then retested for entire system.

5.4 The contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Owner's site representative.

5.5 The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. In case of improper circulations, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications. He shall bear all expenses for carrying out the above rectifications, including the tearing up and re-finishing of floors and walls as required.

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

5.7 After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified, quoted or as directed, to individual air handling units and fan coil units cooling coil.

5.8 Water circuit shall be adjusted by balancing cocks provided for balancing; these shall be permanently marked after balancing is completed so that they can be restored to their correct positions, if disturbed.

5.9 Complete certified balancing report shall be submitted for evaluation and approval. Upon approval, four copies of the balancing report shall be submitted with complete drawings and documents.

5.19 Commissioning of all building systems and including required equipment pre-start and start-up checklists and verification checklists. Additional document including air test and balance report, operating &maintenance manuals, highlighted cut sheets, record As- Build" Documents in pdf format and warranties on all equipments.

5.10 Painting of condenser water pipes as per approved colour.

I) THERMAL/ACOUSTIC INSULATION:

1.0 GENERAL:

Scope of this specification comprises of supplying, installing, testing and commissioning of insulation on ducts.

2.0 DUCT INSULATION (CLOSED CELL CROSSED LINK INSULATION):

High quality closed cell crossed linked insulation with factory laminated aluminum foil. The thermal conductivity of insulation shall not exceed0.03 W/M^{o}K (0.26 Btu. In/hr. Sq Ft ^{o}F) at 20^{o}c (68^{o}F) mean temperature and density shall not be less than 25-30 kg/m^{3}. Temperature range shall be –40^{o}c to +105^{o}C and should
be self extinguishing type.

2.1 Thickness of Insulation:

a.	Supply duct (In Non A.C. Area)	=	19 mm with protection
b.	Supply duct (In A.C. Area)	=	13 mm with protection
c.	Return duct (In Non A.C. Area)	=	13 mm with protection
d.	Return duct (In A.C. Area)	=	9 mm with protection
e.	Air Washer ducts	=	9 mm with protection

2.2 Application:

a. Clean the surface of duct and apply a thin coat of adhesive (Polybond V-9/ Starglue R-242) and leave it for 10-15 minutes for drying once the adhesive is dry but tacky to touch place the insulation sheet in designed position.

b) Join seams after insulation is in place by separating the cut edges and brushing a thin coat adhesive on both surfaces.

c) Seams/Flange joints shall be insulated with strips of insulation sheet.

d) For Exposed Duct following additional treatment to be given.

Apply Starbond 30-36 as a track coat over the insulation surface evenly by brush or roller.

Embed the fiber glass cloth while coating is wet. Install fiber cloth fibric gently to avoid wrinkles. After the wrapping of fiber cloth wait until the track coat is cured that is 1 to 2 hours depending upon the weather conditions.

e) Apply 1st coat of Starbond 30-36 evenly by brush or roller.

f) Apply 2st coat of Starbond 30-36 evenly by brush, roller or spray once 1st coat is cured that is 3 to 5 hours depending upon the weather conditions.

3.0 ACOUSTIC LINING OF DUCTS:

3.1 For acoustic lining of indoor unit ducts the material shall be Elastomeric Nitrile Rubber Open Cell Foam of density 140-180 kg/m^3 and Thermal Conductivity of 0.045 W/m.K @ 20^{0}C.All duct upto a distance of minimum 5m from indoor unit outlet or as shown in the drawing shall be acoustically lined from inside the duct.

3.2 Thickness of Acoustic Insulation:

a.	FCUs	=	15 mm with protection
b.	AHUs	=	25 mm with protection

3.3 Application:

3.3.1 Duct Lining:

Clean the inner surface of duct, which is to be lined with wire brush to remove the dirt.

Apply Armaflex duct seal adhesive (BM Sed on rubber in a blend of solvents) quick setting adhesive compound over duct surface.

The adhesive shall be non flammable vapor proof, odorless type.

Before use stir container thoroughly to ensure uniform consistency and disperse and solids which may have settled.

Use a brush which has short stiff bristles. Apply a thin uniform film of adhesive to both surfaces to be joined.

Allow the adhesive to “tack” dry. It shall take 45 seconds to 120 seconds, depending upon ambient conditions.

Check the adhesive surface using the back of a fingernail. If the fingernail does not stick to the surface does not feel tacky, the joint may be closed.

Firmly press together the full area of the surfaces being joined.

4.0 PIPING INSULATION:

High quality closed cell crossed linked insulation. The thermal conductivity of insulation shall not exceed0.038 W/M^{o}K at 10^{o}C mean temperature and density shall not be less than 30-35 kg/m^3. Temperature range shall be –80^{o}c to +95^{o}C and should be self extinguishing type.

4.1 Thickness of Acoustic Insulation:

a.	Condensate Drain	=	6 mm
b.	Refrigerant Piping	=	13mm th. Up to 20 mm dia.&19mm th. Above 20mm dia.

J) BUILDING AUTOMATION SYSTEM (BAS):

1.0 Scope:

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

1.1 System Overview.

It is the intent of these specifications to integrate the **Building Automation,** through a software interface to achieve the following minimum features

- A common database for all the system.
- Same set of graphics and same methods for issuing commands to be used for all systems.
- Consistent alarm management across systems
- Consolidated historical data and reports.
- In an emergency, all of the building systems respond in a co-ordinated manner.
- Information is entered to one system (.e. occupancy via. Access card swipe and other systems can respond (i.e. air conditioning, lighting etc.)
- BAS connectivity & control through telephone interface.
- Energy management functions.
- Dial out to an assigned number in case of an emergency

2.0 System Requirement

2.1 Control Stations (Operator Workstation, PLC) shall be located in the Elect Room in the basement

2.2 The Operator Workstation (PLC) software as offered by the bidders shall, as a minimum, provide the following functions :-

- Enable / disable change-of-state reporting for a point.
- Set / change alarm parameter's such as alarm limits and differential.
- Read current point value.
- Override current point value for data points and output points.
- Begin / end Trend Log data collection.
- Read all or part of an on-line or archived Point Profile data file
- Read point parameter, once or every "n" seconds
- Subscribe to receive change-of-state messages.
- Read / add / delete weekly or temporary schedules.
- Read all or part of an on-line or archived Tantalization record file.
- Delete an archived Tantalization record file
- Delete an archived Trend Log data file.

- Write to point parameters.
- Dial out alarm conditions in case of an emergency through an dedicated telephone line to an assigned number
- Log on line data as received through an integrator for on line diagnostics.

2.3 It is the fundamental requirement that the tenderer shall provide written confirmation that the system software & firmware are millennium **(Y2K) compliant.**

3.0 DESIGN AND PERFORMANCE CRTERIA

3.1 Provide stable control of all connected systems with a closed loop control accuracy not to be worse than.

a)	Temperature	:	± 2 percent of sensor span.
b)	Humidity	:	± 4 percent of sensor span.
c)	Pressure	:	± 2 percent of sensor span.
d)	Flow	:	± 3 percent of sensor span.

3.2 Environmental Conditions.

a) The DDCs, Field Equipment Panels, and other field equipment's shall operate under ambient environmental conditions of 0° to 50° C dry bulb and 10% to 95% relative humidity, non-condensing. Sensors and control elements shall operate under the ambient environmental temperature, pressure, humidity, and vibration conditions normally encountered for the installed location.

b) Other equipment, such as CRTs and printers, shall unless designated other operate properly under ambient environmental conditions of 10° to 40°C and a relative humidity of 20% to 80%.

3.3 Materials and Equipment

a) Where multiple units of the same type are required the units shall be products of a single manufacturer.

However, the component parts of the system need not be the products of a single manufacturer. The components shall not require customising other than setting jumpers and switches and adding firmware. Each major component of equipment shall be labelled with the manufacturer's name, address, model and serial number.

3.4 The following commands shall be able to be time scheduled to be issued at a later day and time :-

Start or stop a point.

Lock/unlock point reporting or point control.

Demand Limit target setting.

Duty cycling rolling target setting.

Trend Log point enable / disable for a point.

Tantalization enable / disable for a point.

3.5 SENSORS AND CONTROL DEVICES

3.5.1 General: Catalogues to be submitted for proposed Sensors and Control Devices along with Model Nos.

3.5.2 Provide sensors and control devices as indicated on mechanical plants, control flow diagrams and as required to meet specified performance. Where performance specifications exceed capabilities of hardware specified, performance governs. The installation of such devices shall be the responsibility of this contractor.

A. All analog sensors shall be industry standard 0 to 10 volt or 4 to 20 ma type with built-in circuit protection against reverse polarity and supply voltage transients. The transmitters shall be matched to the sensing elements and be compatible with the DDC.

B. All sensor / transmitters assemblies shall be factory calibrated.

C. All sensor wiring, analog or digital, input or output, shall be capable of sharing single conduit runs without affecting signal performance. All signal wiring shall also be capable of sharing signal conduit runs with switched AC of 240 volts.

D. The sensor range shall be suitable to the application.

E. Minimum contact rating of relays and switches shall be 5 amp 240 volts. Resistive.

F. All components of sensors exposed of process shall be rated to withstand 150 percent of maximum process temperature and pressure.

3.5.3 Thermo wells.

A. Provide brass thermowells for each immersion type temperature sensor and switch. Thermowells shall have extension for pipe insulation and threaded

connection to pipe. Threaded connection shall be a minimum of 20 mm. Maximum insertion length shall be 150 mm or ¾ the pipe diameter which ever is smaller.

3.5.4 Temperature Sensors

A. Temperature sensor assemblies shall consist of a 100 or 1000 OHM platinum RTD sensor protected in a housing suitable for the environment in which it is installed. There should be a suitable housing for Room / Duct and Immersion applications.

B. Sensor accuracy shall not exceed 0.75°C. Except for chilled water applications, the accuracy shall not exceed 0.25°C.

C. Sensors for mixed air and coil discharge applications and for fan discharge applications is systems over 25 cube meters per second averaging type sensors shall be used. Probe length shall be at least one linear meter per 1.25 square meters of duct area or equal to duct width where installed, whichever is longer.

D. Outside air sensors shall be mounted on a northern exposure and mounted within a ventilated enclosure.

3.5.5 Pressure Sensor - Liquid

Assembly shall consist of a pressure sensor enclosed in a gasketed, dust and water tight case. All body cavities open to the process fluid shall be provided with frain ports at the cavity bottom and vent ports at the top of the cavity.

3.5.6 Transducer

Current, Voltage, Frequency, kW & Phase Angle Transducer shall have output open and short circuit protection. Total accuracy of ± 2% of span.

3.5.7 Flow Switches

A. Flow switches shall be suitable for monitoring the flow of water in pipes. The switches shall be suitable for operation in high humidity atmosphere and for pipes handling water below dew point temperature. Parts in contact with water shall be of brass or phosphor bronze construction.

B. Pipe connection shall be treaded, complete with stop cock. Flow switches shall be capable of withstanding the duty water pressure (but of not less than 1050 KN/m2), water temperature of 0°C to 50°C and ambient temperature of 10°C to 40°C. Paddle length (height) shall be more than 60% of the pipe diameter for pipe up to 150 mm diameter and shall be not less than 150 mm of larger pipes. Flow switches shall be SPDT contacts rated at 1.2A/230V AC or DC.

C. Velocity required to actuate switch shall be field adjustable. Flow switches shall be selected to suit the flow velocities expected.

3.5.8 Air Flow Switch

Air Flow switches shall be of sturdy and corrosion resistant construction and suitable for monitoring air flow in ducts, and supplied with mounting plate and gasket for duct mounting. Paddle shall be of stainless steel of size 50 mm x 150 mm minimum. Air Flow switches shall be chosen to suit the velocities to be monitored. Performance of Air Flow switches shall not be affected when mounted on ducts handling air below ambient dew point temperature.

4.0 AUTOMATION CONTROL SEQUENCES

4.1 General

Trade Contractor to customize control strategies and control sequences and be able to define appropriate control loop algorithms and choose the optimum loop parameters for loop control. All control loops shall be tuned to stabilise within ± 1% of set point within 5 minutes of set-point change or system start-up.

Safety devices shall be hardwire inter locked with “hand” and “automatic” positions in series with motor controller holding coil circuit.

Start up sequences and automatic control sequences as described on hereinafter shall operate in both automatic and manual modes.

Rest schedules and set-points shown in sequences are for initial programming and start-up, during system check out the reset schedules and set-points shall be fine-tuned to obtain desired comfort and energy results.

The output of the reset schedules should be limited between maximum and minimum values. In the control sequences when a reset schedule is indicated, the range of the output be limited between the minimum and maximum values indicated in the reset schedules.

All functions which use analog points to switch equipment on and off (e.g. fans, pumps) must be programmed with dead bands, and if necessary, time delays to prevent short cycling of equipment.

4.2 VRV System

The following functions shall be carried out by the Building Automation System.

1. Monitor status of ach VRV unit.

2. Switch ON/OFF VRV Machine each pump / cooling tower.

3. Sequence each VRV Machines/pump/cooling towers to maintain equal run time..

4. Monitor status of each of the water pumps through a differential pressure switch and keep a log of run-time.

5. Monitor the cold store temperatures.

6. Monitor the outside air temperature and relative humidity.

7. Interface card to hook up with the BAS System

4.3 Air Handling Units

1. Program the start/stop of each air handling unit supply fan and carry out the duty cycling (from AHU panel).

2. Monitor the running status of each blower fan through a differential pressure switch and keep a log of the number of hours run.

3. Monitor filter status of each AHU by a pressure differential switch & give an alarm in case the filter gets choked.

4. Monitor the return air temperature & RH & give an alarm for a high/low supply air temperature.

5. Room in side-conditions.

6. Indicate any unit running in Manual mode.

4.4 Exhaust Fans

1. Control Start/Stop of each fan.

2. Monitor the status (air flow) of each fan.

3. Monitor the status of each fan through a air flow switch.

5.0 Temperature gauge:

Shall be H.GURU make DIAL type with 1bs/Kg/Sqcm both scales Temperature gauge shall be of the separate able socket type and shall have extended neck, where required, for insulated pipes. Temperature gauge shall be installed at chilled water supply and return at air handling units, as shown on the Drawings.

Range of scales shall be 30-120 deg. F (0- 50 deg. C) for air conditioning applications.

6.0 Pressure Gauges:

Shall be H.GURU or approved equal, installed on suction and discharge of pumps, supply and return of chilled water pump, supply/return in at air handling units, inlet and outlet at chillers, and condensers and shown on the Drawings and included in Schedules of Quantities. Section side gauges at pumps shall be compounded gauges with 150 mm dia of the range 0-75cm. (0-30 inches) mercury vacuum and 0 - 4 Kg. per Sq.cm (0-60 psi) pressure. Discharge side gauges at pumps and at all other locations shall be 150 mm dia. of the range 0.5 Kg. per sq.cm. (0-60 psi) pressure. Gauges shall be connected to the pipes by 6mm. diameter copper tubing through 6mm. dia shut-off cocks, required for gauge protection during testing.

7.0 CABLE SPECIFICATIONS

7.1 Signal Cable

The signal cable shall be of the following specifications :-

a.	Wire	:	Annealed Tinned Copper.
b.	Size	:	18 AWG Stranded.
c.	No. of conductors	:	Two (One pair)
d.	Shielding	:	Overall beld foil aluminum
	Polyester shield.		
e.	Jacket	:	PVC
f.	Colour	:	Black & Red.

7.2 <u>Communication Cable</u>

The Communication cable shall be of the following specifications :-

a.	Wire	:	Annealed Tinned Copper.
b.	Size	:	1Sq. mm
c.	No. of conductors	:	Two (One pair)
d.	Shielding	:	Overall beld foil aluminum
	Polyester shield.		
e.	Jacket	:	PVC
f.	Colour	:	Black & Red.

7.3 LAN Cable

The signal cable shall be of the following specifications :-

a.	Wire	:	Cat-5e/Cat-6
b.	Size	:	1.5 Sq. mm or as per manufacturer standard
c.	No. of conductors	:	As per manufacturer standered
d.	Resistance	:	75 ohms.
e.	Jacket	:	PVC
f.	Colour	:	Black.

8.0 LIST OF APPROVED MAKES:

S.NO	PRODUCT/MATERIAL	MAKES
1.	Direct Digital Controller	L&S/Automated Logic/ Johnson Controls/Honeywell
2.	Control Panel Housing	Rittal/Enclotek/EEPL
3.	Supervisory Control Unit	L&S/Automated Logic/ Johnson Controls/ Honeywell
4.	Central Control Station with Printer	HP/Wipro/IBM
5.	Printer	Epson/HP/TVSE
6.	Software for Centralised BMS Control system	L&S/Automated Logic/ Johnson Controls/ Honeywell
7.	Immersion type Temperature sensor	L&S/Automated Logic/ Johnson Controls
8.	Water Flow Switches	L&S/Automated Logic/ Johnson Controls/ Honeywell
9.	Duct Type temperature sensor	L&S/Automated Logic/ Johnson Controls/ Honeywell
10.	Air Flow switches	L&S/Automated Logic/ Johnson Controls
11.	Enthapy sensor	L&S/Automated Logic/ Johnson controls/ Honeywell
12.	Liquid level flow switch	Veklser/Nevelco/Minilec/Johnson
13.	Differential pressure switch for filter status	L&S/Automated Logic/ Johnson controls/ Honeywell
14.	Room temperature sensor	L&S/Automated Logic/ Johnson controls/ Honeywell
15.	Differential pressure switch for pump status	L&S/Automated Logic/ Johnson controls/ Honeywell
17.	Electromagnetic Flowmeter	Khrone/Kele/ Shenitech/ Alsonic
18.	DC Voltage transducer	SITU/ABB

19.	Flame proof flow switch	Veklser/ Nevelco/ Minilec Johnson Controls
20.	2/3 way modulating valves for AHU/FCUs	L&S/Johnson Controls / Honeywell
21.	Motorized 2-way butterfly valves	L&S/Johnson controls/ Honeywell
22.	25 mm MS conduit	BEC/AKG/NIC
23.	Sensory cable	R R Kable/Finolex/National/Fusion
24.	LAN Cable	R R Kable/Finolex/National/Fusion
25.	Communication cable	R R Kable/Finolex/National/Fusion
26.	Variable Frequency Drives	Danfoss/Siemens/ABB

K) ELECTRICAL WORK:

1.0 SCOPE:

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of Electrical Power/ control panels, wiring and earthing of all air-conditioning equipment components and accessories, including supply, installation and wiring of remote control with indicating lamps.

The following exclusions from this contract may be provided by Owner, through other agencies, as per special conditions of contract.

i) Wiring and earthing of incoming breakers in the airconditioning plant room control panel.

ii. Supply, installation, wiring and earthing of 15 amps three pin socket in vicinity of each IDU any and each single phase ventilation fan.

2.0 GENERAL:

Work shall be carried out in accordance with the specifications of local rules, Indian Electricity Act 1910 as ammended upto date, and rules issued there under, regulations of the Fire Insurance Company and Indian Standard Code of practice No. IS: 732-1963 (revised).Wiring for items of work not covered by any of the above regulations, shall be carried out in accordance with the CPWD specifications.

3.0 WIRING SYSTEM:

All power wiring shall be carried out with 1100 volt grade XLPE insulated, armoured, overall, PVC sheathed aluminium conductor cables. Cables shall be sized for taking care of starting current and by applying proper derating factor. All control wiring shall be carried out by using 1100 volts PVC insulated copper conductor wires in wire ways or in conduit. Minimum size of control wiring shall be 1.5 sq.mm.

4.0 CONSTRUCTION FEATURES:

The control panel shall be metal enclosed sheet steel cubical indoor type, dead front, floor mounting/wall mounting type. The control panel shall be totally enclosed, completely dust and vermin proof, Gaskets between all adjacent units and beneath, all covers shall be provided to render the joints dust proof. Control panels shall be arranged in multitier formations. All doors and covers shall be locable. All mild steel sheets used in the construction of control panels shall be 2mm. thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all slag grounded off and welding pits wiped smooth with plumber metal.

All panels and covers shall be properly fitted and square with the frame,and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with hank nuts. Self threading screws shall not be used in the construction of panels. Base channel shall of 75mm x 75mm x 5mm thick shall be provided at the bottom. Minimum clear space of 200mm between the floor of panel and bottom most unit shall be provided.

The panels shall be of adequate size with a provision of 25% spare space to accomodate possible future additional switch gear. Knockout holes of appropriate size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. All equipment such as meters and indicating lamps, etc shall be located adjacent to the unit with which it is associated and care shall be taken to achieve a neat and symmetrical arrangement. Facility shall be provided for termination of cables from both above and below the panel. Where cables enter below, cables boxes shall be fitted at the rear and arranged in tiers to facilitate making connections to the upper and lower units. Clamps shall be provided to support the weight of the cables. All incoming and outgoing feeders shall be brought out to a terminal block of adequate size at suitable location inside the panel. All wiring inside the panel shall be colour coded and labelled with approved plastic beads for identification. Circuit diagrams showing the arrangement of circuits shall be pasted on the inside of the panel door and covered with transparent plastic sheet and all labelling shall be provided on the front face of the panel board.

5.0 CIRCUIT COMPARTMENTS:

Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the 'ON' position. Safety interlocks shall be provided to prevent the breaker or Contactor from being drawn out when the breaker is in the draw out portion of the panel. Instruments and indicating lamps shall not be mounted on the panel compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

6.0 INSTRUMENT ACCOMODATION:

Separate and adequate compartments shall be provided for accomodating instruments, indicating lamps, control contactors and control fuses etc. These shall be accessible for testing and maintenance without any danger of accident contact with live parts of the circuit breaker and bus bar.

7.0 BUS BARS AND BUS BAR CONNECTION:

The bus bar and interconnections shall be of aluminium and of rectangular cross sections suitable for full load current for phase bus bars and half rated current for neutral bus bars and shall be extensible on either side. The bars and interconnections shall be insulated with heat shrinkable and colour coded PVC sleeve. All bus bars shall be supported on unbreakable, non-hygroscopic insulated

supports at regular intervals, to withstand the forces arising in case of short circuit in the system. Bus bars shall be provided in separate chamber. Extra cross section of bus bars shall be provided if holes have to be drilled for making connections.

All bus bar connections in smaller control panels shall be done by drilling hole and connecting by brass bolts and nuts. Additional cross section of bus bars shall be provided in small control panels to cover up the holes drilled in the bus bars.

All connections between the bus bar and breaker and between breaker and contactor, shall be through aluminium strips of proper size to carry full rated current and shall be insulated with PVC sleeves.

8.0 TERMINALS:

The outgoing terminals and neutral links shall be brought out to a terminal block suitably located in the panels. The current transformer for instruments, metering and for protection shall be mounted on the terminal blocks. Separate cable compartment shall be provided for incoming and outgoing cables.

9.0 WIRE WAYS:

A horizontal wire way screwed covers shall be provided at the top to take in the connecting control wiring of different vertical sections.

10.0 CABLE COMPARTMENTS:

Cable compartments of adequate size shall be provided in the panels for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate and proper supports shall be provided in cable compartments to support cables. All incoming and outgoing terminals shall be brought out to terminal blocks in the cable compartment.

11.0 MATERIALS:

All materials shall be of the best quality complying with the appropriate Indian Institutions and British Standard specifications, Materials used shall be subject to the approval of the Architect/Consultant and sample of the same shall be furnished where required.

a) AIR CIRCUIT BREAKERS:

The air circuit breaker shall comply with the requirements of IS:13947-2 (1993) and shall have:

i) A service short circuit breaking capacity shall be as specified and equal to short circuit withstand values. All short circuit ratings shall be Ics values.

ii) A short circuit making capacity of 75 KA.

iii) A short time withstand capacity of 35 KA for 1 second.

iv) Mechanical and electrical endurance for 2000 operating cycles out of which 100 cycles should be for electrical endurance.

v) Electrical overload performance at 6 times the rated current, 110% of the rated voltage as recovery voltage and 0.5 power factor.

vi) Dielectric test of 2.5 KV applied for one minute on main circuits. Test evidence from a recognised independent laboratory/institution shall be furnished for compliance of the breakers with the above requirements.

vii) Each pole of the ACB's shall be equipped with an inverse time delay thermal set micro over current trip device and an electro magnetic instantaneous over current trip device. The ACB's shall be equipped with under voltage trip release. The trip devices shall be direct acting. ACB shall be capable of providing short circuit overload and earthfault protection (in absolute values) if required, thru microprocessor based control unit sensing the true RMS values to ensure accurate measurement meeting the EMI/EMS requirement as per the standard.

viii) Disconnecting devices of approved type shall be provided to facilitate the removal of the circuit breakers from the housing for test and maintenance purposes.

ix) The ACB's shall be fitted with detachable type re- quenching device on each pole. The ACB's shall have auxiliary contacts for signalling, interlocking etc. The ACB's shall have slow close facilities for checking contact operation and contact gap adjustment.

x) All contacts subject to arcing shall be tipped with arc resisting material. Main contacts shall be silver plated to ensure reliability in service.

xi) Isolating contacts shall be of the silver plated, multifinger, spring loaded type. Facilities shall be provided to isolate the circuit breaker for inspection purpose. Feature of contact wear inspection indicating the life of contacts shall be provided. The ACB shall have double insulation (class-II) with moving and fixed contacts totally enclosed for enhanced safety and inaccesiability to live parts. The breaker shall have three distinct positons with in the cassette as follows:

a) 'Service Position' - with main and auxiliary contacts connected.

b) 'Test Position' - with power contacts fully disconnected and control circuit contacts connected.

c) 'Isolated position' - With both power and control circuit contacts fully disconnected.

xii) Interlocks shall be provided to :

a) Prevent the breaker from being isolated unless it is in the OFF position.

b) Prevent the breaker from being racked into the service position unless it is in the OFF position.

c) Prevent the breaker from being accidentally pulled completely OFF the guide rail.

xiii) Safety shutters of an insulation material shall be provided to prevent access to all live contacts, when the breaker is in the inspection position or completely withdrawn.

xiv) Facilities for pad locking the safety shutters when breaker is completely withdrawn shall be provided.

Facilities shall be provided for earthing the circuit breaker.

xv) Air circuit breaker shall be capable of clearing the maximum fault current which can occur.

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

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

b) <u>MOULDED CASE CIRCUIT BREAKERS (MCCB)</u>:

MCCBs shall satisfy the requirements of IS-2516 and shall be of current limiting type. MCCB shall provide type 'C' protection to the

contactors as per IEC 158-1B. MCCBs shall be quick make, quick break, independent manual type with trip free feature with mechanical ON, OFF, and TRIP indications. A trip button shall be provided for tripping the breaker.

MCCB shall have thermal, magnetic, undervoltage and earth fault releases.
Alarm and auxiliary contacts, terminal shrouds, sliding type front operation kit with facility for door interlocking and pad locking shall be provided.
MCCB-above 250 Amp shall have microprocessor based release.

c) FUSE SWITCH UNITS

The fuse switch units shall be 3 pole double break type suitable for load break duty, quick make and break action. Separate neutral link shall be provided in the switch. All fuse switch units shall be provided with hinged doors duly interlocked with operating mechanism so as to prevent opening of the door when the switch is in "ON" position and also prevent closing of the switch when the door is not properly secured. All contacts shall be silver plated and all live parts shall be shrouded. The incoming and outgoing terminals of switch shall be adequately sized to receive proper size of cables. High rupturing capacity (HRC) fuse links shall be provided with switch fuse units and shall be in accordance with IS: 2208-1962 and having rupturing capacity of not less than 35 MVA at 415 volts. HRC fuse links shall be provided with visible indicators to show that they have operated. The switch fuse unit shall be manufactured in accordance with IS:4047-1967 as amended to date.

d) MINIATURE CIRCUIT BREAKER

Miniature circuit breakers shall be quick make and break type and conform to IS:8828. The housing of MCBs shall be heat resistant and having a high impact strength. The fault current of MCBs shall not be less than 10000 amps, at 230 volts. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical "ON" and "OFF" indications.

The circuit breaker dollies shall be of the trip free pattern to prevent closing the breaker on a faulty circuit.

The MCB contacts shall be silver nickel and silver graphite alloy and tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCB's shall be provided with magnetic fluid plunger release for over current and short circuit protection.

The over load or short circuit devices shall have a common trip bar in the case of DP and TPN Miniature Circuit Breakers. All the MCB's shall be tested and certified as per Indian Standards, prior to installation.

e). Rotary Switches:

Switches upto 60 amps shall be rotary type with compact and robust construction, built up from one or more stacks with contacts and a positioning mechanism, with stop as required. The terminals shall be shrouded with insulation to prevent accidenttal contact with live parts. Rotary switches shall be backed up with moulded type HRC fuse fittings of appropriate rating.

f). Selector Switch:

When called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

g). Switches:

Switches beyond 60 amps shall be panel mounted double break type and suitable for load break duty, quick make and break action, manufactured in accordance with IS: 4047 - 1967. Switch contacts shall be silver plated and shall be backed up with HRC fuses of appropriate rating. The switch handles shall be located at the front. Switches shall be of Larson and Toubro, Siemens, English Electric make or approved equal.

h). HRC Fuses:

Fuses shall be high Rupturing capacity and shall be in accordance with IS: 3208 - 1962 and having rupturing capacity of not less than 20 MVA at 415 volts. The back up fuse rating of each motor/heater/equipment shall be so chosen that the fuse does not operate on starting of motor/heater/equipment. Fuses shall be of the same make as the switches.

i). Starters:

Each motor shall be provided with a starter of suitable rating. Starter shall be in accordance with IS: 1822 - 1967. Direct on line starters shall be provided for motors upto 10 HP. Star Delta Type starters shall be provided for motors 12.5 HP to 50 HP capacity. Motors having capacity more than 50 HP shall be provided with Auto Transformer/Reduced Voltage/Starter Rotor.

Starters contactors shall have 3 main and 3 auxillary contacts and shall be air break type suitable for making and breaking contact a minimum power factor of 0.35. For design consideration of contactors, the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of star delta/reduces Voltage starters.

Main and auxillary contacts shall be silver or silver alloy. The insulation for contactor coils shall be of class "E". Operating coils of contactors shall be suit able for 220/415 +/- 10% volts AC, 50 cycles supply sys tem. The contactor shall drip out when voltage drops to 90% of the rated voltage. The housing of the contactors shall be heat resistant and having high impact strength. Each starter shall have thermal overload protection on all three phases. Starters shall be of Siemens/Larson and Toubro make or approved equal.

j) CONTACTORS:

The contactors shall meet with the requirements of IS: 2959.

The contactors shall be of MN series or equivalent only.

The contactors shall have minimum making and breaking capacity in accordance with utilization category AC3 and shall be suitable for minimum class II intermittent duty.

If the contactor forms part of a distribution board then a separate enclosure is not required, but the installation of the contactor shall be such that it is not possible to make an accidental contact with live parts.

k) Over Load Relays:

Contactors shall be provided with a three element, posi tive acting ambient temperature compensated time lagged hand-reset type thermal over load relay with adjustable setting. Hardreset button shall be flush with the front door for resetting with starter compartment door closed, Relays shall be directly connected for motors below 35 HP capacity. C.T. operated relays shall be provided for motors above 35 HP capacity. Heater circuit contactors may not be provided with overload relays.

l) Current Transformers:

Current Transformer shall be of accuracy class - I and suitable VA burden for operation for the connected meters and relays.

m). Single Phase Preventers:

Single phase preventers shall be provided as per schedule of quantities and shall be in conformity with relevant ISI standards. Single phase preventers shall act when the supply voltage drops down to 90% of the rated voltage or on failure of one or more phases.

n). Time Delay Relays:

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one at auxiliary contacts for indicating lamp connection.

o). Indicating Lamp and Metering:

All meters shall be digital type and indicating lamps shall be LED type. The meters shall be flush mounted and drawout type. Each main panel shall be provided with operated ammeter of suitable range with three Nos. CTs of suitable ratio with selector switch, phase indicating lamps, and other indicating lamps as called for. Each phase indicating lamp shall be backed up with control SP MCB.

p). Toggle Switch:

Toggle switches, where called for, shall be in conformity with IS: 3854-1969 and shall be of 5 Amps rating.

q). Push Button Stations:

Push button station shall be for manual starting and stopping of motors/equipment as called for. Red and Green colour push buttons shall be provided for starting and stopping operations. Start or stop indicating flaps shall be provided for push buttons. Push buttons shall be suitable for panel mounting and accessible from front without opening door, lock lever shall be provided for stop push button. One set of normally open and one set of normally closed contacts shall be provided in push button stations. The push buttons contacts shall be suitable for 15 Amps current capacity.

r). Cables:

M.V. cables shall be XLPE insulated aluminium conductor / copper condutor and armoured cables conforming to IS: 7098 part I. MV cables shall be armoured and suitable for laying in trenches, duct, and on cable trays as required. MV cables shall be termite resistant. Control cables, and indicating panel cables shall be termite resistant,

PVC insulated copper conductor and armoured cables confirming to IS:1554 part -I.

s). Wires:

1100 volts grade PVC insulated copper conductor wires in conduit shall be used.

12.0 CABLE LAYING:

Cable shall be laid generally in accordance with Indian Standard Code of practice. Cable shall be laid on 14 gauge perforated M.S. sheet hot dip galvanized cable trays as approved by the owner. Easy access to all cables shall be provided to allow cable withdrawl/replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimise the loss in current carrying capacity.

Cable shall be suitably supported with GI saddles and spacers when run on wall/floor ducts. When buried, they shall be covered with a layer of soft sand and protected with cement concrete tiles / bricks. Special care shall be taken to ensure that the cable are not damaged at bands. The radius of band of the cables when installed shall not be less than 12 times the diameter of the cable.

13.0 WIRE SIZES:

For all single phase/3 phase wiring, 1100 volts grade XLPE insulated copper conductor cables / wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of insulated copper conductor wires of adequate size in exposed conduits. Final connections to the equipment shall be through wiring enclosed in G.I. flexible conduits 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 of through ceiling construction. PVC insulated stranded 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 ends for easy identification.

The minimum size of control wiring shall be 1.5 sq.mm. PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power Wiring shall be of the following sizes:

i.	Upto 7.5 HP motors/5.76 KW	3 x 6 Sq.mm. copper conductor armoured cables.
ii.	From 7.5 HP to 10 HP motors	3 x 10 Sqmm copper cond armoured cables.

iii.	From 12.5HPto15 HP motors	2 x 3 x 10 Sq.mm copper armo cables.conductor.
iv.	From 20 HP to 25 HP motors.	2 x 3 x 10 Sq.mm copper conductor armoured cables.
v.	From 30 HP to 35 HP motors.	2 x 3 x 16 Sq.mm copper cond armoured cables.
vi.	From 40 HP to 50 HP motors.	2 x 3 x 25 Sq.mm copper cond armoured cables.
vii.	From 60 HP to 75 HP motors (Auto Transformer starter)	3 x 70 Sq.mm. aluminium cond armoured cables.
viii.	100 HP motor (Auto Transformer Sta 1 No.	3 x 150 Sq.mm aluminium armo conductor.cables.
ix.	200 HP motor (Auto Transformer Star No.	3 x 225 Sq.mm aluminium cond armoured cables.
x.	300 HP motor (Auto Transfo-Starter). 2 Nos.	3 x 240 Sq.mm aluminium cond armoured cables.
xi.	400 HP motor (Auto Transfo-Starter). 2 Nos.	3 x 300 Sq.mm aluminium cond armoured cables.

All the switches, conductors, push buttons stations, indicating lamps shall be distinctly marked with a small description of the service installed. Circuit wiring diagram of control panel shall be fixed to the cover of control panel for verification. The following capacity contactors and overload relays shall be provided for different capacity motors:

1.

	Motor Capacit	Type of Sta	Contactor Current capacity (in Amps) (AC3 duty)	Overload relay range (in Amps)
1.	5 HP	DOL	12	6-10
2.	7.5 HP	DOL	16	9-14
3.	10 HP	DOL	32	13-21
4.	12.5HP	STAR DELT	25	9-14
5.	15HP	STAR DEL	25	10-16
6.	20 HP	STAR DEL	32	14-23

1.	Motor Capacit	Type of Sta	Contactor Current capacity (in Amps) (AC3 duty)	Overload relay range (in Amps)
7.	25 HP	STAR DEL	32	14-23
8.	30 HP	STAR DEL	45	20-32
9.	35 HP	STAR DEL	45	20-32
10.	40 HP	STAR DEL	45	30-50
11.	45 HP	STAR DEL	65	30-50
12.	50 HP	STAR DEL	65	30-50
13.	60 HP	AUTO TRANSFOI R / reduced	80	30-50
14.	65 HP	-DO-	80	45-75
15.	70 HP	-DO-	80	45-75
16.	75 HP	-DO-	95	45-75
17.	100 HP	-DO-	140	C.T. OPERAT RELAY
18.	135 HP	-DO-	185	-DO-
19.	150 HP	-DO-	185	-DO-
20.	175 HP	-DO-	265	-DO-
21.	200 HP	-DO-	325	-DO-
22.	240 HP	-DO-	325	-DO-
23.	250 HP	-DO-	325	-DO-
24.	275 HP	DO-	325	-DO-
25.	300 HP	-DO-	325	-DO-
26.	400 HP	-DO-	325	-DO-

14.0 EARTHING:

Shall be in galvanised Iron Strips/wires, or copper strips/wires as mentioned in Schedule of Quantities.

a. G.I. Earthing:

The main panel shall be connected to the main earthing system of the building by means of 2 Nos. 25mm x 6mm GI strips. All single phase metal clad switches and control panels shall be earthed with minimum 3mm diameter GI conductor wire. All 3 phase motors and equipment shall be earthed with two numbers distinct and independent GI wires/tapes as follows:

i. Motors upto and including 10 HP rating. — 2 Nos. 4mm dia GI wires including

ii. Motors 12.5 HP to 40 HP — 2 Nos. 6mm dia GI wires.

iii. Motors 50 to 75 HP — 2 Nos. 25 x 3mm GI strips.

iv. Motor above 75 HP — 2 Nos. 25mm x 6mm GI strips

All the switches shall be earthed with two numbers distinct and independent GI wires/tapes as follows:

i. 3 phase switches and control panels upto 60 Amps rating. — 2 Nos. 4mm dia GI wires

ii. 3 phase switches and co panel 63 Amps to 100 A rating. — 2 Nos. 8mm dia GI wires

iii. 3 phase switches and co panels 125 Amps to 200 A rating. — 2 Nos. 25 x 3mm GI tapes.

iv. 3 phase switches and co panels, bus ducts above Amps rating. — 2 Nos. 25mm x 6mm GI tap

b. Copper Earthing:

The main panel shall be connected to the main earthing system of the building by means of 2 Nos. 25mm x 3mm copper tapes. All single phase metal clad switches and control panels be earthed with minimum 2mm diameter copper conductor wired. All 3 phase motors and equipment shall be earthed with two numbers distinct and independent copper wires/tapes as follows:

i. Motors upto and inclu including 10 HP rating. — 2 Nos. 3mm dia copper wire

ii. Motors 12.5 HP to 40 HP capa — 2 Nos. 4mm dia copper wire

iii.	Motors 50 to 75 HP capacity	2 Nos. 6mm copper wires.
iv.	Motor above 75 HP	2 Nos. 25mm x 3mm copper wir

All the switches shall be earthed with two numbers dis tinct and independent copper wires/tapes as follows:

i.	3 phase switches and control pa upto 60 Amps rating.	2 Nos. 3mm dia copper Wires
ii.	3 phase switches and control p 125 amps to 200 Amps rating	2 x 6mm dia copper wire.
iii.	3 phase switches and control pa 63 Amps to 100 Amps rating	2 Nos. 4mm dia copper wires
iv.	3 phase switches and control pa bus ducts above tapes 200 A rating.	2 Nos. 3mm x 6mm copper.

The earthing connections shall be tapped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be minimum 75mm. These straight joints shall be rivetted with and brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termi-nation of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned off paint and/other only substance and properly tinned.

15.0 MOTORS:

All motors shall be confirming to energy efficient motors. IS : 12614 – 2004 (Energy Class Eff 1). Motors shall be suitable for (wherever specified) 3 phase, (wherever specified) 415V $\pm$10%, 50Hz $\pm$5%, combined variation of $\pm$10% motors shall be TEFC having class 'F' insulation with temperature rise limited to class 'B'. Degree of protection IP 55, motors shall be suitable to work at 50^0C ambient-temperature

L) TESTING & BALANCING:

1. System may be tested in sections and such sections shall be securely capped, then retested for entire system.

2. The contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of installation and all testing shall be witnessed and recorded by Owner's site representative.

3. The contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. If proper circulation is not achieved the contractor shall rectify the defective connection. He shall bear all expenses for carrying out the above rectifications, including the tearing up and refinishing of floors and walls as required.

4. The contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test.

5. Complete certified report shall be submitted for evaluation and approval to Engineer in charge. Upon approval, four copies of the balancing report shall be submitted with complete drawings and documents duly hard bound.

M) MODE OF MEASUREMENTS:

Mode of Measurement for payment of items of ducting and piping & their insulation shall be as follows:

1.0 DUCTING:

Payment for ducting shall be on the BMSis of the external surface area of the ducting including all material and labour for installed duct.
The rate per Sq.meter of the external surface shall include all wastage flanges, gaskets for joints, bolts and nuts, duct supports and hanger vibration isolation pads or suspenders, flexible connections, inspection doors, dampers running vanes, straight vanes, and any item which will be required to complete the external insulation and acoustic lining.
The external area shall be calculated by measuring the over all width and depth (including the corner joints) in the centre of the duct section from flange face to flange face in case of ducts length with uniform cross section. Total area will be arrived at by adding up the area of all duct sections.

In case of taper pieces average width and depth will be worked out as follows:

W 1 = Width of small cross section
W 2 = Width of large cross section
D 1 = Depth of small cross section
D 2 = Depth of large cross section

$$\text{Average Width} = \frac{W\,1 + W\,2}{2}$$

$$\text{Average Depth} = \frac{D\,1 + D\,2}{2}$$

Width and depth in the case of taper pieces shall be measured at the edge of the collar of the flange for duct sections flatted with angle iron flanges, otherwise at the bottom of the flange where the flanges are of duct sheet.

For circular pieces the diameter of the section midway between large and small diameters shall be measured and adopted as the mean diameter for calculating the surface area of the taper piece. Duct measurements for calculation of area shall be taken before applications of insulation.

For the special pieces like bends, branches and tees etc, same principles of areas measurements as for liner and outer periphery along the curvature angle of the piece shall apply.

2.0 DUCT INSULATION/ACOUSTIC LINING:

This item is provided separately for various thickness and shall be paid for an area BMSis of uninsulated duct. The area of the duct to be insulated shall be measured before application of insulation.

N) TECHNICAL DATA:
To Be Furnished By the Contractor along with Tender as "Technical Bid"

1.0 AIR COOLED VRV UNITS: No.1 No.2 No.3 N0.4 ----- -

a) Out Door Unit Make & Model No. :

b) I) Nominal cooling capacity (tons):
II) KW/TR :

c) Actual cooling capacity at specified Ambient conditions :

d) Operating weight of Air cooled Condenser unit (Kg.) :

e) Refrigerant & maximum length of Refrigerant piping between indoor & Outdoor unit :

f) Compressors :
I) Type of compressor :
II) Incoming power connection
V) Starting Current :
VI) Running Current :
V) Dimensions of Outdoor unit:

g) Condenser
No. of Fans & Fans Size :
Air Qty of each fan :
Motor HP :
Dimensions of outdoor unit :

h) No of Indoor Units connected to the System:

i) Air Quantity of Indoor Unit (CFM):

j) Cooling Capacity of each indoor Unit:

k) Place of Manufacturing:

2.0 COOLING TOWER:

a) Manufacturer :

b) Type :

c) Model No. & Dimensions (L x W x H) (mm) :

d) Overall dimensions (mm) :

e) Operating Weight (Kg) :

f) Capacity (TR) :

g) Water Flow rate (USGPM) :

h) Wet bulb (design) (^{o}F) :

i) Fan motor rating (HP) :

j) Motor Full Load Current (Amp) :

k) Fan speed (RPM) :

l) Fan diameter (mm) :
m) Fan capacity (CFM) :
n) No. of fans :
o) Outlet velocity (FPM) :

p) Drift loss (USGPM) :

q) Evaporative loss (USGPM) :

r) Total water loss (USGPM) :

s) Range (^{0}F) :

t) Approach to design wet bulb (^{o}F) :

u) Bird Screen :

v) Eliminator material :

w) Casing Material :

x) Basin Material :

y) Piping Material :

3.0 AIR HANDLING UNIT:

a) Manufacturer :

b) Model no. :

c) Material/Gauge :

d) Inner sheet casing :

e) Outer sheet casing / thermal break :

f) Fans :

g) Details of Insulation (Material/Thickness) :

h) Type of Bearing :

i) Dia of Fans (mm.) :

j) No. of Fans :

k) Overall Dimension
- L mm. :
- D mm. :
- H mm. :

l) Operating Weight (Kg.) :

m) Type of Vibration isolators :

n) Balancing Static/Dynamic :

o) Drain pan material, gauge, insulation :

3.1 Coils:

a) Make :

b) Face Velocity (FPM) :

c) Water velocity in tubes (FPS) :

d) Material of tubes/fins :

e) Pressure Drop :

f) Pressure Drop across coils (mm WG) :

g) Dia of tubes (inch/mm) :

h) Rows deep :

i) Fins/Inch :

3.2 Filters:

a) Make :
b) Filter medium :
c) Material of Frame Work :
d) Filter face velocity (FPM) :
e) Pressure output rated Air quantity (mm WG) :

3.3 Motors:

a) Manufacturer :
b) Motor HP :
c) Type :
d) Class of Insulation :
e) Electrical Characteristics :
f) Starting Current (Amps) :
g) Full Load Current (Amps) :
h) Motor Speed RPM :
i) Method of Starting :
j) Starter manufacturer :

k) No. of Control Kits per Indoor Unit:

l) No. of AHU Connecting Kits per indoor Unit:

3.4. Air Handling Units (Operating Data):

AHU No.	Type of AHU	Air Qty(CFM)	Coil Face Area (Sqft.)	Filter Face Area	Fan Outlet Vel. (FPM)	No. of Fans	Dia of Fans	Fan Speed (RPM)	No. of Rows of Coil	Fan of Motor (HP)	Static Pressure (mm Wg)	AHU Opt. Wt. (kg)	No. Ex. Valves mm dia	No. of Valves

4.0 FANS:

S. No.	Type	Manufacturer	Air Qty (CFM)	Static Pressure (mmWg)	Motor (HP)	Outlet Vel. (FPM)	RPM	Type of Drive	Noise Level DB

5.0 MS PIPE:

a) Make :

b) Class :

c) Wall thickness of pipes :

6.0 VALVES:

a) Balancing valve make & test pressure :

b) Non return valve make & test pressure :

c) Butterfly valve make & test pressure :

d) Ball valves make & test pressure :

e) Y strainer make, test pressure & <p :

f) Pot strainer make, test pressure & <p :

7.0 GRILLES/DIFFUSERS/DAMPERS:

Make, Materials and Gauge

a) Fire dampers make, actuators rating & CBRI approval :

b) Grilles :

c) Louvers with bird screen :

d) Diffusers :

e) Duct Dampers / Splitter dampers :

8.0 INSULATION

		Ducting	Acoustic	Piping Lining
Manufacturer	:			
Materials	:			
Density	:			
Mean 'K' value at 50^{o}C	:			

9.0 CONTROLS:

Refrigerant	:
Manufacturer	:
Capacity	:

10.0 AIR WASHERS:

a)	Make	:
b)	Size of Air washer (mm)	:
c)	Air Quantity (CFM)	:
d)	Fan Size (mm)	:
e)	Static Pressure (mm WG)	:
f)	Motor (KW)	:
g)	Pump (Nos. x KW)	:
h)	Make-up water quantity (LPH)	:
i)	Size of Air Cooling Pad (mm)	:
j)	Depth of Pad (mm)	:
k)	Operating Weight (kg)	:

11.0 ELECTRICAL ACCESSORIES:

Make and Model No. for the following:

a.	Main Electrical Panel.	:
b.	Air Circuit Breaker	:

c.	Switch fuse units and HRC fuses.	:
d.	Rotary Switches	:
e.	Capacitor Banks	:
f.	Auto-transformer starter.	:
g.	Star Delta Starter	:
h.	Direct on line starter	:
i.	Contactors	:
j.	Current Transformer	:
k.	Single Phase preventers	:
l.	Push Buttons	:
m.	Ammeter & Voltmeter	:
n.	Relays	:
o.	Indication Lamps	:
p.	Cables	:
q	Wires	

5) LIST OF APPROVED MAKES FOR HVAC WORKS

	DESCRIPTION	MANUFACTURE
1.	VRV Heat Pumps/Split Units	Daikin, Toshiba/Carrier, Samsung
2.	Fan	
	(i) Inline Fans	Caryaire, Systemair, Kanalflakt,
	(ii) Propeller	Alsthom, Crompton
	(iii) Centrifugal	Air-flow, Humdian
3.	Pipes	.
	(a) M S Class (Heavy Class)	Tata Steel, GST, JINDAL, SAIL.
	(b) G.I.	Tata Steel, GST, JINDAL, SAIL
	(c) Copper	Raj Co., Mandve Tube.
4.	Air Filter	Purolator, Anfilco, American Air Filter,
5.	Vibration Isolators	Resistoflex, Dunlop.
6.	Motor	General Electric, Siemens, Marthen Motors, Crompton, Greaves, Bharat- Bijlee, ABB.
7.	Automatic Control	Siemens (Landis & Staefa), Honeywell, Johnson, Danfoss.
8.	Instrumentation/Thermostat	Siemens (Landis & Staefa), Johnson, Honeywell, Danfoss
9.	Valve and Accessories	
	- Ball Valve, Cum Strainer	Rapidcool.
	- Ball Valve	Rapidcool, Danfoss, Zoloto.
	- Butterfly Valve	Audco/ Advanc/Danfoss
	- Check Valve	Advance, Danfoss/ Honeywell
	- 2-Way/3 Way Control Valve	Siemens (Landies & Staefa), Johnson Control, Honeywell, Danfoss

	DESCRIPTION		MANUFACTURE
	-	Balancing Valve	Advance, T A Hydronics/ Honeywell, Danfoss
	-	Strainer	Maharaj Casting, D.S. Engg.
	-	Automatic Air Vent	Honeywell, Amtrol, Anergy/ Danfoss.
	-	Gauges	Fiebig, Guru.
	-	Automatic Balancing Valve	Flowcon (Sevcon), Danfoss, T.A. Hydronics.
	-	Suction Guide	Anergy/ ITT Bell & Gussett.
10	Insulation		
	-	Refrigerant Pipe	Thermaflex, Torcelene
	-	Duct (Exposed) (Expanded Polystyrene)	Beardsell, Lloyd.
	-	Duct (Insulation)	
	-	Closed Cell, closed Linked	Torcelene/ Thermaflex /A-flex
	-	Duct (Acoustic Lining)	Armacell (Arma Sound)
	-	Ex. Hood Duct	Lloyd Insulation, 3M Fire Barrier
11	G.I. sheets		TATA, SAIL, National, Jindal
12.	Diffusers, Grilles, Louvers		Mapro,Dynacraft, Caryaire,
14.	Thermostats		Honeywell, Johnson Control, Siemens (Landis & Staefa), Indicom.
15.	Motor Control Center(Electrical Panels)		KEPL, Tricolite, Advance, System Projects & Engineers.
16.	Fuse-switches, Switch Fuses and isolating switches		L&T, GE, HH-Elecon , ABB/ Siemens.
17.	Fire Damper		Caryaire, Conaire
18.	Cables		CCI, Gloster, Universal, Skyline.
19.	Control Cable		CCI, Gloster, Universal, Skyline.
20.	Single Phase Preventer		L&T, Minilec.
21.	Thermal Relays		L&T, GE, Siemens.
22.	Lamps		Siemens, L&T, EE, BCH.

	DESCRIPTION	MANUFACTURE
23.	Lugs	Dowell/Comet.
24.	Relays/Push Buttons	L & T, Siemens.
25.	Current Transformers/Ammeter/Voltmeter	Automatic Electric, Kappa.
26.	Time delay relay / limit switch	Bhartiya Cutler Hammer.
27.	Starters / Switches/Contractors	L&T, GE, Siemens.
28.	ACB / MCCB	L&T, GE, Siemens, Group Schneider, ABB.
29.	MS Conduit (ISI Mark)	AKG, BEC.
30.	MCB / Isolators	L&T, GE, MDS, Siemens, Group, Schneider.
31.	PVC insulated copper wires	Finolex, National, Skyline, Rajnigandha
32.	HDPE Pipes	Dura Line, Griplast
33.	HDPE Fitting	Dura Line, Griplast
34.	UPVC Pipe & Fitting	Suppreme, Finolex, Prince, Jain PVC Pipe
35.	Epoxy Paint	Asian, Berger, Jen
36.	Anti Corrosive Bitumastic Paint	Asian, Berger, Jen
37.	Paint Primer	Asian, Jenson Nicholson, ICI, Berger
38.	Enamle Paint	Asian, Goodlac, Nerolac
39.	Dash Fasteners	Hilti, Fisher
40.	Cooling Towers	Flow Tech, Delta, Bell,
41.	Pumps	Beacon, Kirlsoker, Xylem water
42.	Factory made Ducts	GP Spiral Ducts, Eco Duct, Zeco
43.	Round, Flat-oval , spiral Ducts	GP Spiral Ducts, Sphere
44.	AHUs, Air-Washers/Scrubbers	Edgetech, Zeco
44.	AHUs, Air-Washers Fans	Nicotra, Comefri, Kruger

6) LIST OF TENDER DRAWINGS

S. No.	Description	Drawing No.
1	HVAC LAYOUT BASEMENT PLAN	HVAC - 1
2	HVAC LAYOUT GROUND FLOOR PLAN	HVAC - 2
3	HVAC GROUND FLOOR SECTION	HVAC - 2A
4	HVAC LAYOUT FIRST FLOOR PLAN	HVAC - 3
5	HVAC FIRST FLOOR SECTION	HVAC - 3A
6	HVAC LAYOUT SECOND FLOOR PLAN	HVAC - 4
7	HVAC SECOND FLOOR SECTION	HVAC - 4A
8	HVAC LAYOUT TERRACE	HVAC - 5
9	HVAC LAYOUT MS PLATFORM FOR EX. FANS ON TERRACE	HVAC - 6
10	HVAC SCHEMATIC DIAGRAM REFRIGERANT PIPE	HVAC - 7
11	HVAC SCHEMATIC AHU & AIR WASHER CONTROL DIAGRAM	HVAC - 8

PROJECT: GURU RAMDASS LANGAR HALL AT SHI HARMINDER SHAB, AMRITSAR

TABLE-1

7) SCHEDULE OF RE□UIREMENTS & ROOM INTERNAL LOADS

Sl. No.	Room Name	Area (Sq.Mt.)	AC Area (Sq.FT)	Non-AC Area (Sq.FT)	Occupancy (Nos.)	Electrical Load		Air Qty (CFM)			Cooling Load (TR)			Remarks
						Light (W)	Equip (W)	Fresh Air	Exhaust Air	Dehum Air	Summer	Monsoon	Winter (KW)	
1.0	**BASEMENT**													
1.1	PLUMBING PLANT ROOM	308.3		3317.0				23965	28195					
1.2	LT. ROOM & HT ROOM	242.6		2610.0				18303	21533					
1.3	TRANSFORMER-ROOMS	109.3		1176.0				8247	9702					
1.4	EMPTY STORE	204.8		2204				3572	4202					
1.5	GHEE & OIL STORE	294.7		3171				5139	6046					
1.6	RECIVING OFFICE	16.3	175.0		2	175	100.0	30		629	1.0	0.6	0.5	**1.5 TR Split AC**
1.7	RECIVING Dock	93.5		1006				1630	1918					
1.8	CHEMICAL STORE	41.2		443				718	845					
1.9	DAL STORE	254.6		2739				4439	5222					
1.10	MILK STORE	64.2		691				1120	1318					
1.11	SUGAR, RICE & ATTA STORE	880.9		9478				15361	18071					
1.12	VEG STORE	97.6		1050				1702	2002					
1.13	LOCKERS ROOM	12.6		136				413	486					
1.14	DAL CLEAINING AREA	121.2		1304				2113	2486					
1.15	MASLA STORE	118.3		1273				2063	2427					

Sl. No.	Room Name	Area (Sq.Mt.)	AC Area (Sq.FT)	Non-AC Area (Sq.FT)	Occupancy (Nos.)	Electrical Load		Air Qty (CFM)			Cooling Load (TR)			Remarks
						Light (W)	Equip (W)	Fresh Air	Exhaust Air	Dehum Air	Summer	Monsoon	Winter (KW)	
1.16	ISSUUE OFFICE	6.8	73.0		2	73	100.0	15		354	0.6	0.4	0.2	**1.0 TR Split AC**
1.17	TEA STORE	46.9		505				818	963					
1.18	GENERAL STORE	111.1		1195				1937	2278					
	BASEMENT TOTAL	**3024.7**	**248.0**	**32298**	**4**	**248**	**200**	**91585**	**107694**	**983**	**1.6**	**1.1**	**0.6**	
2.0	**GROUND FLOOR**													
2.1	LANGAR HALL	1528.0	16447		1730	24671	7460	8650		60694	175.8	177.7	245.6	**12X17.0 TR C.M.AHU**
2.2	TEA LANGAR HALL	401.1	4317		400	6476	3750	2086		13749	42.7	43.7	43.8	**3X17.0 TR C.M.AHU**
2.3	WASHING AREA	702.8	7565					39976	54090	6000	27.2	46.0		**2X 25 TR TFA AHUs**
2.4	UTENSILS STORE	137.9		1484				2405	2829					
2.5	COOKED FOOD HOLDING AREA	62.1		668				1083	1274					
2.6	HOT FOOD PREP AREA	508.0	5468					27663	36076	3000	13.6	23.0		**1X 25 TR TFA AHUs**
2.7	DAL AND RICE WASHING AREA	43.7		470				2380	2800					
2.8	POT WASH&STORAGE	88.5		952				5786	6807					
2.9	UTENSILS SERVICE AREA	50.7		546				3318	3904					
2.10	HAND WASH	40.5		436				2594	3052					
2.11	HAND WASH	17.9		193				306	360					
	GROUND FOOLR TOTAL	**3581**	**33797**	**4749**	**2130**	**31146**	**11210**	**96248**	**111192**	**83442**	**259.3**	**290.4**	**289.4**	
3.0	**FIRST FOOLR**													
3.1	LANGAR HALL	1384	14897		1540	22346	5250	7700		45499	141.6	153.8	133.6	**8X22.0 TR C.M.AHU**
3.2	LANGAR HALL-2	892	9598		1000	14397	3500	5000		36182	106.3	105.1	167.8	**6X20.0 TR C.M.AHU**
3.3	PANTRY FOOD COOKED FOOD	107	1155					3510	4129					

Sl. No.	Room Name	Area (Sq.Mt.)	AC Area (Sq.FT)	Non-AC Area (Sq.FT)	Occupancy (Nos.)	Electrical Load		Air Qty (CFM)			Cooling Load (TR)			Remarks
						Light (W)	Equip (W)	Fresh Air	Exhaust Air	Dehum Air	Summer	Monsoon	Winter (KW)	
	PANTRY	40	430					1307	1537					
3.4	VEG WASH MACHINE	356	3832		16	3832	5000	3582	3000	11429	26.4	33.5	83.4	**3X15.0 TR C.M.AHU**
3.5	POT WASH	23	250					1519	1788					**1X 25 TR TFA AHUs**
3.6	SWEET PREP	204	2201					13377	15737	3000	13.6	23.0		
3.7	RAW FOOD STORE	25	273		2	273	0	510		1960	2.9	4.3	5.6	**Incloded in 3.4**
	FIRST FLOOR TOTAL	**3032**	**32636**	**0**	**2558**	**40848**	**13750**	**36505**	**26191**	**98070**	**290.8**	**319.7**	**390.4**	
4.0	**SECOND FLOOR**													
4.1	CHAPATI MAKING AREA	390.4	4202					35500	45300	3000	13.6	23.0		**1X 25 TR TFA AHUs**
4.2	DOUGH KNEADING AREA	267.2	2876					13300	19200	3000	13.6	23.0		**1X 25 TR TFA AHUs**
4.3	FLOUR SIFTING AREA	25.5	275					446	524					
4.4	FLOUR STORE AREA	45.2	486					788	927					
4.5	CHAPATI COLLECTING AREA	86.4	930					1507	1773					
4.6	READY TO COOK AREA	66.1	711		3	711	0	171		1460	2.6	2.5	4.2	**4X12.5 TR C.M.AHU**
4.7	SEWA AREA	448.5	4828		96	7242	1000	1161		13519	23.9	22.2	31.8	
4.8	LOCKERS ROOM	22.3	240		2	240	0	115		1315	2.2	2.0	4.4	
4.9	RAW FOOD AREA	64.3	692		4	692	0	125		1622	3.5	2.8	3.9	
4.10	Onion Pelling;SEWA AREA-2	142.4	1533		50	2300	0	1106		6829	13.6	14.9	22.3	**1X17.5 TR C.M.AHU**
4.11	WASHING AREA	17.9	193		2	290	0	232		483	1.3	1.8	4.1	**Includerd in 4.7**
4.12	Hall	479.7	5164		500	7746	1000	3750		26214	57.59	58.39	67.07	**4X17.5 TR C.M.AHU**
	SECOND FLOOR TOTAL	**2056**	**22130**	**0**	**657**	**19220**	**2000**	**58202**	**67724**	**57442**	**131.9**	**150.5**	**137.8**	
	GRAND TOTAL	**11693.7**	**88811.0**	**37047.0**	**5349.0**	**91462**	**27160**	**282540**	**312802**	**239937**	**683.6**	**761.7**	**818.2**	**886.0 TR. Installed Capacity**

PROJECT : GURU RAMDAS LANGAR HALL AT AMRITSAR

TABLE- 2

8) DETAIL OF VENTILATION & EXHAUST SYSTEM

S.NO.	AREA DESCRIPTION	Area	Height	Air	Exhaust	Exhaust Machine	Fresh Air	Air Washer		TFA AHU	Centrifugal Exhaust Fan		Propeller/ Inline Fan
		(Sqft)	(Feet)	Change / Hours	CFM	CFM	CFM	No	CFM	CFM	No	CFM	
1.0	**Basement :**												
1.1	PLUMBING PLANT ROOM	3317	17	30	28195		23965	**AW..B-4**	**24000**		**Ex.F..B-4**	**28,200**	
1.2	LT PANEL & HT ROOM	2610	16.5	30	21533		18303	**AW..B-3**	**24000**		**Ex.F..B-3**	**18,000**	
1.3	TRANSFORMER ROOMS	1176	16.5	30	9702		8247						6 X 380Dia .(1650 CFM EACH)
1.4	EMPTY STORE	2204	14.3	8	4202		3572						2 X 380Dia .(2100 CFM EACH)
1.5	GHEE & OIL STORE	3171	14.3	10	7558		6424						5X 380Dia (1300 CFM EACH)
1.6	RECEIVING OFFICE	175	14.3	0.7	29		25						
1.7	RECIVING Dock	1006	14.3	8	1918		1630						
1.8	CHEMICAL STORE	443	14.3	8	845		718						
1.9	DAL STORE	2739	14.3	8	5222		4439						
1.10	MILK STORE	691	14.3	8	1318		1120						
1.12	SUGER , RISE & ATTA STORE	9470	14.3	8	18056		15348						
1.12	VEG. STORE	1050	14.3	8	2002		1702						
1.13	LOCKERS ROOM	136	14.3	15	486		413						
1.14	DAL CLEAINING AREA	1304	14.3	8	2486		2113						

S.NO.	AREA DESCRIPTION	Area	Height	Air	Exhaust	Exhaust Machine	Fresh Air	Air Washer		TFA AHU	Centrifugal Exhaust Fan		Propeller/ Inline Fan
		(Sqft)	(Feet)	Change / Hours	CFM	CFM	CFM	No	CFM	CFM	No	CFM	
1.15	MASALA STORE	1273	14.3	8	2427		2063						
1.17	TEA STORE	505	14.3	8	963		818						
1.18	GENERAL STORE	1195	14.3	8	2278		1937						
	TOTAL	**25362**			**49791**		**42322**	**AW..B-2**	**29500**		**Ex.F..B-2**	**10,350**	
								AW..B-1	**24000**		**Ex.F..B-1**	**29,000**	
TOTAL OF BASEMENT		**32465**			**109220**		**92837**						
2.0	**GROUND FLOOR**												
2.3	WASHING AREA	7565	14.3	30	46790	7300	33771						
2.4	UTENSILS STORE	1484	14.3	8	2829		2405						
2.9	UTENSILS SERVE AREA	546	14.3	30	3904		3318						
2.10	HAND WASH	436	14.3	30	3117		2650						
	TOTAL	**10031**			**56641**	**7300**	**42144**	**AW..G-5**	**15000**	**G-2**	**Ex.G-5**	**12,000**	
								AW..G6	**15000**	**G-3**	**Ex.G-6**	**7,300**	
								AW..G7	**18000**		**Ex.G-7**	**17,000**	
											Ex.G-8	**26,000**	
2.5	COOKED FOOD HOLDING AREA	668	14.3	8	1274		1083						
2.6	HOT FOOD PREP AREA	5468	14.3			36074	27663						
2.7	DAL & RICE WAHING AREA	470	14.3	25	2800		2380						
2.8	POT WASH & STORAGE	952	14.3	30	6807		5786						

S.NO.	AREA DESCRIPTION	Area	Height	Air	Exhaust	Exhaust Machine	Fresh Air	Air Washer		TFA AHU	Centrifugal Exhaust Fan		Propeller/ Inline Fan
		(Sqft)	(Feet)	Change / Hours	CFM	CFM	CFM	No	CFM	CFM	No	CFM	
	TOTAL	**7558**			**10881**	**36074**	**36912**	**AW..G-1**	**8000**	**G-1**	**Ex.G-1**	**12,000**	Exhaut Hood
								AW..G-2	**12000**		**Ex.G-2**	**19,000**	Exhaut Hood
								AW..G-3	**18000**		**Ex.G-3**	**10,000**	Exhaut Hood
								AW..G-4	**8000**		**Ex.G-4**	**9,000**	Gen. Exhaust
2.2	**TEE LUNGER-PREPRATION**				**8000**						**Ex.G-9**	**8,000**	
3.0	**FIRST FLOOR**												
3.3	PANTRY FOOD COOKED FOOD	1155	14.3	15	4129		3510						
	PANTRY	430	14.3	15	1537		1307						
3.5	POT WASH	250	14.3	30	1788		1519						
3.6	SWEET PREP	2201	14.3	30	10107	5630	11893						
	TOTAL	**4036**			**17561**	**5630**	**18228**	**AW.F-1**	**17,000**	**F-1**	**Ex.F-3**	**17,000**	
											Ex.F-2	**6,000**	Exhaut Hood
3.4	VEG WASH MAHINE	3852	14.3			3000							
3.7	RAW FOOD STORE	23	14.3	8	44		37						
	TOTAL	**3875**			**44**	**3000**	**37**				**Ex.F-1**	**3,000**	
4.0	**SECOND FLOOR**												
4.1	CHAPATI MAKING AREA	4202	14.3			45314	35517						
4.2	DOUGH KNEADING AREA	2876	14.3			19200	13320						

S.NO.	AREA DESCRIPTION	Area	Height	Air	Exhaust	Exhaust Machine	Fresh Air	Air Washer		TFA AHU	Centrifugal Exhaust Fan		Propeller/ Inline Fan
		(Sqft)	(Feet)	Change / Hours	CFM	CFM	CFM	No	CFM	CFM	No	CFM	
4.3	FLOUR SIFTING AREA	275	14.3	8	524		446						
4.4	FLOOR STORE AREA	486	14.3	8	927		788						
4.5	CHAPATI COLLECTING AREA	930	14.3	8	1773		1507						
	TOTAL	**8769**			**3224**	**64514**	**51577**	**AW..S-1**	**16,000**	**S-1**	**Ex.S-1**	**5,100**	Exhaut Hood
								AW..S-2	**26,000**		**Ex.S-2**	**8,200**	Exhaut Hood
								AW..S-3	**10,000**		**Ex.S-3**	**8,000**	Exhaut Hood
											Ex.S-4	**30,000**	Exhaut Hood
											Ex.S-5	**8,200**	
4.8	LOCKER ROOM	240	14.3	8	458		0				**Ex.S-6**	**500**	**Inline Fan**
4.10	ONION PELLING	1553	14.3	4	1481		0				**Ex.S-7**	**1,500**	**Inline Fan**
4.1	WASHING AREA	193	14.3	20	920		0				**Ex.S-8**	**1,000**	**Inline Fan**
	TOTAL	**1986**			**2858**		**0**						

PROJECT : GURU RAM DAS LANGAR HALL, AMRITSAR

TABLE-3

9) DETAILS OF AC DX SYSTEM

S.NO	AREAS	TR (Summer)	TR (Monsoon)	TR (Selected)	Air Quantity (CFM/E)	INDOOR UNIT NO.	INDOOR UNITS	OUTDOOR UNITS	Remarks
1.0	**Basement**								
1.6	**Receviing**	1.0	0.6	1.5			High Wall	Split Unit	
1.16	**Issue Office**	0.6	0.4	1.0			High Wall	Split Unit	
	Total	**1.6**	**1.0**	**2.5**					
2.0	**Ground Floor**								
2.1	LANGAR HALL	175.8	177.7	204.0	6000	4 to 15	12Nosx 17.0 TR C/M UNIT	6Nosx 34.0 TR Each	6 Nos. Circuits
2.2	TEA LANGAR HALL	*42.7*	43.7	51.0	6000	1 to 3	3Nosx 17.0 TR C/M UNIT	3Nosx 17.0 TR C/M UNIT	3 Nos. Circuits
	Total	**218.5**	**221.4**	**255.0**					
3.0	**First Floor**								
3.1	LANGAR HALL - 1	141.6	153.8	176.0	8000	16 to 23	8Nosx 22.0 TR C/M UNIT	4Nosx 44.0 TR Each	4 Nos. Circuits
3.2	LANGAR HALL - 2	106.3	105.1	120.0	7000	24 to 29	6Nosx 20.0 TR C/M UNIT	3Nosx 40.0 TR Each	3 Nos. Circuits
3.4	VEG.WASH MACHINE AREA	26.4	33.5	45.0	5000.0	30 to 32	3Nosx 15.0 TR C/M UNIT	1Nosx 45.0 TR Each	1 Nos. Circuits
3.7	RAW STORE	2.9	4.3						
	Total	**277.2**	**296.7**	**341.0**					

S.NO	AREAS	TR (Summer)	TR (Monsoon)	TR (Selected)	Air Quantity (CFM/E)	INDOOR UNIT NO.	INDOOR UNITS	OUTDOOR UNITS	Remarks
4.0	**Second Floor**								
4.6	READY TO COOK AREA	2.6	2.5						
4.7	SEVA AREA	23.9	22.2						
4.8	LOCKER ROOM	2.2	2.0						
4.9	RAW FOOD AREA	3.5	2.9						
4.11	WASHING AREA	1.3	1.8						
	Total	**33.5**	**31.4**	**50**	**5000**	**34 to 37**	**4Nosx 12.5 TR C/M UNIT**	**2Nosx 25.0 TR Each**	**2 Nos. Circuits**
4.10	ONION PELLING AREA	13.6	14.9	17.5	7000	33	1Nox 17.5 TR C/M UNIT	1Nox 17.5 TR	1 No. Circuit
4.12	HALL	57.6	58.4	70.0	7000	38 to 41	4Nosx 17.5 TR C/M UNIT	2Nosx 35.0 TR Each	2 Nos. Circuits
	Total	**138.2**	**136.1**	**137.5**					
	GRAND TOTAL	**635.5**	**655.2**	**736.0**					
	Say			**740.0**					

PROJECT : GURU RAM DAS LANGAR HALL, AMRITSAR
TABLE-4
10) SCHEDULE OF AHUs

AHU NO.	Unit Locarion	S.NO	AREAS	AC Area	Air Qty(CFM)		Cooling Load (TR)		Air Quantity Selected	TR (Selected)	ADP	DX-Cooling Coil	CW-Cooling Coil	Static Pressure	Fan Motor	Remarks	
				Sq.Ft.	Fresh Air	Dehum. Air	Summer	Monsoon	CFM		^{0} F	Rows	Rows	mm wg.	KW	Indoor Units	Out Door Units
4 To 15	Ground Floor	2.1	LANGAR HALL	16447	720	5057	14.7	14.8	6000	17.0	54	6		40	3.7	12 Nos C/S Unit	6Nosx 34.0 TR Each
1 To 3	Ground Floor	2.2	TEA LANGAR HALL	4317	695	4583	*14.2*	14.6	6000	17.0	54	6		40	3.7	3 Nos. C/S Unit	3Nosx 17.0 TR Each
TFA G-2 & G-3	Terrace	2.3	WASHING AREA		3000	3000	13.6	23.0	3000	25.0	60		8	50	2.2	2Nos. F/S Unit	25.0 TR Chilled Water
G-1	Terrace	2.6	HOT FOOD PREPERATION AREA		3000	3000	13.6	23.0	3000	25.0	60		8	50	2.2	1No. F/S Unit	25.0 TR Chilled Water
16 To 23	First Floor	3.1	LANGAR HALL - 1	14,897	962	5687	17.7	19.2	7000	22.0	54	6		40	3.7	8 Nos. C/S Unit	4Nosx 44.0 TR Each
24 To 29	First Floor	3.2	LANGAR HALL - 2	9598	833	6030	17.7	17.5	7000	20.0	53	6		40	3.7	6 Nos. C/S Unit	3Nosx 40.0 TR Each
		3.4	VEG.WASH MACHINE AREA	3832	3582	11429	26.4	33.5									
		3.7	RAW STORE	273	510	1960	2.9	4.3									
30 To 32	First Floor		Total	4105	1364	4463	9.77	12.6	5000	15.0	57	6		40.0	2.2	3 Nos. C/S Unit	1Nox 45.0 TR
TFA F-1	Terrace	3.6	SWEET PREPERATION AREA		3000	3000	13.6	23.0	3000	25.0	60		8	50	2.2	1No. F/S Unit	25.0 TR Chilled Water

AHU NO.	Unit Locarion	S.NO	AREAS	AC Area	Air Qty(CFM)		Cooling Load (TR)		Air Quantity Selected	TR (Selected)	ADP	DX-Cooling Coil	CW-Cooling Coil	Static Pressure	Fan Motor	Remarks	
TFA S-1	Terrace	4.1	CHAPATI MAKING AREA	4202	3000	3000	13.6	23.0	3000	25.0	60		8	50	2.2	1No. F/S Unit	25.0 TR Chilled Water
TFA S-2	Terrace	4.2	DOUGH KNEADING AREA	2876	3000	3000	13.6	23.0	3000	25.0	60		8	50	2.2	1No. F/S Unit	25.0 TR Chilled Water
		4.6	READY TO COOK AR	711	171	1460	2.6	2.5									
		4.7	SEVA AREA	4828	1161	13519	23.9	22.2									
		4.8	LOCKER ROOM	240	115	1315	2.2	2.0									
		4.9	RAW FOOD AREA	692	125	1622	3.5	2.9									
		4.11	WASHING AREA	193	232	483	1.3	1.8									
34 To 37	Second Floor		Total	6664	451	4600	8.4	7.9	5000	12.5	57	6		40	2.2	4 Nos. C/S Unit	2Nosx 25.0 TR
33	Second Floor	4.10	ONION PELLING ARE	1533	1106	6829	13.6	14.9	7000	17.5	57	6		40.0	3.7	1 No. C/S Unit	1Nox 17.5 TR
38 To 41	Second Floor	4.12	HALL	5164	938	6554	14.4	14.6	7000	17.5	57	6		40.0	3.7	4 Nos. C/S Unit	2Nosx 35.0 TR Each

PROJECT : GURU RAMDAS LANGAR HALL AT SHI HARMINDER SHAB, AMRITSAR

TABLE- 5

11) SCHEDULE OF AIR WASHERS

Air Washer No.	Location of Air Washer	S.NO.	AREA DESCRIPTION	Area	Air Washer		Cooling Coil			Pump	Fan		Remarks
				(Sqft)	CFM	Face Area (Sq. Ft.)	TR	Rows deep	GPM	HP	SP (mm wg)	Motor (HP)	
		1.0	**Basement :**										
AW.B-4	Terrace	1.1	PLUMBING PLANT ROOM	3317	**24000**	**48**				**1.0**	**50**	**15.0**	
		1.2	LT PANEL & HT ROOM	2610									
		1.3	TRANSFORMER ROOMS	1176									
AW.B-3	Terrace		Total	3786	**24000**	**48**				**1.0**	**50**	**15.0**	
		1.4	EMPTY STORE	2204									
		1.5	GHEE & OIL STORE	3171									
		1.6	RECEIVING OFFICE	175									
		1.7	RECIVING Dock	1006									
		1.8	CHEMICAL STORE	443									
		1.9	DAL STORE	2739									
		1.10	MILK STORE	691									
		1.12	SUGER , RISE & ATTA STORE	9470									

Air Washer No.	Location of Air Washer	S.NO.	AREA DESCRIPTION	Area	Air Washer		Cooling Coil			Pump	Fan		Remarks
				(Sqft)	CFM	Face Area (Sq. Ft.)	TR	Rows deep	GPM	HP	SP (mm wg)	Motor (HP)	
		1.12	VEG. STORE	1050									
		1.13	LOCKERS ROOM	136									
		1.14	DAL CLEAINING AREA	1304									
		1.15	MASALA STORE	1273									
		1.17	TEA STORE	505									
		1.18	GENERAL STORE	1195									
AW..B-2	Terrace		**TOTAL**	**25362**	**29500**	**59**				**1.0**	**50**	**20.0**	
AW..B-1	Terrace				**24000**	**48**				**1.0**	**50**	**15.0**	
		2.0	**GROUND FLOOR**										
		2.3	WASHING AREA	7565									
		2.4	UTENSILS STORE	1484									
		2.9	UTENSILS SERVE AREA	546									
		2.10	HAND WASH	436									
AW..G-5	Terrace		**TOTAL**	**10031**	**15000**	**30**	**-**	**-**	**-**	**0.5**	**50**	**10.0**	
AW..G-6	Terrace				**15000**	**30**	**-**	**-**	**-**	**0.5**	**50**	**10.0**	
AW..G-7	Terrace				**18000**	**36**	**-**	**-**	**-**	**0.5**	**50**	**12.5**	
		2.5	COOKED FOOD HOLDING AREA	668									
		2.6	HOT FOOD PREP AREA	5468									

Air Washer No.	Location of Air Washer	S.NO.	AREA DESCRIPTION	Area	Air Washer		Cooling Coil			Pump	Fan		Remarks
				(Sqft)	CFM	Face Area (Sq. Ft.)	TR	Rows deep	GPM	HP	SP (mm wg)	Motor (HP)	
		2.7	DAL & RICE WAHING AREA	470									
		2.8	POT WASH & STORAGE	952									
AW..G-1	Terrace		**TOTAL**	**7558**	**8000**	**16**	**30**	**4**	**78**	**0.25**	**60**	**5.0**	**CW.Coil**
AW..G-2	Terrace				**12000**	**24**	**24**	**4**	**114**	**0.25**	**60**	**7.5**	**CW.Coil**
AW..G-3	Terrace				**18000**	**36**	**66**	**4**	**172**	**0.5**	**60**	**10.0**	**CW.Coil**
AW..G-4	Terrace				**8000**	**16**	**-**	**-**	**-**	**0.25**	**50**	**5.0**	**CW.Coil**
		3.0	**FIRST FLOOR**										
		3.3	PANTRY FOOD COOKED FOOD	1155									
			PANTRY	430									
		3.5	POT WASH	250									
		3.6	SWEET PREP	2201									
AW.F-1	Terrace		**TOTAL**	**4036**	**17000**	**34**				**0.5**	**50**	**10.0**	
		4.0	**SECOND FLOOR**										
		4.1	CHAPATI MAKING AREA	4202									
		4.2	DOUGH KNEADING AREA	2876									
		4.3	FLOUR SIFTING AREA	275									

PROJECT : GURU RAM DAS LANGAR HALL AT AMRITSAR

TABLE- 6

12) SCHEDULE OF EXHAUST FANS

Exhaust Fan No.	Location of Fan	S.NO.	AREA DESCRIPTION	Area	Type of Fan	Exhaust Fan		Motor	Propeller/ Inline Fan
				(Sqft)		CFM	SP(mmWg)	Phase/HP	
		1.0	**Basement :**						
Ex.F..B-4	Terrace	1.1	PLUMBING PLANT ROOM	3317	Centrifugal	28200	40	3/15.0	
Ex.F..B-3	Terrace	1.2	LT PANEL & HT ROOM	2610	Centrifugal	18,000	40	3/10.0	
		1.3	TRANSFORMER ROOMS	1176	Propeller	1650	5	1/ 0.24	6 X 380Dia
		1.4	EMPTY STORE	2204	Propeller	2100	5	1/ 0.24	2 X 380Dia
		1.5	GHEE & OIL STORE	3171	Propeller	1000	5	1/ 0.24	5X 380Dia
		1.6	RECEIVING OFFICE	175					
		1.7	RECIVING Dock	1006					
		1.8	CHEMICAL STORE	443					
		1.9	DAL STORE	2739					
		1.10	MILK STORE	691					
		1.12	SUGER , RISE & ATTA STORE	9470					

Exhaust Fan No.	Location of Fan	S.NO.	AREA DESCRIPTION	Area	Type of Fan	Exhaust Fan		Motor	Propeller/ Inline Fan
				(Sqft)		CFM	SP(mmWg)	Phase/HP	
		1.12	VEG. STORE	1050					
		1.13	LOCKERS ROOM	136					
		1.14	DAL CLEAINING AREA	1304					
		1.15	MASALA STORE	1273					
		1.17	TEA STORE	505					
		1.18	GENERAL STORE	1195					
Ex.F..B-2	Terrace		TOTAL	25362	Centrifugal	10,350	40	3/5.0	
Ex.F..B-1	Terrace				Centrifugal	29,000	40	3/15.0	
		2.0	**GROUND FLOOR**						
		2.3	WASHING AREA	7565		54090			
		2.4	UTENSILS STORE	1484		2829			
		2.9	UTENSILS SERVE AREA	546		3904			
		2.10	HAND WASH	436		3060			
Ex.G-5	Terrace		**TOTAL**	**10031**	Centrifugal	**12,000**	**40**	3/7.5	
Ex.G-6	Terrace				Centrifugal	**7,300**	**40**	3/5.0	Machine Exhaust
Ex.G-7	Terrace				Centrifugal	**17,000**	**40**	3/10.0	
Ex.G-8	Terrace				Centrifugal	**26,000**	**40**	3/12.5	

Exhaust Fan No.	Location of Fan	S.NO.	AREA DESCRIPTION	Area	Type of Fan	Exhaust Fan		Motor	Propeller/ Inline Fan
				(Sqft)		CFM	SP(mmWg)	Phase/HP	
		2.5	COOKED FOOD HOLDING AREA	668		1274			
		2.6	HOT FOOD PREP AREA	5468		36076			
		2.7	DAL & RICE WAHING AREA	470		2800			
		2.8	POT WASH & STORAGE	952		6807			
Ex.G-1	Terrace		**TOTAL**	**7558**	Centrifugal	**12,000**	**65**	3/10.0	Exhaust Hood
Ex.G-2	Terrace				Centrifugal	**19,000**	**65**	3/15.0	Exhaust Hood
Ex.G-3	Terrace				Centrifugal	**10,000**	**65**	3/7.5	Exhaust Hood
Ex.G-4	Terrace				Centrifugal	**9,000**	**40**	3/5.0	General Exhaust
Ex.G-9	Terrace	**2.2**	**TEE LUNGER-PREPRATION**	**4317**	Centrifugal	**8000**	**30**	3/5.0	General Exhaust
		3.0	**FIRST FLOOR**						
		3.3	PANTRY FOOD COOKED FOOD	1155		4129			
			PANTRY	430		1537			
		3.5	POT WASH	250		1788			
		3.6	SWEET PREP	2201		15737			Machine Exhaust
Ex.F-3	Terrace		**TOTAL**	**4036**		**17,000**	**35**	3/7.5	General Exhaust
Ex.F-2	Terrace					**6,000**	**65**	3/5.0	Exhaust Hood

Air Washer No.	Location of Air Washer	S.NO.	AREA DESCRIPTION	Area	Air Washer		Cooling Coil			Pump	Fan		Remarks
				(Sqft)	CFM	Face Area (Sq. Ft.)	TR	Rows deep	GPM	HP	SP (mm wg)	Motor (HP)	
		4.4	FLOOR STORE AREA	486									
		4.5	CHAPATI COLLECTING AREA	930									
AW..S-1	Terrace				**16000**	**32**	**61**	**4**	**159**	**0.5**	**60**	**10.0**	**CW.Coil**
AW..S-2	Terrace		**TOTAL**	**8769**	**26000**	**52**	**96**	**4**	**250**	**1.0**	**60**	**15.0**	**CW.Coil**
AW..S-3	Terrace				**10000**	**20**	**30**	**4**	**78**	**0.5**	**60**	**7.5**	**CW.Coil**

Exhaust Fan No.	Location of Fan	S.NO.	AREA DESCRIPTION	Area	Type of Fan	Exhaust Fan		Motor	Propeller/ Inline Fan
				(Sqft)		CFM	SP(mmWg)	Phase/HP	
Ex.F-1		3.4	VEG WASH MAHINE	3852		3000	40	3/2.0	Machine Exhaust
		4.0	**SECOND FLOOR**						
		4.1	CHAPATI MAKING AREA	4202		45300			
		4.2	DOUGH KNEADING AREA	2876		19200			
		4.3	FLOUR SIFTING AREA	275		524			
		4.4	FLOOR STORE AREA	486		927			
		4.5	CHAPATI COLLECTING AREA	930		1773			
						22424			
Ex.S-1	Terrace		**TOTAL**	**8769**	Centrifugal	**5,100**	**65**	3/5.0	Exhaust Hood
Ex.S-2	Terrace				Centrifugal	**8,200**	**65**	3/7.5	Exhaust Hood
Ex.S-3	Terrace				Centrifugal	**8,000**	**65**	3/7.5.0	Exhaust Hood
Ex.S-4	Terrace				Centrifugal	**30,000**	**65**	3/20.0	Exhaust Hood
Ex.S-5	Terrace				Centrifugal	**8,200**	**35**	3/5.0	
Ex.S-6		4.8	LOCKER ROOM	240		**500**	8	1/ 0.4	**Inline Fan**
Ex.S-7		4.10	ONION PELLING	1553		**1,500**	4	1/ 0.7	**Inline Fan**
Ex.S-8		4.1	WASHING AREA	193		**1,000**	10	1/ 0.7	**Inline Fan**

PROJECT: GURU RAM DAS LANGAR HALL, AT AMRITSAR

TABLE-7

13) DATA POINT SUMMARY

S.NO.	ITEM	QTY	AI	AO	DI	DO	Field Devices
1	**Heat Pumps**	**2**					
a	HEAT PUMP RUN STATUS				2		Potential free contact
b	HEAT PUMP TRIP ALARM				2		Potential free contact
c	CHW SUPPLY TEMPERATURE		2				Immersion type temp sensor on each chiller outlet.
d	COMMON CHW HEADER SUPPLY AND RETURN TEMP SENSOR		2				Immersion type temp sensor
e	CDW SUPPLY TEMPERATURE		2				Immersion type temp sensor on each condenser.
g	COMMON CDW HEADER SUPPLY AND RETURN TEMP SENSOR		2				Immersion type temp sensor
e	COMMON HEADER RETURN PRESSURE		1				Pressure Transmitter
g	COMMON HEADER RETURN FLOW		1				Flow Transmitter
2	**CHILLED WATER PUMPS**	**3**					
a	PUMP RUN STATUS				3		Current Relay
b	PRESSURE		1				Pressure sensor
3	**HOT (CONDENSER)WATER PUMPS**	**3**					
a	PUMP RUN STATUS				3		Current Relay
b	PRESSURE		1				Pressure sensor
c	COMMON HEADER SUPPLY AND RETURN TEMP. SENSOR.		2				Immersion type temp. sensor.
4	**HOT WATER PHE TEMPERATURE**	**2**					
a	TEMP. SENSOR.		4				Immersion type temp sensor on each In & outlet of PHE
5.0	**CONDENSOR WATER PUMPS -Cold Stores**	**2**					
a	START /STOP COMMAND					2	Relay Output
b	PUMP RUN STATUS				2		Current Relay
6.0	**COOLING TOWERS-Cold Stores**	**2**					
a	START /STOP COMMAND					2	Relay Output
b	FAN RUN STATUS				2		Current Relay
c	SUMP HIGH/LOW				4		Level Switches
7.0	**OUTSIDE AIR CONDITIONS**						
a	OUTSIDE AIR TEMPERATURE		1				O/A Temperature Sensor
b	OUTSIDE AIR HUMIDITY		1				O/A Humidity Sensor
8.0	**AIR WASHERS**	**16**					
a	FAN START/STOP COMAND					16	Relay Output
b	FAN RUN STATUS				16		Current Relay
c	PUMP START /STOP					16	Relay Output
d	PUMP RUN STATUS				16		Current Relay
e	AUTO-MANUAL SWITCH STATUS				16		Potential free contact

S.NO.	ITEM	QTY	AI	AO	DI	DO	Field Devices
9.0	**TFA AIR HANDLING UNITS (COOLING)**	**6**					
a	FAN START /STOP COMMAND					6	Relay Output
b	AIR FLOW STATUS				6		Current Relay
c	FILTER STATUS				6		Differential pressure switch
d	AUTO-MANUAL SWITCH STATUS				6		Potential free contact
e	SUPPLY AIR TEMPERATURE		6				Duct type temperature sensor
f	SIGNAL TO 3 WAY VALVE (CHW)			6			Modulating Valve (Globe Type)
10.0	**EXHAUST AIR FANS**	**22**					
a	SUPPLY FAN START /STOP COMMAND					22	Relay Output
b	AIR FLOW STATUS				22		Current Relay
c	AUTO-MANUAL SWITCH STATUS FOR				22		Potential free contact
d	STATUS ONLY FOR FANS				22		Current Relay
11.0	**DOMESTIC WATER SUPPLY/RETURN**	**4**	4				Immersion Temperature Sensor
12.0	**WATER TANK LEVEL SENSOR**	**5**	5				Level Sensor
13.0	**COLD ROOM TEMPERATURES(-20 deg C)**	**7**	7				Temperature Sensor for Cold
14.0	**SUMP PUMP HI LEVEL**	**6**			6		Relay to be provided
15.0	**AIR WASHERS**	**41**					
a	AHUs (VRV System)				41		Current Relay
	TOTAL		**42**	**6**	**156**	**64**	

Note: 41 Nos. AHUs are part of VRF System hence the signals of VRF System to be take to BAS for Operation and montoring by inter face card.

PROJECT : CONSTRUCTION/EXTENSIN OF GURU RAMDAS LANGAR HALL AT SRI HARMINDER SHAB, AMRITSAR

14) SUMMARY OF COST FOR HVAC WORKS

S. NO.	DESCRIPTION	AMOUNT (Rs.)
1.0		
A)	SUPPLY OF EQUIPMENT :	
B)	INSTALLATION OF EQUIPMENT AND SUPPLY & INSTALLATION OF EQUIPMENT:	
C)	AIR DISTRIBUTION:	
D)	INSULATION:	
E)	CONDENSER WATER PIPING	
F)	ELECTRICAL:	
G)	BAS:	
	TOTAL OF 1.0	
2.0	Comprehencive AMC After the expiring of defect liability period.Including gas charging incae of leakage, repair of all types required for full running of the system, including all spares etc.excluding filters. The contractor shall give a bank gaurantee equivalaent to the value of the entire AMC contract or minimum Rs 40 lacs whichever is higher.	
2.1	Ist Year	
2.2	IInd Year	
2.3	IIIrd Year	
2.4	IVth Year	
2.4	Vth Year	
	TOTAL OF 2.0	

PROJECT : CONSTRUCTION/EXTENSION OF GURU RAMDAS LANGAR HALL AT SRI HARMINDER SHAB, AMRITSAR

14 A) BILL OF QUANTITIES FOR HVAC WORKS

PART-1 SUPPLLY

S.No.	Description	Unit	Qty	Rate (Rs)	Amount (Rs)
1.0	**VRV SYSTEM :**				
	Supply of high energy efficient, low noise. Heat pumps to provide automatic cooling/heating, Variable Refrigerant Volume system.				
	Units shall be suitable to operate at 4 ˚C - 46˚C ambient conditions.				
	Refrigerant : R-410A The required capacity of out door and indoor units shall be as follows to meet the above requirements. Supply of high energy efficient, low noise Indoor Units. Room sound level shall not exceed 35 DB at 1.0 meter distance from the unit. The Selection of Units shall be on the follows conditinos:				
	a) Indoor Temperature : 77 ^{U} F DB, 66 ^{U} F WB. b) Out door Temperature : 113 ^{0} F DB.				
1.1	**Out Door Units**				
	2.1 Langar Hall (G.Fl.)				
	- 34.0 TR,	Set	6		
	2.2 Tea Langar Hall (G.Fl.)				
	- 17.0 TR,	Set	3		
	2.3 Washing Area (G.Fl.)				
	- 25.0 TR,	Set	R.O		
	2.6 Hot Food Preperation Area (G.Fl.)				
	- 25.0 TR,	Set	R.O.		
	3.1 Langar Hall-1 (F.Fl.)				
	- 44.0 TR,	Set	4		
	3.2 Langar Hall-2 (F.Fl.)				
	- 40.0 TR,	Set	3		
	3.4 Veg. Wash Machine Area(F.Fl.)				
	- 45.0 TR,	Set	1		
	3.6 Sweet Preperation(F.Fl.)				
	- 25.0 TR,	Set	R.O		
	4.1 Chapati Making Area(S.Fl.)				
	- 25.0 TR,	Set	R.O		
	4.2 Dough Kneding Area(S.Fl.)				
	- 25.0 TR,	Set	R.O		

S.No.	Description	Unit	Qty	Rate (Rs)	Amount (Rs)
	4.6-11 Ready to Cook & Wasing Area (S.Fl.)				
	- 25.0 TR,	Set	2		
	4.1 Onion Pelling Area Area (S.Fl.)				
	- 17.5 TR,	Set	1		
	4.1 Hall (S.Fl.)				
	- 35.0 TR,	Set	2		
1.2	Supply of suitable referigerant Y Joints for copper piping	Lot	LS		
1.3	Supply of suitable AHU/TFA Connecting Kits with electronic parts, Expansion Valves & Corded Remote	Lot	LS		
1.4	Supply of Centralised Controller capable to control the AHUs/ODUs. With the features like weekly scheduling etc.	Lot	1		
	TOTAL SUPPLY OF EQUIPMENT CARRIED OVER TO SUMMARY				

Notes: 1. Rates shall be included the costum duty
2. Csustm duit, Insurance,all other expensis to be added
3. Converation rate of currency to indicated.

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
B)	**Supply & INSTALLATION OF EQUIPMENT :**				
1.0	**VRV SYSTEM:**				
	Receiving,shifting, installing, testing & commissioning of units including gas top, inter connection between indoor & outdoor units, control wiring including fixing of thermostats, providing suitable vibration isolation pads, Self leveling type ODU body coloured power coated MS stand and painting etc.to complete the installation.				
1.1	**Out Door Units**				
	2.1 Langar Hall (G.Fl.)				
	- 34.0 TR,	Set	6		
	2.2 Tea Langar Hall (G.Fl.)				
	- 17.0 TR,	Set	3		
	2.3 Washing Area (G.Fl.)				
	- 25.0 TR,	Set	R.O		
	2.6 Hot Food Preperation Area (G.Fl.)				
	- 25.0 TR,	Set	R.O		
	3.1 Langar Hall-1 (F.Fl.)				
	- 44.0 TR,	Set	4		
	3.2 Langar Hall-2 (F.Fl.)				
	- 40.0 TR,	Set	3		
	3.4 Veg. Wash Machine Area(F.Fl.)				
	- 45.0 TR,	Set	1		
	3.6 Sweet Preperation(F.Fl.)				
	- 25.0 TR,	Set	R.O		
	4.1 Chapati Making Area(S.Fl.)				
	- 25.0 TR,	Set	R.O		
	4.2 Dough Kneding Area(S.Fl.)				
	- 25.0 TR,	Set	R.O		
	4.6-11 Ready to Cook & Wasing Area (S.Fl.)				
	- 25.0 TR,	Set	2		
	4.1 Onion Pelling Area Area (S.Fl.)				
	- 17.5 TR,	Set	1		
	4.1 Hall (S.Fl.)				
	- 35.0 TR,	Set	2		
1.2	Installation testing and Commissioning of suitable referigerant Y Joints for copper piping	Lot	LS		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
1.3	Installation testing and Commissioning of suitable AHU/TFA Connecting Kits with electronic parts, Expansion Valves & Corded Remote	Lot	LS		
1.4	Installation testing and Commissioning of Centralised Controller capable to control the AHUs/ODUs. With the features like weekly scheduling etc.	Lot	1		
1.3	**TREATED FRESH AIR,AIR HANDLING UNITS (FLOOR MOUNTED DOUBLE SKIN, 46mm THICK INSULATION WITH RAIN WATER CANOPY :**				
	Supply, installation, testing & commissioning of double skin air handling units with thermal break consisting of fan section with fan, motor, motor mounting arrangement belt drive system and vibration isolators, chilled water cooling coil & Aluminium volume control damper on the outlet of AHU, filter section with filters, double canvas connections,etc complete as per specifications and drawings.				
	i) AHU No. G-1 for Hot Food Prep. (G.Fl.) Air Qty 3000 CFM	No.	1		
	2) AHU No.G-2 & 3 for Washing Area (G. Fl.) Air Qty 3000 CFM	Nos.	2		
	3) AHU No.F-1 for Sweet Pre.(F.Fi.) Air Qty 3000 CFM	No.	1		
	4) AHU No.S-1 for Chapati Making Area (S.Fl.) Air Qty 3000 CFM	No.	1		
	4) AHU No.S-2 for Dough Kneding Area (S.Fl.) Air Qty 3000 CFM	No.	1		
3.0	**CEILING SUSPENDED AIR HANDLING UNITS (25mm THICK INSULATION)**				
	Supply, installation, testing & commissioning of double skin ceiling suspended horizontal mounted, horizontal discharge air handling units consisting of VCD on the outlet direct driven/belt driven fan, motor, mounting arrangements,DX cooling coil, filters with mounting arrangement enabling filter removal from bottom, stainless steel drain, the single/three phase motor etc. complete as per specification & drawings.				
	1) AHU No.1-3 for Tea Langar Hall (G.Fl.) Air Qty 6000 CFM	Nos.	3		
	2) AHU No.4-15 for Langar Hall (G.Fl.) Air Qty 6000 CFM	Nos.	12		
	3) AHU No.16-23 for Langar Hall-1(F.Fl) Air Qty 7000 CFM	Nos.	8		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	4) AHU No.24-29 for Langar Hall-2 (F.Fl.) Air Qty 7000 CFM	Nos.	6		
	5) AHU No.30-32 for Veg. Wash Area (F.Fl.) Air Qty 5000 CFM	Nos.	3		
	6) AHU No.33 for Onion Pelling Area (S.Fl.) Air Qty 7000 CFM	No.	1		
	8) AHU No.33-37 for Wash Area (S.Fl.) Air Qty 5000 CFM	Nos.	4		
	9) AHU No.38-41 for Hall (S.Fl.) Air Qty 7000 CFM	Nos.	4		
	Note : Room sound level shall not exceed 35 DB at 1.0 meter distance from the unit. The detail of units are as follows.				
1.4	Supply Installation Testing and Commissioning of Interconnecting Refrigent piping of Required sizes with closed cell crossed linked insulation of thickness of 13/19 mm thick for VRV System. Along with making suitable holes in the walls and providing PVC sleaves & filling with suitable material.				
	a. 41.3 mm O.D. (insulation :19 mm)	RM	900		
	b. 38.1 mm O.D. (insulation : 19 mm)	RM	6		
	c. 34.9 mm O.D. (insulation : 19 mm)	RM	500		
	d. 31.7 mm O.D. (insulation : 19 mm)	RM	300		
	d. 28.6 mm O.D. (insulation : 19 mm)	RM	600		
	e. 25.4 mm O.D. (insulation : 19 mm)	RM	6		
	f. 22.2 mm O.D. (insulation : 13 mm)	RM	150		
	g. 19.1 mm O.D. (insulation :13 mm)	RM	900		
	h. 15.9 mm O.D. (insulation : 13 mm)	RM	950		
	i. 12.7 mm O.D. (insulation : 13 mm)	RM	300		
	j. 9.5 mm O.D. (insulation : 13 mm)	RM	750		
	k. 6.4 mm O.D. (insulation : 13 mm)	RM	6		
	Note: Above piping quantities are indicative for comparision,Venders have to mentioned the actual piping quantities as pre there Units configrations.				
1.5	Supply Installation Testing and Commissioning of Interconnecting wiring between indoor & outdoor unit.				
a)	3.C x 1.5 Sqmm with copper shielded cable in 20 mm dia. PVC conduit between ODUs & Central Control Unit	RM	3200		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
b)	2.C x 1.5 Sqmm with copper wire in 20 mm dia. PVC conduit between indoor unit & outdoor unit	RM	3200		
	Notes: 1.Refrigerant and cable quantities are tatitive contractor has to re-check and designas per there standards to suit the layout and if required can be changed 2. Nothing extra will be paied				
2.0	**SPLIT AC SYSTEMS :**				
	Supply, installation, testing & commissioning of Air cooled Split air-conditioning units of high energy efficient, low noise. Heat pumps to provide automatic Cooling/Heating, consisting of hermitically sealed Reciprocating/Rotary compressor, indoor & outdoor units, interconnecting insulated & weather protected copper refrigerant piping, interconnecting power & control cabling/wiring for the outdoor unit. The unit shall include blowers, cooling coil, drain pan, insulated pipe, washable pre-filter, safety and automatic control cabling etc complete as per specifications & drawings.				
	Units shall be suitable to operate at 4˚C-46˚C ambient conditions.The units shall be suitable for 230 ± 6% volts, Single phase, 50 Hz, 3 wire electrical power supply.				
	The required capacity of Indoor & Out door units shall be as follows to meet the above requirements.				
2,1	**1.6 Receving Office (Basement)**				
	- Indoor: High Wall Unit				
	- 1.5 TR, (Nominal Capacity)	Set	1		
	- Wired remote control				
	1.2 Issue Office (Basement)				
	- Indoor: High Wall Unit				
	- 1.0 TR, (Nominal Capacity)	Set	1		
	- Wired remote control				
3.0	**Condensate Drain Water Pipes**				
	Supplying, laying, fixing, testing & commissioning of PVC pipes of 6 Kg/cm^2, insulation of closed cell crooed linled of thickness 6 mm and complete with all necessary fittings such as elbows, tees, reducers, along with drain trap and supports such as clamps etc,The piping can be above false ceiling, chased in the wall or burried in the ground as required at site.				
	i) 80 mm dia (PVC)	RM	20		
	ii) 65 mm dia (PVC)	RM	30		
	iii) 50 mm dia (PVC)	RM	150		
	iv) 40 mm dia (PVC)	RM	350		
	v) 32 mm dia (PVC)	RM	150		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	vi) 25 mm dia (PVC)	RM	30		
	vii) 20 mm dia (PVC)	RM	30		
4.0	**POWDER COATED COVERED GI TRAY:**				
	Supply & installation of Powder coated GI tray with Cover for exposed copper piping including supports as requiredat site of following sizes:				
	a) 400 mm wide	RM	60		
	b) 300 mm wide	RM	300		
	c) 250 mm wide	RM	50		
	a) 200 mm wide	RM	50		
	b) 150 mm wide	RM	60		
	c) 100 mm wide	RM	100		
5.0	**EXTRACTOR FANS FOR TOILETS:**				
	Supply, installation, testing, commissioning of Extractor fans of low noise , Automatic shutters, Fan consisting of motor, drive arrangement,Motor shall be with speed regulator.				
	a) 25CFM	No.	R.O.		
	b) 125CFM	No.	R.O.		
	c) 125CFM	No.	R.O.		
6.0	**INLINE FANS:**				
	Supply, installation, testing, commissioning of Inline fans of low noise easy. Fan consisting of motor, drive arrangement,Motor shall be of bearing type with overheat protection device and speed regulator.				
	a) Locker Room: 500CFM @ 8mm SP	No.	1		
	b) Onion Pelling: 1500CFM @ 10mm SP	No..	1		
	c) Washing Area: 1000CFM @ 10mm SP	No..	1		
7.0	**PROPELLER FANS:**				
	Supply, installton, testing & commissioning of propeller type fan complete with automatic shutter mechanism,anti-vibration isolators & speed regulators, motor 230 Volts, 50Hz, capacity shall be as follows				
	a) 300 Dia Fans	No.	1		
	b) 380 Dia Fans	Nos.	13		
	c) 450 Dia Fans	No.	2		
	d) 600 Dia Fans	Nos.	2		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
8.0	**CENTRIFUGAL FAN:**				
	Supply, installation, testing, commissioning of Centrifugal Fan, belt drive,forward/backward curve, with radial tip,single inlet single width, Both bearings one side out of the air stream, M.S channel common base frame for fan and motor, cushy foot mounting and damper on outletas per specification and drawing.				
	Power Supply 415/3-Phase/50Hz.				
1)	Ex FAN No.B-1, Stores (Basement) Air Qty. : 29000 CFM @ 40 mm S.P. (BC) Motor : 15.0 HP	No.	1		
2)	Ex FAN No.B-2, Stores (Basement) Air Qty. : 10350 CFM @ 40 mm S.P. (BC) Motor : 5.0 HP	No.	1		
3)	Ex FAN No.B-3, LT Room (Basement) Air Qty. : 18,000 CFM @ 40 mm S.P. (BC) Motor : 10.0 HP	No.	1		
4)	Ex FAN No.B-4, Plumbing Plant Room (Basement) Air Qty. : 28,200 CFM @ 40 mm S.P. (BC) Motor : 15.0 HP	No.	1		
5)	Ex FAN No.G-1, Hot Food Area (G,Fl.) Air Qty. : 12,000 CFM @ 65 mm S.P. (BC) Motor : 10.0 HP	No.	1		
6)	Ex FAN No.G-2, Hot Food Area (G,Fl.) Air Qty. : 19,000 CFM @ 65 mm S.P. (BC) Motor : 15.0 HP	No.	1		
7)	Ex FAN No.G-3, Hot Food Area (G,Fl.) Air Qty. : 10,000 CFM @ 65 mm S.P. (BC) Motor : 7.5 HP	No.	1		
8)	Ex FAN No.G-4, Hot Food Area (G,Fl.) Air Qty. : 9,000 CFM @ 65 mm S.P. (BC) Motor : 5.0 HP	No.	1		
9)	Ex FAN No.G-5, Wash Area (G,Fl.) Air Qty. : 12,000 CFM @ 40 mm S.P. (BC) Motor : 7.5 HP	No.	1		
10)	Ex FAN No.G-6, Wash Area (G,Fl.) Air Qty. : 7,300 CFM @ 40 mm S.P. (BC) Motor : 5.0 HP	No.	1		
11)	Ex FAN No.G-7, Wash Area (G,Fl.) Air Qty. : 17,000 CFM @ 40 mm S.P. (BC) Motor : 10.0 HP	No.	1		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	12) Ex FAN No.G-8, Wash Area (G,Fl.) Air Qty. : 26,000 CFM @ 40 mm S.P. (BC) Motor : 12.5 HP	No.	1		
	13) Ex FAN No.G-9, Tea Langar Hall (G,Fl.) Air Qty. : 8,000 CFM @ 30 mm S.P. (BC) Motor : 5.0 HP	No.	1		
	14) Ex FAN No.F-1, Veg. Wash (F,Fl.) Air Qty. : 3,000 CFM @ 40 mm S.P. (BC) Motor : 2.0 HP	No.	1		
	15) Ex FAN No.F-2, Cooked Food Area (F,Fl.) Air Qty. : 6,000 CFM @ 65 mm S.P. (BC) Motor : 5.0 HP	No.	1		
	16) Ex FAN No.F-3, Cooked Food Area (F,Fl.) Air Qty. : 17,000 CFM @ 35 mm S.P. (BC) Motor : 7.5 HP	No.	1		
	17) Ex FAN No.S-1, Chapati Making Area (S,Fl.) Air Qty. : 5,100 CFM @ 65 mm S.P. (BC) Motor : 5.0 HP	No.	1		
	18) Ex FAN No.S-2, Chapati Making Area (S,Fl.) Air Qty. : 8,200 CFM @ 65 mm S.P. (BC) Motor : 7.5 HP	No.	1		
	19) Ex FAN No.S-3, Chapati Making Area (S,Fl.) Air Qty. : 8,000 CFM @ 65 mm S.P. (BC) Motor : 7.5 HP	No.	1		
	20) Ex FAN No.S-4, Chapati Making Area (S,Fl.) Air Qty. : 30,000 CFM @ 65 mm S.P. (BC) Motor : 20.0 HP	No.	1		
	21) Ex FAN No.S-5, Chapati Making Area (S,Fl.) Air Qty. : 8,200 CFM @ 35 mm S.P. (BC) Motor : 5.0 HP	No.	1		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
9.0	**AIR WASHER (PAD TYPE):**				
	a) Supply, installation, testing & commissioning of package type double skin 25 mm thick PUF construction air washer of minimum 90% efficiency consisting of centrifugal fan, motor, mounting arrangements, metallistic vibration isolation, belt drive arrangement, VCD, distribution headers, access door, pump, stainless steel water tank, suction screen, 200mm thick impregnated cellulose paper fills, nylon prefilter, GI 'B' class piping & associated works, quick fill, makeup & drain connections with butterfly valves & float valves etc complete as per specifications & drawings. Air washer tank shall be made out of 16 gauge 304 Stainless Steel with 300 mm height to maintain water level of 250 mm				
	1) AW. No.B-1& 3, Stores (Basement) Air Qty. : 24,000 CFM @ 50 mm S.P. Motor : 15.0 HP	No.	1		
	2) AW. No.B-2, Stores (Basement) Air Qty. : 29,500 CFM @ 50 mm S.P. Motor : 20.0 HP	No.	1		
	3) AW. No.B-3, LT Panel Room (Basement) Air Qty. : 24,000 CFM @ 50 mm S.P. Motor : 15.0 HP	No.	1		
	4) AW. No.B-4, Plumbing Plant Room (Basement) Air Qty. : 24,000 CFM @ 50 mm S.P. Motor : 15.0 HP	No.	1		
	5) AW. No.G-1& 4, Hot Food Prep. (G.Fl.) Air Qty. : 8,000 CFM @ 50 mm S.P. Chilled Water Cooling Coil Motor : 5.0 HP	Nos.	2		
	6) AW. No.G-2, Hot Food Prep. (G.Fl.) Air Qty. : 12,000 CFM @ 50 mm S.P. Chilled Water Cooling Coil Motor : 7.5 HP	No.	1		
	7) AW. No.G-3, Hot Food Prep. (G.Fl.) Air Qty. : 18,000 CFM @ 50 mm S.P. Chilled Water Cooling Coil Motor : 10.0 HP	No.	1		
	8) AW. No.G-5 & 6, Washing Area. (G.Fl.) Air Qty. : 15,000 CFM @ 50 mm S.P. Motor : 10.0 HP	Nos.	2		
	9) AW. No.G-7, Washing Area. (G.Fl.) Air Qty. : 18,000 CFM @ 50 mm S.P. Motor : 12.5 HP	Nos.	2		
	10) AW. No.F-1, Washing Area. (F.Fl.) Air Qty. : 17,000 CFM @ 50 mm S.P. Motor : 10.0 HP	No.	1		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	11) AW. No.S-1, Chapati Making Area. (S.Fl.) Air Qty. : 16,000 CFM @ 50 mm S.P. Chilled Water Cooling Coil Motor : 10.0 HP	No.	1		
	12) AW. No.S-2, Chapati Making Area. (S.Fl.) Air Qty. : 26,000 CFM @ 50 mm S.P. Chilled WaterCooling Coil Motor : 15.0 HP	No.	1		
	13) AW. No.S-3, Chapati Making Area. (S.Fl.) Air Qty. : 10,000 CFM @ 50 mm S.P. Chilled Water Cooling Coil Motor : 7.5 HP	No.	1		
7.0	**COOLING TOWERS:**				
	Supplying, installing, testing & commissioning of FRP cooling tower each of the following heat rejection capacity with deep FRP water basin. PVC fillings, axial flow with statically/dynamically balanced direct driven fan TEFC induction motor, suction screen, makeup and quick fill arrangement, overflow and drain connections, suitable GI inspection ladder, Stainless steel Hardware, anti-vibration mounting etc complete as per specification.				
	a) Suitable For Cold Rooms Chiller Capacity : 50 TR CD. Water in : 36.6 ^{o}C CD. Water out : 32.2.0 ^{o}C Wet Bulb Temp. : 28.0 ^{o}C Water Flow rate : 720 USGPM	Nos.	2 (1W+1		
5.0	**CONDENSER WATER PUMP:**				
	Unloading at site, storing, handling, hoisting, Installing, testing and commissioning of end suction centrifugal pump sets with suitable electric motor for circulation of condenser water for central air-conditioning system. All pumps shall be aligned. The pump motor shall be suitable for 415 ± 10% volts, 50 cycles, 3 phase power supply suitable for parellel pump operation as per specifications. Pump performance characteristics shall be as follows:-				
	a) For Cold Stotes Water Flow rate : 150 US GPM Head : 21 MT Motor HP : 5.0 HP	Nos.	2 (1W+1		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
7.0	**SCRUBBER (SPRAY TYPE):** a) Supply, installation, testing, commissioning of double skin 25 mm thick PUFconstruction Exhaust air scrubber, water spray type, along with all necessary and vibration isolator pads complete.VCD, distribution headers, access door, pump, stainless steel water tank, suction screen, GI 'C' class piping & associated works, quick fill, makeup & drain connections with butterfly valves & float valves etc complete as per specifications & drawings.(spray shall be double bank). Air washer tank shall be made out of 16 gauge 304 Stainless Steel with 300 mm height to maintain water level of 250 mm b) Air Quantity : 5000 CFM c) No.Of Nozzles : 22 (Min.) d) Pump Motor : 2.0 HP	No.	R.O.		
	TOTAL OF INSTALLATION CARRIED OVER TO SUMMARY				

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
C)	**AIR DISTRIBUTION:**				
1.0	**SHEET METAL DUCT:**				
1.1	**Factory Fabricated.**				
	Supply, installation,testing and balancing of sheet metal ducts of following thicknesses including necessary supports, hangers, nut & bolts, gaskets, splitter dampers, vanes, making holes in the walls and making them good with suitable wooden frame in the popenings etc complete as per specifications in accordance with the approved shop drawings and as required.				
	i) 24 gauge galvanised sheet	Sqm.	4500		
	ii) 22 gauge galvanised sheet	Sqm.	5400		
	iii) 20 gauge galvanised sheet	Sqm.	2000		
	iv) 18 gauge galvanised sheet	Sqm.	1100		
1.2	**Kitchen Exhaust duct work:**				
	Supply,fabrication, installation testing and balancing of Kitchen exhaust duct shall be made out of 1.463 mm (min) carbon steel sheets. All longitudinal seams and transverse joints shall be continuously welded. Ducts shall be without any dips or traps that may collect residues. Necessary access windows shall be provided for cleaning of ducts. Access windows shall be provided at an intervals of not more than 6 meters	Sqm.	1700		
1.3	**Flexible duct work:**				
	Supply, installation,testing and balancing of flexible ducts of following sizes including necessary supports, hangers, nut & bolts, gaskets, and other accessories etc complete asrequired at site and as per the approved shop drawings.Spira uninsulated flexible duct shall be made out of 2 ply multilarered metalized aluminum polyster permanently bonded to a coated spring steel wire helix.				
	i) 100 mm dia.	RM	R.O.		
	ii) 150 mm dia.	RM	R.O.		
	iii) 200 mm dia.	RM	20		
	iv) 250 mm dia.	RM	50		
	ii) 300 mm dia.	RM	20		
	iii) 350 mm dia.	RM	R.O.		
	iv) 400 mm dia.	RM	50		
	iii) 450 mm dia.	RM	20		
	iv) 500 mm dia.	RM	50		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
1.4	**Flexible duct work (Insulated):**				
	Supply, installation,testing and balancing of flexible insulated ducts of following sizes including necessary supports, hangers, nut & bolts, gaskets, and other accessories etc complete asrequired at site and as per the approved shop drawings.Spira uninsulated flexible duct shall be made out of 2 ply multilarered metalized aluminum polyster permanently bonded to a coated spring steel wire helix. Wrapping the blanket of fiber glass insulation (24 kg/cu.mt. density) The insulation to be covered with metalized polyester vapor barrier jacket.				
	i) 100 mm dia.	RM	R.O.		
	ii) 150 mm dia.	RM	20		
	iii) 200 mm dia.	RM	170		
	iv) 250 mm dia.	RM	20		
	iii) 350 mm dia.	RM	20		
	iv) 400 mm dia.	RM	20		
	iii) 450 mm dia.	RM	20		
	iv) 500 mm dia.	RM	20		
1.5	Supply, fabrication, installation and testing of MS 'A' Class steel pipe ducts alonf with bends,hangers etc comlete withanti crossive pant and painting as required at site of following sizes				
	a) 350 dia	RMT	6		
	b) 250 dia	RMT	6		
2.0	**FLEXIBLE CONNECTION:**				
	Supply, fabrication, installation and testing of double canvas (fire proof) flexible connection constructed of fire resistant material as per drawings/specifications.	Sqm.	120		
3.0	**VOLUME CONTROL DAMPER:**				
	Supply, installation and testing of GI/Aluninium volume control dampers within ducts complete with suit-able links, levers and quadrants for manual control of volume of air flow and for proper balancing of air distribution system.				
	a) Manual(G.I.)	Sqm.			
	b) Aluninium	Sqm.	6.0		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
4.0	**FIRE DAMPERS (motorized with spring return):**				
	Supply, installation, testing and commissioning of fire damper of at least 90 minutes fire rating as per specification & approved shop drawings, complete with fusable link suitable for 90 minutes fire rating, and provision to shut off TFA AHU/Air- Washer when the damper closes.Fire damper shall be located in the supply\ return air ducts,complete with fixing fram work and painting.				
	i) Fire damper	Sqm.	18.0		
	ii) 90 minutes fusable link	Nos.	21		
	iii) Inter connection wiring between AHU/Fan/Air Washer and the damper.	Set	1.0		
5.0	**SUPPLY & RETURN / EXHAUST AIR GRILLE:**				
	Supply, installation, testing and balancing of supply/return air grilles. Each grill shall be provided with individually adjustable air distribution patterns, air distribution grid for straightening the air flow through the collar and register and removable key-operated volume control dampers along with suitable wooden frame in the wall for grilles.				
	a) Aluminium powder coated air grilles with VCD.	Sqm.	30.0		
	b) Aluminium powder coated Supply/return / exhaust air grilles without VCD.	Sqm.	30.0		
6.0	**SUPPLY AIR DIFFUSER:**				
	Supply, installation, testing and balancing of square, rectangular and round supply air diffusers. Each diffuser shall be equipped with fixed air distribution, grid, removable key operated volume control damper and antis-mudge ring where required as per the shop drawings.				
	a) Aluminium powder coated diffusers	Sqm.	10		
7.0	**RETURN AIR DIFFUSER:**				
	Supply, installation, testing and balancing of square, rectangular and round return air diffusers similar to supply air diffusers but without any volume control dampers, equipped with antismudge ring where required as per the approved shop drawings.				
	a) Aluminium powder coated diffuser	Sqm.	10		
8.0	**SLOT DIFFUSERS**				
	Supply, installation, testing & balancing of extruded aluminium powder coated slot diffusers as per approved shop drawings & samples.				

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	a) Supply air aluminium continuous slot diffusers with Hit and miss dampers.	Sqm	1.0		
	b) Return air aluminium continuous slot diffusers without damper.	Sqm	1.0		
9.0	**SUPPLY / RETURN AIR FIXED CORE LINEAR BAR GRILLES**				
	Supply, installation, testing and balancing of extruded powder coated aluminium linear grilles/diffusers along with suitable wooden frame in the wall for grilles as per approved shop drawings & approved samples.				
	a) Supply /Return air aluminium continuous grilles/diffusers with damper.	Sqm	150		
	b) Supply/ Return air aluminium continuous grilles/diffusers without damper.	Sqm	180		
10.0	**FRESH / EXHAUST AIR INTAKE LOUVER:**				
a)	Supply, installation and testing of fresh air louver of extruded aluminium section inlet louvers, bird screen, volume control damper in accordance with approved shop drawings.	Sqm	30		
b)	Supply, installation and testing of Exhaust air of extended aluminium section outlet louvers, bird screen in accordence with approved shop drawings.	Sqm	30		
	TOTAL OF AIR DISTRIBUTION CARRIED OVER TO SUMMARY	**Rs.**			
D)	**INSULATION:**				
1.0	**ACOUSTIC LINING (DUCTS):**				
	Supply, installation & testing of acoustic lining within supply and return air ducts as per specifications. All ducts shown cross hatched on the approved shop drawings shall be provided with 140-180 kg/m cu. elastomeric nitrile rubber open cell foan acoustic lining as per the specifications.				
	a) 15mm thick acoustic lining. (Ceiling Mounted AHUs/FCU's)	Sqm.	480		
	b) 25 mm thick acoustic lining (TFA-AHU's)	Sqm.	350		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
2.0	**THERMAL INSULATION:**				
	Supply, installation & testing of external thermal insulation on ducts with closed cell crossed linked factory laminated aluminum foil insulation of 30 Kg/m^3 as per the specifications & approved shop drawings.				
	a) 25mm thick insulation.Supply air Duct(TFA-Exposed)	Sqm.	300		
	b) 19mm thick insulation.Supply air Duct(TFA-in side Building)	Sqm.	380		
	c) 19mm thick insulation.Supply air Duct(In non AC Area))	Sqm.	50		
	d) 13mm thick insulation.Supply air Duct(In AC Area))	Sqm.	280		
	e) 13mm thick insulation.Return air Duct(In non AC Area))	Sqm.	10		
	d) 9mm thick insulation.Return air Duct(In AC Area))	Sqm.	10		
	e) 9mm thick insulation. Air-Washer duct	Sqm.	800		
2.1	Supply, installation, testing of external thermal insulation of expanded polystyrene 18 Kg/m^3 on exposed duct finished with cement sound plaster as per specification and approved shop drawing				
	a) 50 mm thick insulation	Sqm.	R.O.		
2.2	Supply, installation of 25 mm thick Supercera ceramic fiber blanket of 96 KgCum. Density in two layers external insulation of kitchen exhaust ducts shall be provided as per the specification.				
	a) 50 mm thick insulation (Two layers of 25 mm thick insulation) Inside The Building	Sqm	800		
3.0	**ACOUSTIC LINING (INDOOR UNIT ROOMS):**				
	Accoustic lining of walls of Indoor Unit's room with 50mm thick fibre glass insulation 32 Kg/m^3 covered with tissue paper and perforated aluminium sheet as per specifications.	Sqm.	RO		
	TOTAL OF INSULATIONCARRIED OVER TO SUMMARY	**Rs.**			

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
E)	**PIPING WORK**				
1.0	**CONDENSER WATER PIPING**				
1.1	Supply, laying, fixing, testing & commissioning of MS class 'C' chilled and hot water pipes complete with all necessary fittings such as bends, tees, reducers, flanges etc and supports such as clamps, anti-vibration hangers etc all pipes fitting/supports shall be painted of approved colour of synthetic enamel paint and direction of flow of fluid in the pipes shall be visibly marked with identifying arrows complete as per specifications & drawings.				
	i) 200 mm dia	RM	R.O.		
	ii) 150 mm dia	RM	R.O.		
	iii) 125 mm dia	RM	10		
	iv) 100 mm dia	RM	120		
	v) 80 mm dia	RM	30		
	vi) 65 mm dia	RM	36		
	vii) 50 mm dia	RM	246		
	viii) 40 mm dia	RM	24		
	ix) 32 mm dia	RM	24		
	x) 25 mm dia	RM	24		
1.2	**VALVES**				
	Supply, fixing,, testing, and commissioning in position the following valves, strainer etc. in chilled water line/hot water pipes complete with flanges etc as per specifications & drawings.				
	a) Butterfly Valves:				
	i) 200 mm dia	Nos.	R.O.		
	ii) 150 mm dia	Nos.	R.O.		
	iii) 125 mm dia	Nos.	18		
	iv) 100 mm dia	Nos.	18		
	v) 80 mm dia	Nos.	2		
	vi) 65 mm dia	Nos.	R.O.		
	vii) 50 mm dia	Nos.	10		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	b) Ball Valve				
	i) 40 mm dia	Nos.	R.O.		
	ii) 32 mm dia	Nos.	1		
	iii) 25 mm dia	Nos.	4		
	c) Dual Plate Non-Return Valve				
	i) 100 mm dia	Nos.	2		
	d) Suction Guide/'Y' strainers:				
	i) 100 mm dia	Nos.	2		
	e) Balancing Valves				
	i) 80 mm dia	Nos.	1		
	ii) 50 mm dia	Nos.	5		
	f) Pressure Gauges & Thermometers: Providing and fixing in position dial type pressure gauges & dial				
	i) Pressure Gauges	Nos.	16		
	ii) Thermometers	Nos.	12		
1.3	**FLEXIBLE COUPLING**				
	Supply, fixing, in position the following flexible coupling in pipe				
	i) 100 mm dia	Nos.	4		
	ii) 150 mm dia	Nos.	R.O.		
1.4	Fixing of Sensors in the Chilled Water and Condenser Pipe	Nos.	40		
2.0	**CHILLED WATER PIPING:**				
2.1	Supply, laying, fixing, testing & commissioning of MS class 'C'				
	a) For Internal Pipes (Insulated)				
	i) 150 mm dia (50mm Thick Insulation)	RM	60		
	ii) 125 mm dia (50mm Thick Insulation)	RM	R.O		
	iii) 100 mm dia (50mm Thick Insulation)	RM	R.O		
	iv) 80 mm dia (40mm Thick Insulation)	RM	R.O		
	v) 65 mm dia (40mm Thick Insulation)	RM	R.O		
	vi) 50 mm dia (40mm Thick Insulation)	RM	R.O		
	vii) 40 mm dia (40mm Thick Insulation)	RM	R.O		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	viii) 32 mm dia (40mm Thick Insulation)	RM	R.O		
	ix) 25 mm dia (25mm Thick Insulation)	RM	R.O		
	x) 20 mm dia (25mm Thick Insulation)	RM	R.O		
	b) For Exposed Pipes (Insulated)				
	i) 150mm dia (50mm Thick Insulation)	RM	130		
	ii) 125 mm dia (50mm Thick Insulation)	RM	18		
	iii) 100 mm dia (50mm Thick Insulation)	RM	12		
	iv) 80 mm dia (50mm Thick Insulation)	RM	36		
	v) 65 mm dia (50mm Thick Insulation)	RM	80		
	vi) 50 mm dia (50mm Thick Insulation)	RM	6		
	vii) 40 mm dia (50mm Thick Insulation)	RM	15		
	viii) 32 mm dia (50mm Thick Insulation)	RM	6		
	ix) 25 mm dia (40mm Thick Insulation)	RM	6		
	x) 20 mm dia (40mm Thick Insulation)	RM	R.O.		
2.2	**VALVES (INSULATED)**				
	Supplying, fixing, testing and commissioning in position the				
	a) Butterfly Valves:				
	i) 150 mm dia	Nos.	R.O.		
	ii) 125 mm dia	Nos	R.O.		
	iii) 100 mm dia	Nos.	2		
	iv) 80 mm dia	Nos.	8		
	v) 65 mm dia	Nos.	16		
	vi) 50 mm dia	Nos.	R.O.		
	b) <u>Ball Valves</u>				
	i) 40 mm dia	Nos.	R.O.		
	ii) 32 mm dia	Nos.	R.O.		
	iii) 25 mm dia	Nos.	R.O.		
	iv) 20 mm dia	Nos.	R.O.		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
	v) 15 mm dia	Nos.	14		
	c) Motorized 3Way valve (Modulating Type) for AHUs				
	Supply,Installation, testing, commissioning of motorized 3Way				
	i) 100 mm dia pipe connection	Nos.	1		
	ii) 80 mm dia pipe connection	Nos.	4		
	iii) 65 mm dia pipe connection	Nos.	8		
	iv) 50 mm dia pipe connection	Nos.	R.O		
	v) 40 mm dia pipe connection	Nos.	R.O		
	d) Balancing valves with Flanges:				
	i) 100 mm dia	Nos	1		
	ii) 80 mm dia	Nos.	4		
	iii) 65 mm dia	Nos.	8		
	iv) 50 mm dia	Nos.	R.O		
	v) 40 mm dia	Nos.	R.O		
	e) 'Y' strainers				
	i) 100 mm dia	Nos	1		
	ii) 80 mm dia	Nos.	4		
	iii) 65 mm dia	Nos.	8		
	iv) 50 mm dia	Nos.	R.O		
	v) 40 mm dia	Nos.	R.O		
	f) Auto Air Vent valves with Ball valves				
	i) 10 mm dia	Nos.	30		
	g) Pressure Gauges & Thermometers				
	Providing and fixing in position dial type pressure gauges & dial				
	i) Pressure Gauges	Nos.	30		
	ii) Thermometers	Nos.	30		
	TOTAL OF PIPING CARRIED OVER TO SUMMARY	**Rs.**			

S.NO.	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
F)	**ELECTRICAL:**				
1.0	**M.V. SWITCH GEARS & DISTRIBUTION BOARDS:**				
1.1	**MCC / PANEL BOARDS:** Design, manufacture, supply installation, testing and commissioning of following MCCs / panels suitable for 415 V, 3 phase, 4 wire, 50 Hz power distribution system. The panel shall be suitable for Out-door installation in IP 65 protection, free standing, floor/wall mounting, sheet metal clad, cubicle, dead front, dust and vermin proof type compartmentalised design fabricated out of 14 SWG sheet steel, complete with aluminium bus bars, separate earth bus bar to be provided through out the length of the panel. The incoming and outgoing feeders shall be accommodated in a modular multitier arrangement, adequate size cable alley, painting, earthing, numbering, danger plate etc as required as per specifications .				
1.1.1	**Panel No.1 to 8(For 40-45 TR ODUs)** **a) Incomer:** 200 A 4 Pole MCCB with overload, short ckt., earth fault, protection release, with 96 mm (0-300 A) ammeter with 3 CT and selector switch, 96 mm (0 - 500 V) Voltmeter with selector switch, phase indication light with protection fuse, on / off / trip indicating light. **b) Outgoing:** 3 nos. 40 A 4 pole MCB & 300 mA ELCB with ammeter (0-63A) with three CT & selector switch, on/off/trip indication lights with single phase preventer.	Nos.	8		
1.1.2	**Panel No.9 to 16(For 34-35 TR ODUs)** **a) Incomer:** 160 A 4 Pole MCCB with overload, short ckt., earth fault, protection release, with 96 mm (0-300 A) ammeter with 3 CT and selector switch, 96 mm (0 - 500 V) Voltmeter with selector switch, phase indication light with protection fuse, on / off / trip indicating light. **b) Outgoing:** 3 nos. 40 A 4 pole MCB & 300 mA ELCB with ammeter (0-63A) with three CT & selector switch, on/off/trip indication lights with single phase preventer.	Nos.	8		
1.1.3	**Panel No.9 to 16(For 34-35 TR ODUs)** **a) Incomer:** 100 A 4 Pole MCCB with overload, short ckt., earth fault, protection release, with 96 mm (0-300 A) ammeter with 3 CT and selector switch, 96 mm (0 - 500 V) Voltmeter with selector switch, phase indication light with protection fuse, on / off / trip indicating light. **b) Outgoing:** 2 nos. 40 A 4 pole MCB & 300 mA ELCB with ammeter (0-63A) with three CT & selector switch, on/off/trip indication lights with single phase preventer.	Nos.	8		

S.NO.	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
1.1.4	**Panel No.17 to 20(For 17.0-17.5TR ODUs)** **a) Incomer:** 63 A 4 Pole MCCB with overload, short ckt., earth fault, protection release, with 96 mm (0-300 A) ammeter with 3 CT and selector switch, 96 mm (0 - 500 V) Voltmeter with selector switch, phase indication light with protection fuse, on / off / trip indicating light. **b) Outgoing:** 1No. 40 A 4 pole MCB & 300 mA ELCB with ammeter (0-63A) with three CT & selector switch, on/off/trip indication lights with single phase preventer. 1No. 25 A 4 pole MCB & 300 mA ELCB with ammeter (0-63A) with three CT & selector switch, on/off/trip indication lights with single phase preventer.	Nos.	4		
1.1.5	**AHU Starter Panel for Ceiling Mounted AHUs** One (1) no. DOL starter (2.2/3.7/5.5KW) with MPCB (35KA), auto/manual switch, Local/Remote switch, suitable over load relay, ON/OFF push buttons, 9A AC3 duty contactor suitable for auto/manual, remote/local operation,Phase indication lights with protection fuse,on /off/trip indicating lights with fuse,single phse prevevnter, complet as required. Notes: MCCB / MPCB for starter feeders shall be provided with magnetic release only for short circuit protection. MCCB shall be (Ics=100% Icu). MCCB shall be provided with spreader terminals, phase barriers and rotary handle operating mechanism. Starter shall have provision of controlling from three locations (i.e from MCC, near motor and remote). Starter shall have sufficient number of potential free contacts, aux. contactors etc. for Building Management system / PLC control, interlocking and for remote on/off/trip indications. Switchgear ratings shown in dwg and mentioned above are selected from one particular make. The bidder shall select the ratings as per type -2 co ordination charts of the make to be used. However contactor ratings shall remain as shown in dwg. All AHU starters shall be provided with one (1) no. 6A fuse with fuse base for control circuit. All MCBs shall be rated for motor duty.	Set	47		
1.1.6	**AHU Starter Panel for TFA Floor Standing Mounted AHUs** One (1) no. DOL starter (2.2/3.7/5.5KW) with MPCB (35KA), auto/manual switch, Local/Remote switch, suitable over load relay, ON/OFF push buttons, 9A AC3 duty contactor suitable for auto/manual, remote/local operation,Phase indication lights with protection fuse,on /off / trip indicating lights with fuse,single phse prevevnter, Ammeter with selector switch and suitable ratio CTs etc complete as required. Notes: MCCB / MPCB for starter feeders shall be provided with magnetic release only for short circuit protection. MCCB shall be (Ics=100% Icu). MCCB shall be provided with spreader terminals, phase barriers and rotary handle operating mechanism. Starter shall have provision of controlling from three locations (i.e from MCC, near motor and remote).	Set	R.O.		

S.NO.	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Starter shall have sufficient number of potential free contacts, aux. contactors etc. for Building Management system / PLC control, interlocking and for remote on/off/trip indications. Switchgear ratings shown in dwg and mentioned above are selected from one particular make. The bidder shall select the ratings as per type -2 co ordination charts of the make to be used. However contactor ratings shall remain as shown in dwg. All AHU starters shall be provided with one (1) no. 6A fuse with fuse base for control circuit. All MCBs shall be rated for motor duty.				
1.2	Supply, installation, testing and commissioning of mushroom head "Emergency stop" push buttons with NC contact in sheet metal enclosure suitable for outdoor use. Push button shall have the feature Push to lock & turn to release.	Nos	R.O.		
1.3	Supply, installation, testing and commissioning of Start + Stop push button station with NO +NC contact in sheet metal enclosure suitable for outdoor use with start/stop marking.	Set	R.O.		
1.4	Supply, installation, testing and commissioning of following rating AC-3 duty load break switches with Start + Stop push buttons in outdoor type enclosures.				
a)	40A 4P with Start+Stop Push buttons	Nos.	R.O.		
b)	63A 4P with Start+Stop Push buttons	Nos.	R.O.		
c)	25A 4P with Start+Stop Push buttons	Nos.	R.O.		
d)	16A 4P with Start+Stop Push buttons	Nos.	R.O.		
e)	10A 4P with Start+Stop Push buttons	Nos.	R.O.		
f)	6A 4P with Start+Stop Push buttons	Nos.	R.O.		
1.5	Supply, installation, testing and commissioning of following rating AC-3 duty load break switches in outdoor type enclosures.				
a)	150A/4p	Nos.	R.O.		
b)	40A 4P	Nos.	R.O.		
c)	63A 4P	Nos.	R.O.		
d)	32/25A 4P	Nos.	R.O.		
e)	16A 4P	Nos.	R.O.		
f)	10A 4P	Nos.	R.O.		
g)	6A 4P	Nos.	R.O.		
2.0	**CABLES, SUB MAINS & CABLE TRAYS:**				
2.1	**1.1 KV Cabling** Supply, installation, testing & commissioning of following sizes of PVC sheathed XLPE insulated Al/copper conductor power/muticore control ARMOURED cables of 1.1 KV grade on wall or in existing cable tray /masonry ducts/hume pipe with fixing hardware etc as required.				
2.1.1	**<u>Aluminium Conductor armoured Cables :</u>**				
a)	3.5 core 240 sqmm XLPE AL cable	RM	R.O.		
b)	3 core 10 sqmm XLPE AL cable	RM	R.O.		
c)	3 core 6 sqmm XLPE AL cable	RM	R.O.		
2.1.2	**<u>Copper Conductor armoured Cables :</u>**				
a)	4 core 1.5 sqmm XLPE Cu cable	RM	R.O.		
b)	4 core 2.5 sqmm XLPE Cu cable	RM	R.O.		
c)	4 core 4 sqmm XLPE Cu cable	RM	R.O.		
d)	4 core 6 sqmm XLPE Cu cable	RM	R.O.		

S.NO.	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
e)	4 core 10 sqmm XLPE Cu cable	RM	R.O.		
f)	4 core 16 sqmm XLPE Cu cable	RM	R.O.		
g)	4 core 25 sqmm XLPE Cu cable	RM	R.O.		
h)	4 core 35 sqmm XLPE Cu cable	RM	R.O.		
2.2	Supply and making end termination with brass double compression glands for the following XLPE insulated PVC sheathed & armoured 1100 V grade cable including cost of crimping lugs/ferrules, compression glands, solder, cable sockets, insulation tape etc complete as required.				
2.2.1	**Aluminium Conductor armoured Cables :**				
a)	3.5 core 240 sqmm XLPE AL cable	Nos.	R.O.		
b)	3 core 10 sqmm XLPE AL cable	Nos.	R.O.		
c)	3 core 6 sqmm XLPE AL cable	Nos.	R.O.		
2.2.2	**Copper Conductor armoured Cables :**				
a)	4 core 10 sqmm XLPE Cu cable	Nos.	154		
b)	4 core 16 sqmm XLPE Cu cable	Nos.	R.O.		
c)	3 core 25 sqmm XLPE Cu cable	Nos.	R.O.		
d)	3 core 35 sqmm XLPE Cu cable	Nos.	R.O.		
2.3	**Cable Trays :** Supply and installation of ladder type/perforated type cable trays of the following sizes fabricated out of perforated hot dip galvanised MS sheets of minimum 2 mm thick with 75 mm flange to be installed horizontally or vertically. The cable tray shall be complete including cost of bends, elbows, cross, tees, reducers etc as per drawings/site condition and rate shall include cost of anchor fasteners, screws, nuts, bolts and misc. other fixing hardware painting of support structure etc as required. **Note :** i) Structural steel such as ISMC, ISA, flats, rods etc to be used for cable tray/bus duct support shall be included in the cost of tray. ii) The cable tray shall be factory built. Bidder shall include in his price, required numbers of Tees, Crosses, Bends, Elbows etc as required as per actual site conditions. Bidder may refer to the drawings for estimation purpose. **Perforated Type Cable Tray :**				
a)	900 mm x 50 x 50 x 2 mm thick	RM	10		
b)	600 mm x 50 x 50 x 2 mm thick	RM	10		
c)	450 mm x 40 x 40 x 2 mm thick	RM	50		
d)	300 mm x 40 x 40 x 2 mm thick	RM	50		
e)	150 mm x 25 x 25 x 2 mm thick	RM	50		
f)	75 mm x 25 x 25 x 2 mm thick	RM	150		
2.4	**Cable Tray Support Structure :** Supply, fabrication and installation of cable support structure as per drawings/specification/ site requirement and the direction of Project manager/Consultant comprising of ISMCS, ISA's flats rods, turnbuckles etc for supporting cable trays in multitier formation. The rate shall include painting with 2 primer coats of red oxide and two finishing coats of approved enameled paint.	Kg.	50		

S.NO.	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
4	**EARTHING :** Supply, installation, testing & commissioning of following sizes of GI strip/wire clamped to wall, cable trays complete as required including inter connection between lengths at joints, all fixing accessories saddles, clamps etc. and other fixing hardware material as required for proper installation.				
a)	25 x 3 mm strip	RM	R.O.		
b)	8 SWG wire	RM	400		
c)	10 SWG wire	RM	400		
	TOTAL OF ELECTRICAL WORKS CARRIED OVER TO SUMMARY	**Rs.**			

S.NO.	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
G)	**BUILDING AUTOMATION SYSTEM**				
1.0	**CENTRAL CONTROL STATION & DIGITAL CONTROLLERS:**				
	Supply, installation, testing & commissioning of the central control station consisting of the following.				
1.1	Intel (R) core 2 duo @ 3.0 GHz with FSB 1333 MHz , Operating System - Win XP Professional, , Internet Explorer 6.0, 4 GB RAM (Random Access Memory), 14" TFT LCD Color monitor, Video card with 64 MB Unshared RAM ,Network Interface Card - 10/100mbps, 320 GB HDD,Mouse and Key board	Set	1		
1.2	Report Printer (A-3 Size) Latest version, Colour	No.	1		
1.3	Alarm Printer (A-4 Size) Latest vrsion	No.	1		
1.4	UPS with 30 minutes SMF battery backup.	No.	1		
1.5	Supply, Installation, Testing and Commissioning of the unlimited multi user with simultaneous minimum 4 user web based Server **Software for Building Management System with dynamic graphics**. The software shall have unlimited number of user license with minimum upto 5 simultaneous users. The Web-Based Server software shall permit use of Standard Web-Browsers such as Microsoft Internet Explorer, Netscape Navigator, etc and unlimited users. Software should have licensce of 12,000 points (hardwired 3000 points & software 9000 points both).Compatible with Energy Management software capable of fetching the energy data from the BMS and store the data into separate application database (SQL server) for analysis. This Software should have the following Key features: 1. SEGMENTATION OF ENERGY INFORMATION AT A GLANCE. 2. CUSTOMISABLE ENERGY DASH-BOARD. 3. ENERGY REPORT GENERATION AGAINST SELECTION OF TIME AND FREQUENCY. 4. WEB BASED TOOL. NO ADDITIONAL SOFTWARE REQUIRED. 5. EMAIL / SMS OPTION AVAILABLE 6. MULTIPLE **(with Hardware lock or Original CD)**	Nos.	1		
2.0	Supply, installation, testing & commissioning of direct digital controllers with Real Time Clock comprising of various AI, DI, AO & DO conforming to Data Point Summary as enclosed(not more than 18-20 I/O's per Controller). The controllers shall be locked in a vermin proof, lockable and well secured MS cabinet, confirming to IP 55 standards.	Lot	1		
3.0	Supply, installation, testing & commissioning of supervisory control unit having a connectivity to director digital controllers.	Lot	1		

S.NO.	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
4.0	Portable operated terminal (should connect to any DDC & get data for all the DDC's on the trunk)	Nos.	RO		
2.0	**SENSORS:**				
2.1	Supply, installation, testing & commissioning of the following field sensors:-				
i)	Immersion type temperature sensor for measuring Hot Water (Domeatic)& condenser water (Cold Stores) temperature	Nos.	14		
ii)	Flow transmitter for measuring the flow through the header.				
	a) 100 mm dia pipe common	No.	R.O.		
iii)	Pressure sensor transmitter	Nos.	2		
iv)	Transducer to measure current.	No.	2		
v)	Current Relays for the Pumps/Cooling Towers/Air-Washers/Blowers for indicating the status.	Nos	133		
vi)	Level Transmitter/Switch (Cooling Towers & Sumps	Nos.	10		
vii)	Duct mounted temperature sensor.	Set	6		
viii)	Duct mounted RH sensor.	Set	R.O.		
ix)	Outside Air Temp & Rh (+/- 3% RH)	Set	1		
x)	Differential pressure switch for monitoring the return air filter status.	Set	6		
xi)	Cold Room Temperature Sensors (-20 deg C)	Nos.	7		
xii)	Auxiliary Relays	Nos.	6		
3	Supply, installing, testing & commissioning of **Globe type 3–Way valve** with provision for feedback signal for chilled water & hot water line & manual override facility.Suitable to the following Pipe Connection Sze:				
a)	80 mm dia	No.	R.O.		
b)	65 mm dia	No.	6		
c)	50 mm dia	Nos.	2		
d)	40 mm dia	Nos.	2		
e)	32 mm dia	Nos.	2		

S.NO.	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
3.0	**CABLES & CONDUITS:**				
a	2 C X 1.5 Sq mm twisted pair, annealed tinned copper multstand conductor PVC insulated, Signal Cable.(From field device to DDC)	Mts.	1500		
b	2 C X 1.5 Sq mm twisted, annealed tinned copper multstand conductor PVC insulated, shielded communication cable.(From Controler to Controler)	Mts.	800		
c	3 C X 1.5 Sq mm armoured twisted pair, annealed tinned copper multstand conductor PVC insulated, (From field device to DDC)	Mts.	1000		
d	Lan Cable.	Mts.	100		
e	20 mm MS Conduit for Communication Cable.	Mts.	2500		
f	25mm PVC Conduit for Signal cable.	Mts.	2500		
	TOTAL OF CABLES & CONDUITS CARRIED OVER TO SUMMARY				