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

TENDER DOCUMENT
FOR
HOT WATER SYSTEM

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

INDEX FOR MECHANICAL WORKS

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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 HOT WATER 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, ARCHITECT, SERVICES CONSULTANTS:

The Owner, Architects & Services Consultants 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 2% of the contract value, while submission of tender. Earnest money and 50% of the total security deposit shall be refunded after thecompletion of the 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.

One bill in a month. There shall be no minimum value of bill, 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 HOT WATER installations of building which form together with the project documents, a complete volume of work and quality description.

All HOT WATER installations shall be of high quality, complete and fully operational including all necessary items and accessories whether or not specified herein. All HOT WATER 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 HOT WATER works shall be protected till the end - by the HOT WATER 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 HOT WATER 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. pressure drop of each system 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 HVAC 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 HOT WATER ducting/piping layouts.

2.7.5 Co-ordination with Civil Contractor

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

To provide all pipes, boxes, sleeves, HOT WATER 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 HOT WATER System.

2.7.7 Co-ordination with Electrical works Contractor:

To co-ordinate the requirement of electrical power for various HOT WATER works equipment’s.
To co-ordinate bus duct crossing of pipes/ducts.
To co-ordinate HOT WATER 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. HOT WATER 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 HOT WATER 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 HOT WATER 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 HOT WATER 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 HOT WATER 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 HOT WATER 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 HOT WATER 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 HOT WATER 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 HOT WATER 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:

HOT WATER 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. <u>Insurances/Safeties</u>:

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.

II) TECHNICAL SPECIFICATIONS:

1.0 HOT WATER GENERATORS:

1.1 SCOPE:

The scope of this section comprises the supply, installation testing and commissioning of Hot Water Generator of Thermax / Equivalent make comprising the Generators, burners, ancillaries, control system.

Each hot water Generator shall have required capacity (Kcal/Hr. as mentioned in the BOQ) of heat output giving hot water at 90 degree C. It shall be package type, suitable for operation on H.S.D. & shall be out of purview of IBR.

Hot water Generator shall be forced draft, forced circulation coil type water tube vertical unit. It shall be with built in economizer & shall be suitable for an electric supply of 415 ± 10%, 50 Hz, 3 phase, 4 wire.

Each Hot Water Generator shall comprise of the following:

a) 1 No. Monoblock circulating pump with motor

b) 1 No. Fuel oil pump & motor.

c) 1 No. Pressure Jet Burner assembly

d) 1 No. Combustion air blower with motor

e) 1 No. Coil and Shell assembly

f) 1 No. Fuel oil duplex filter

g) 1 No. temperature indicating switch for fuel oil preheater.

h) 1 No. Temperature controller for burner ON/OFF cycle at inlet of main heater.

j) 1 No. Flame failure detection device connected to alarm with burner trip.

k) 1 No. Fuel oil pressure gauge

l) 1 No. Spring loaded safety valve

m) 1 No. Hooter (audio alarm)

n) 1 No. Differential pressure switch.

o) Thermostat for automatic control of hot water at 65 deg. C at the outlet.

p) Duct proof control panel with instruments & gauges including mounting/fittings.

q) Fuel piping between oil filter, pump & burner.

1.2 PERFORMANCE TEST:

Following listed tests shall be conducted after installation of the hot water Generators, if required.

a) All controls and safety tests.

b) Efficiency test to confirm 80 to 85% on N.C.V.

c) Safety valve flow test.

d) Hydraulic test.

e) Suitability for HSD fuel.

All necessary equipment or instruments required for conducting above tests shall be arranged by the contractor. Hot water Generator will be approved subject to clearance of above tests.

1.3 HOT WATER GENERATOR INSPECTION:

Contractor shall arrange the inspection and dry trial at work prior to dispatch.

1.4 DRAWINGS:

Contractor shall furnish following drawings in triplicate within one month from the date of order to the consultants.

a) Foundation details of each Hot Water Generator.

b) Hot water Generator electrical wiring diagram.

c) Hot water Generator operation manual.

d) P & I diagram.

e) General arrangement & Terminal point details.

f) Proposed layout of Generator house with trench details.

1.5 GUARANTEE:

Contractor shall furnish a guarantee of 12 months from the date of commissioning and testing against faulty design, material or workmanship. During warranty period supplier is bound to replace the defective parts free of cost.

1.6 PRECOMMISSIONING:

On completion of the entire erection of equipment, piping, connection to the pipe system and electrical system, Contractor shall fill the entire system with cold water and test for leakage and other erection defects. All such defects shall be removed. All motors shall be test started.

1.7 COMMISSIONING & TESTING:

On completion of all procedures at pre-commissioning stage, Hot water Generators shall be fired by the respective supplier and all adjustments shall be carried out in valves and other accessories for the related equipment. Hot water Generator shall be allowed to run till the desired temperature in the system is obtained. Any defect noted shall be rectified immediately.

1.8 INSTALLATION INSTRUCTIONS:

On completion of installation, commissioning and testing, contractor shall provide services of their technical staff to train the owner's staff in operating day to day maintenance of the installation for a period of 15 working days.

a) Contractor shall provide four sets of completion drawings showing "As - Installed" location of all equipment's, piping and valves. One copy of the drawing shall be mounted on a glass frame and fixed in Hot water Generator room.

b) Contractor shall provide four sets of erection and maintenance manual of all equipment's supplied and erected by him. The manual shall include information regarding Model No, Year and manufacturer's name, manufacturer's representative name and address. The manuals shall be bound in still covers.

c) Contractor shall perform such tests that may be necessary and required and as directed by Construction Manager/Consultants to test the rated capacity of the equipment.

1.9 The basis of selection of Heat Pump is given below:-

i) Outside Weather Data:

	Location	-	Amritsar, Punjab, India.
a)	Latitude (^{o}N)	-	31.37^{0} N
b)	HT above MSL	-	234 M

ii) Door Design Conditions:

Dry Bulb	**Summer**	**Monsoon**	**Winter**
Deg. F	110.0	95.0	43.0
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

iii) Water Details:

a)	Water Flow	:	27000 LPH
b)	Hot Water Supply Temperature to PHFs	:	90ºC
c)	Hot Water Return Temperature from PHEs	:	73ºC
d)	Cold Water Supply Temperature	:	15ºC
e)	Minimum outside Temperature	:	- 3ºC

1.10 Building Automation System:

Heat Pump vendor to provide all Hardware prints and shall be compatible of providing data's to third party Building Automation Supplier.

2.0 WATER TO WATER HEAT PUMPS TO GENERATOR HOT WATER:

2.1 SCOPE:

The scope of this section comprises the supply, installation testing and commissioning of Water to Water Heat Pumps to generate Hot water system for domestic use and simultaneous Chilled water as by product to be used for Air Conditioning purpose.

Each Heat Pumps shall have required capacity (Kcal/Hr. as mentioned in the BOQ) of heat output giving hot water at 60 degree C. It shall be package type Unit.
Unit shall be suitable for an electric supply of 415 ± 10%, 50 Hz, 3 phase, 4 wire.

2.2 UNIT:

Water to water Heat pumps with Semi hermetic twin screw compressors optimized for R134a, shell and tube condenser and DX/Flooded evaporator; thermostatic/electronic expansion valve.
The unit should be supplied fully refrigerant charged and factory tested.

2.3 STRUCTURE:

Frame should be of polyester-painted galvanized steel construction. The self-supporting frame should be built to guarantee maximum accessibility for servicing and maintenance operations.

2.4 REFRIGENT CIRCUITS:

Unit should be complete with dedicated refrigerant circuit to assure continuous operation, minimum risk of gas leakages and easy maintenance.

Standard components of the refrigerant circuits should be as under:
- electronic expansion valve
- drier filter with replaceable cartridge
- refrigerant line sight glass with humidity indicator
- safety switching device for limiting the pressure
- non-return valve in compressor´s discharge line integrated in the compressor
- Inlet Valve
- High and Low pressure transducer.
- On-off cock on the compressor's suction and delivery line and on the refrigerant line
- Differential Pressure Switch on water side

2.5 COMPRESSORS:

The Semi-hermetic screw-compressors shall be designed for high efficiency both at full load and partial load and shall be with 2 five and six-lobe rotors: the five-lobe rotor is splined directly onto the motor without any interposed over gears.
The use of two rotors shall permit elevated volumetric output, uniform gas flow without jerks and reduced vibrations.
The bearings provided along the rotor axis, in a separate chamber isolated from the compression chamber should be in high-strength carbon steel.

Oil flow should be managed by pressure differential, without any dedicated oil pump, specifically designed so that the smallest differences between high pressure and suction pressure ensure sufficient oil supply to the bearings, both at full and partial load.

The built-in oil separator should have 3 stages of separation with a 10 mm stainless steel mesh filter ensuring the constant presence of oil inside, with an oil carry over rate lower than 0.5%.

Compressor/s shall continuously modulate through a slide valve which, depending on the position assumed, shall permit the compression chamber's stepless reduction.

Each compressor should partialize down to 50% of its maximum capacity.

In addition to standard no-load switch-on procedure, the motor should be fitted with electric devices limiting the absorbed current during start-up.

Each compressor should be fitted with manual reset motor thermal protection, controls for the delivery gas temperature and the oil level flow and an electric resistance to heat the carter while the compressor is stopped.

A check valve on the refrigerant outlet should be provided to protect the compressor from the risk of reverse rotation after stopping.

A compressor discharge valve should be provided to force the refrigerant into the heat exchangers during the compressor/s maintenance operation.

2.5 WATER REFRIGENT HEAT EXGHANGER (Evaporator):

Direct expansion/Flooded type shell and tube exchanger with asymmetric refrigerant circuits for keeping the refrigerant at the correct speed inside the tubes during the change from the liquid to the gaseous phase. The steel shell should be insulated with a closed-cell condensation proof lining in foamed elastomer. The copper pipes should be internally grooved to improve heat exchange and are mechanically expanded onto the tube plate ends.

2.6 REFRIGERANT WATER HEAT (Condenser):

Finned coil exchanger with steel shell and finned coil made from copper tubes with external fins, mechanically expanded onto the tube plate ends. The heads should be removed to inspect the tubes. The steel shell should be insulated with a closed-cell condensation proof lining in foamed elastomer.

2.7 ELECTRICAL AND CONTROL PANEL:

Electrical and Control Panel should be complete with:

- electronic controller
- control circuit transformer
- general door lock isolator
- power circuit with bar distribution system
- fuses for compressors
- compressors protection with internal thermal overload
- terminals for cumulative alarm block
- remote on/off terminals
- spring-type control circuit terminal board
- phases sequence and minimum/maximum voltage control.

2.8 ACCESSORIES:

a) Suitable Vibration Isolators as per manufacturer recommendations

b) Flow switch with each unit.

1.9 INSULATION

Factory-applied, anti-sweat insulation will be attached to the necessary sections on the unit to minimize heat loses. The insulation will be a flexible, closed-cell plastic type, 3/4" thick.

1.10 TESTING OF HEAT PUMP:

a) The Heating capacity testing procedure shall be based on the conditions given in the specifications.

b) Unit capacity in KW(Heating) shall be computed from the temperature reading and water flow measurements after installation at site. Flow measurements shall be through balancing valve. Computed results shall tally with the specified capacities furnished with the tender.

All instruments, services needed for the tests required for the computation of capacities and power consumption shall be furnished by the contractors themselves. All instruments shall be calibrated and the Contractors shall produce calibration certificates in support.

2.11 The basis of selection of Heat Pump is given below:-

i) Outside Weather Data:

	Location	-	Amritsar, Punjab, India.
a)	Latitude (^{o}N)	-	31.37^{0} N
b)	HT above MSL	-	234 M

ii) Door Design Conditions:

Dry Bulb	**Summer**	**Monsoon**	**Winter**
Deg. F	110.0	95.0	43.0
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

iii) Conditions of Pool Heating/Heat Pump Selection:

a)	Hot Water Supply Temperature	:	60ºC
b)	Hot Water Return Temperature	:	55ºC
c)	Chilled Water Supply Temperature	:	7ºC
d)	Chilled Water Return Temperature	:	12ºC
d)	Minimum outside Temperature	:	- 3ºC

Heat Pumps shall be tested at works as per ARI standard/ urovent & detailed report submitted with individual machines on delivery . The test results shall match technical data earlier confirmed by vendor.

2.12 Building Automation System:

Heat Pump vendor to provide all Hardware prints and shall be compatible of providing data's to third party Building Automation Supplier.

3.0 HOT WATER TANK - DOMESTIC WATER SYSTEM:

3.1 Supply, installation, testing & commissioning of SS 304 vertical hot water storage tank (Capacity 6000 Lts) suitable for minimum operating pressure. The tank shall be fabricated out of 5 mm S.S. 304 Sheets for shell and 8 mm thick for dish ends 9 (minimum). Tank shall be provided inlet / outlet, overflow / drain connection with MH cover (450 mm I.D.) pressure relief valves, pressure gauge at inlet / outlet with isolation cock, thermometer at inlet / outlet. All the valves & accessories shall be suitable for an operating pressure as given below.

3.2 Tank shall be insulated as per specification, including 24 gauge aluminium cladding. (inlet temperature to hot water storage tank 55-60 deg.C). The flanges shall be machined from SS304 sheets with dimensions confirming to ANSI, B 16.5 No. 150. The nozzles shall be SS pipes. (Tank shall be fabricated as per unfired pressure vessel code IS 2825-1969, IS 226 / IS 2062).

3.3 Hot Water Mixing Tank working pressure 10 kg/cm²

3.3 Valves and Fitting for Tank are as under:

-Cold Water Inlet Butterfly Valve

-Check Valve in Cold Water inlet line

-Hot Water Outlet Secondary side Ball Valve

-Hot Water Inlet Secondary side Ball Valve

-Hot Water Return Inlet Butterfly Valve

-Tank Drain Conn. Butterfly Valve

-Pressure Gauge

-Dia Type Thermometer

Pressure Relief Valve

Safety Valve

-Hot Water Outlet Butterfly Valve

-Hot Water Outlet NRV

-Hot Water Return Inlet NRV

-Spare Butterfly Valve

-Temperature Controller

-Insulation

4.0 THE PLATE HEAT EXCHANGER:

4.1 Construction:

The plate heat exchanger shall consist of a pack of corrugated metal plates with portholes for the passage of the two fluids between which heat transfer will take place. The plate pack shall be assembled between a frame plate and a pressure plate and compressed by tightening bolts. The plates shall be fitted with a gasket which seals the channel and directs fluids into alternate channels. The number and size of the plates shall be determined by the flow rate, physical properties of the fluids, pressure drop and temperature difference. The plate corrugations shall promote fluid turbulence and support the plates against differential pressure.

The plates and the pressure plate shall be suspended from an upper carrying bar and located by a lower guiding bar both of which shall be fixed to the support columns. Connections shall be located in the frame cover, or if either or both fluids make more than a single pass within the unit, the frame and pressure plates.

The heat exchanger shall be a plate-counter flow type and comply with schedule of capacity that shown on the drawing.

The heat exchanger shall be designed suitable for cold water to water heat exchange and the temperature range shall be 40-90°C and the rated pressure as shown on the equipment schedule. The plate construction shall be 0.6 mm stainless steel AISI 304. The gasket material shall be nitric or suitable materila. The plate heat exchanger shall be expandable by the addition of other plates up to 15% without any change to the frame.

The plate heat exchanger shall be leak tested to 1.5 times the operating pressure from factory.

4.2 Plate Heat Exchanger For Hot Water:

Plate type Heat Exchanger with plates conforming to AISI-304 of 0.6 MM thickness bonded with BNBR gaskets.

Application : Hot Water

Plate/Gasket Material : AISI 304 bonded with Nitrile Rubber Gasket.

DUTY DETAILS:	**PRIMARY SIDE**	**SECONDARY SIDE**
Hot Water Generator:		
Flow Rate	: As Per BOQ	As Per BOQ
Inlet Temperature to PHE	: 90 ^{o}C	26^{o}C
Outlet Temperature from PHE	: 73^{o}C	60^{o}C
Pressure Drop (MWC)	: 5.0 m max.	5.0. m max.
Net output	: As Per BOQ	

Maximum Working Pressure	: 4.5 Kg/Sqcm.	

Heat Pump:

Flow Rate	: As Per BOQ	As Per BOQ
Inlet Temperature to PHE	: 60 ^{o}C	40^{o}C
Outlet Temperature From PHE	: 55^{o}C	55.^{o}C
Pressure Drop (MWC)	: 5.0 m max.	5.0. m max.
Net output	: As Per BOQ	
Maximum Working Pressure	: 4.5 Kg/Sqcm.	
	Test Pressure	**: 6.5 Kg/Sqcm**
Max. working Temperature	: 110 Deg.C.	
Accessories	: (1) 1 No. Spanner for tightening bolts (2) 1 Set of foundation bolts.	

5.0 PUMPS:

5.1 Frame:

Pump frame shall be made out of heavy class grained cast iron accurately machined. The base of the frame shall be accurately machined to give exact height of centre line above the base plate.

5.2 Shaft:

Shaft shall be fabricated from Stainless steel with bronze sleeves to protect the shaft from corrosion.

5.3 Ball Bearings:

Double row deep groove ball bearing at the pulley end to take radial as well as axial load shall be provided. Single row deep groove ball bearing at the impeller end to take the radial load shall be provided.

5.4 Impeller:

The impeller shall be closed type made out of Stainless Steel hydraulically & dynamically balanced. Gun metal/bronze wearing ring shall form a part of the impeller.

5.5 Casing:

Pump casing shall be Stainless Steel.

5.6 Sealing Arrangement:

Pumps shall be provided with mechanical seals.

Pumps shall be provided with close grained C.I. suction head accurately machined & fitted with gun metal/bronze wearing ring. Pumps shall be fitted with an air release valve, grease lubrication nipples, drain plug and seal connections.

5.7 Motor:

Motor shall be totally enclosed, fan cooled, having class 'B' insulation. The motor shall be suitable for 415 $\pm$ 10% volts, 3 phase, 50 Hz AC power supply.

5.8 Coupling:

The pump & motor shall be supplied with either lovejoy or spacer type coupling as specified in the Schedule of quantities. A coupling guard made of sheet steel, duly painted mounted on a common base shall be provided.

6.0 PIPING SYSTEM:

6.1 VALVES:

6.1.1 BALL VALVE:

All ball valves shall be heavy duty of approved make. Valves shall be lever operated & PTEFE seating and shall be suitable for test pressure of 25 Kg/cm^2. Ball valves shall conform to the following specifications.

Size	Construction	Ends
15 to 50 mm	Forged Brass	Screwed

6.1.2 BUTTERFLY VALVE:

All butterfly valves shall be heavy duty cast iron wafer type of approved make. The valves shall conform to IS 210 Gr. FG 200 and shall be suitable for 15 Kg/Sqcm test pressure & shall conform to the following specifications:

Size	Construction
50 mm and above	Cast iron/steel

6.1.3 NON-RETURN VALVES:

All non-return valves shall be provided as shown in the drawings conforming to relevant Indian Standards and in accordance with the following specifications.

Size	Construction	Ends
Upto 40 mm.	Gun metal	Screwed
50 mm and above	Cast iron	Flanged

Non-return valves shall be of approved make. Wafer type non- return valve shall be used & tested to 15 Kg/Sqcm pressure.

6.1.4 DRAIN VALVES:

All valves shall be suitable in all respects for the class of service and function.

Drain valves shall be provided at low points of all water risers and mains to ensure that all sections of pipework and plant can be drained.

Drain valves for piping 50mm or smaller shall be 15mm ball valve, and for piping 65mm and above shall be 20mm ball valve

6.2 Strainers:

Strainers shall be installed in all pump suctions, PRVs and tanks. The strainers shall be of pipeline “Y” type and suitable for use in the appropriate system.

The perforated screen shall have ∅ 0.75 mm hole sizes, and be stainless steel. The following area should be at least 4 times the cross sectional area of the pipe.

40mm and smaller strainer shall have bronze bodies with screwed connections while 50mm strainers and larger shall have cast iron bodies and flanged connections. The cap of the strainer shall be provided with a ∅ 20 drain plug.

6.3 Water Meters:

Water meters shall be of multi-jet magnetic drive (turbine type), displacement and accumulative reading type, conforming to the Metropolitan Water Works Authority Standard with working pressure corresponding with the piping system.

6.4 Pressure Gauges:

Pressure gauges shall be of the bourdon type, stainless steel casing, round type of 100mm dia and scale range of approximate 150 percent of the normal operation (accuracy 1%). Pressure reading shall be in dual scale with psi and kg/sq.cm.

The needle valve and stainless steel siphon with working pressure corresponding with the piping system shall be provided for each pressure gauge.

Pressure gauges, subjected to corrosive liquid, shall be of the chemical type with diaphragm liquid separator.

7.0 G.I. PIPES & FITTINGS

7.1 G.I. PIPES:

All pipes for water supply secondary circuit, make up for Mixing tank, feed water tank shall be galvanized steel tubes conforming to IS:1239 – Part I (for medium grade).

7.2 G.I. Fittings:

All fittings shall be conforming to IS:1879 (Part I to X) (or as revised). All fittings shall have manufacturer's trade mark stamped and ISI stamped on it. Fittings in G.I. pipe lines shall include elbows, tees, bends, reducers, nipples, union, G.I. Clamps / Steel structural supports of approved design, nuts, bolts, washers, etc. All fittings shall be tested at manufacturer's works. Contractors may be required to produce certificate to this effect from the manufacturers.

7.3 Laying and Jointing of G.I. Pipes (External Work) :

Trenches:

The galvanized iron pipes and fittings shall be laid in trenches. The widths and depths of the trenches for different diameters of the pipes shall be as in Table below:

Dia of pipe	Width of trench	Depth of trench
15mm to 50mm	300mm	600mm
65mm to 150mm	450mm	750mm

At joints the trench width shall be widened where necessary. The work of excavation, refilling shall be done true to line and gradient shall be maintained in accordance with drawings & general specifications on earth work in trenches.

When excavation is done in rock, the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand, minimum 75mm deep.

7.4 Cutting And Threading:

Where the pipes have to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The end of the pipes shall then be carefully threaded conforming to the requirements of IS:554-1964 with pipe dies and taps in such a manner that will not result in slackness of joints when the two pieces are screwed together. The screw threads of pipes and fittings shall be protected from damage until they are fitted.

7.5 Jointing:

The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with material suitable to food grade and a few turns of spun yarn wrapped around the screwed end of the pipes. The end shall then be screwed in the socket, tee etc with the pipe wrench. Care shall be taken than all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joints shall be removed after screwing. After laying, the ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

7.6 Painting:

The buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, then wrapped with bitumen faced hesian.

7.7 Testing Of Joints:

After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost.

The pipes and fittings after they are laid shall be tested to hydraulic pressure of 1.5 times the working pressure or at 7.5 Kg / Sqcm whichever is higher. The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock of water hammer. The draw of taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recaliberated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least 24 hours. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing.

The treated water shall be left in the pipe line for a period as directed but not exceeding 24 hours. Chlorine residual tests shall be taken at various points along the pipe line. The sterilization process shall be repeated until the samples of water taken from the pipeline are declared fit for human consumption by a recognized laboratory.

8.0 CPVC PIPES & FITTINGS & VALVES FOR COLD WATER SUPPLY DISTRIBUTION SYSTEM:

CPVC Water Distribution System shall be Flowguard CPVC (Chlorinated Polyvinyle Chloride) Water Supply Piping System with pipe as per CTS SDR-11 at maximum working pressure of 400 psi (28.1 Kg/cm^2) at 23ºC and 100 psi (7.03 Kg/cm^2) at 82ºC (from ½" - 2"), using solvent welded CPVC fitting i.e. Tees, elbows, couplers, unions, reducers, bushing etc. including transition fitting (connection between CPVC and metal pipe / G.I.) i.e. Brass adapter (both male and female threaded) all conforming to ASTMD-2846 with only CPVC solvent cement 5conforming to ASTMF-493 - with only Clamps/ structural metal supports as required/directed at site including cutting chases and filling the same with cement concrete/cement mortar as required. All termination points for installation of faucets shall have brass termination fittings. Installation shall be to the satisfaction of consultant/manufacturers of pipes and fittings.

Outside Diameters and Wall Thicknesses for CPVC 4120, SDR 11 Plastic Pipe

Nominal Size		Outside Diameter, in. (mm)		Wall Thickness, in. (mm)	
(in.)	(mm)	Average	Tolerance	Minimum	Tolerance
½	15	0.625 (15.9)	± 0.003 (± 0.08)	0.068 (1.73)	+ 0.020 (+ 0.51)
¾	20	0.875 (22.2)	± 0.003 (± 0.08)	0.080 (2.03)	+ 0.020 (+ 0.51)
1	25	1.125 (28.6)	± 0.003 (± 0.08)	0.102 (2.59)	+ 0.020 (+ 0.51)
1-1/4	32	1.375 (34.9)	± 0.003 (± 0.08)	0.125 (3.18)	+ 0.020 (+ 0.51)
1-1/2	40	1.625 (41.3)	± 0.004 (± 0.10)	0.148 (3.76)	+ 0.020 (+ 0.51)
2	50	2.125 (54.0)	± 0.004 (± 0.10)	0.193 (4.90)	+ 0.023 (+ 0.58)

Pressure Ratings for CPVC, SDR 11 Plastic Pipes

Nominal Size		Pressure Rating, PSI (Kg/cm^2)			
(in.)	(mm)	73.4°F	(23°C)	180°F	(82°C)
½	15	400	(28.1)	80	(7.0)
¾	20	400	(28.1)	100	(7.0)
1	25	400	(28.1)	100	(7.0)
1-1/4	32	400	(28.1)	100	(7.0)
1-1/2	40	400	(28.1)	100	(7.0)
2	50	400	(28.1)	100	(7.0)

8.1 JOINING FLOWGUARD PIPES AND FITTINGS :

- Cutting :

  Pipe shall be cut with either with a wheel type plastic pipe cutter or hacksaw blade, and care shall be taken to make a square cut, which provides optimal bonding area within a joint.

- Deburring/Beveling :

  Burrs and fillings should be removed from the outside and inside of pipe with a pocket knife or file otherwise burrs and fillings may prevent proper contact between pipe and fittings during assembly.

- Fitting/Preparation :

A clear dry rag/cloth should be used to wipe dirt and moisture from the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.

- Solvent Cement Application :

CPVC solvent cement conforming to ASTM - F493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket, otherwise too much of cement solvent can cause clogged water ways.

- Assembly :

After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds and rotating the pipe 1/4 to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be holded for 10 seconds (approximately) in order to allow the joint to set up.

- **Set and Cure Times** : remake the joint to avoid potential solvent cement set and cure times shall be strictly adhered to as per the below mentioned table.

Minimum cure prior to pressure testing at 150 psi:

Ambient Temperature During Cure Period	Pipe Sizes	
	½" - 1"	1 ¼" - 2"
Above 15 C	1 Hr	2 Hrs
4 - 15 C	2 Hrs	4 Hrs
Below 4 C	4 Hrs	8 Hrs

Special care shall be exercised when assembling flowguard systems in extremely low temperature (below 4 C) or extremely high temperature (above 45 C) in extremely hot temperatures, make sure that both surfaces to be joined are still wet with cement solvent when putting them together.

1. Testing :
   Once an installation is completed and cured or per above mentioned recommendations, the system should be hydrostatically pressure tested at 150 psi (10 bar) for one hour. During pressure testing, the system should be filled with water and if a leak is found, the joint should be cut out and replacing the same with new one by using couplers.

2. Transition of flowguard CPVC to Metals :
   When making a transition connection to metal threads, special Brass (Male and female adapters) should be used.

3. Threaded Sealants:
   Teflon tap shall be used to make threaded connections leak proof.

4. Solvent Cement:

   CPVC solvent cement conforming to ASTMF 493 should be used for joining pipe with fittings and valves. CPVC cement solvent have a minimum shelf life of 1 year. Solvent have a minimum shelf life of 1 year. Aged cement solvent will often

change colour or began to thicken and become gelatinous or jelly to like and when this happens, the cement should not be used. The cement solvent should be used within 30 days after opening the company's seal and tightly close the seal after using in order to avoid its freezing. The freezed cement solvent should be discarded immediately and fresh one should be used.

❒ Hangers and Supports :

Most hangers designed for metal pipe are suitable for flowground. Hangers should not have rough or sharp edges which come in contact with the tubing.

Supports should be as per the below mentioned table :

Horizontal and Vertical Support									
Spacing									
Size of pipe		21 deg. C (70°F)		49 deg. C (120°F)		71 deg. C (160°F)		82 deg. C (180°F)	
Inch	(mm)	Ft.	cm	Ft.	cm	Ft.	cm	Ft.	cm
½"	(15)	5.5	(167.7)	4.5	(137.16)	3.0	(91.44)	2.5	(76.2)
¾"	(20)	5.5	(167.7)	5.0	(152.4)	3.0	(91.44)	2.5	(76.2)
1"	(25)	6.0	(182.88)	5.5	(167.7)	3.5	(106.68)	3.0	(91.44)
1 ¼"	(32)	6.5	(198.12)	6.0	(182.88)	3.5	(106.68)	3.5	(106.68)
1 ½"	(40)	7.0	(213.36)	6.0	(182.88)	3.5	(106.68)	3.5	(106.68)
2"	(50)	7.0	(213.36)	6.5	(198.12)	4.0	(121.92)	3.5	(106.68)

9.0 COPPER PIPES & FITTINGS FOR HOT SUPPLY & DISTRIBUTION SYSTEM:

9.1 COPPER PIPE:

All domestic cold water pipe & hot water supply pipe and hot water return pipe shall be copper pipe conforming to BS : 2871 Part I & EN 1057 in half hard drawn condition as per wall thickness of Table X. All copper pipes well accompany manufacturer certificate certifying chemical composition & that 100% tubes are eddy current tested. These copper tubes will be of non arsenical copper grade C 106 i.e. DHP grade copper confirming to BS : 2871 (Part I).

Table of Metric Sizes for Copper Tubes TO BS 2871 : Part I

Table X

Size of Tube (mm)	Outside Diameter (mm)		Nominal Thickness (mm)	Maximum working Pressure at 65°C Bar
	Maximum	Minimum		
15	15.045	14.965	0.7	58
22	22.055	21.975	0.9	51
28	28.055	27.975	0.9	40
35	35.07	34.99	1.2	42
42	42.07	41.99	1.2	35
54	54.07	53.99	1.2	27
67	66.75	66.60	1.2	20
76	76.30	76.15	1.5	24
108	108.25	108.00	1.5	17
133	133.50	133.25	1.5	14
159	159.50	159.25	2.0	15

Note :
Table X specifies requirements for copper tubes in straight lengths to half hard drawn condition.

9.2 FITTINGS:

- All fitting shall be supplied & installed confirming to specification BS 864 Part II or the New European EN 1254 Part I & Part II. Fitting shall only be supplied in Dezincification resistant materials i.e. either copper or gun metal or dezincification resistant brass (alloy CZ 132). All gun metal fitting will clearly specify with the initial GM that they are gun metal & all dezincification resistant brass fittings will have the word DR embossed on the fitting itself.

- The fitting will also be embossed with the BS symbol mentioning the specification 864 to be used.

- For internal services i.e. for sizes 15mm to 35mm the Integral Solder Ring Fitting will be used. Plain ends of these fittings will contain lead free solder embedded in the end itself. For external services, the fittings to be used will be the endex range or endfeed fittings. For sizes 15mm to 35mm lead free solder wire will be used confirming to BS 219 for jointing & for fitting of sizes 42mm & above, the fittings will be joined with copper pipes by the use of copper to copper brazing. Under no circumstances will brazing be used as a method for joining for 35mm & above.

- Jointing of Copper Fittings (such as Tees, crosses, plugs, sockets, elbows, reducers, flanges, unions, sleeves etc.) shall be as follows :

  i) 15 mm dia to 35 mm dia - Integrated Solder Ring (ISR) Type Fittings.
  ii) 42 mm dia & above - Endex fittings with soldering.

- Fabrication of copper pipes into fittings is not allowed including making of Tees or Elbows at site. Couplings made from copper pipes are not allowed. For all sizes of pipes separate copper fittings or copper couplings are required to be used for jointing pipe to pipe.

- For reduction of one pipe size to another it is a must to use reducing couplings & expanded pipe ends or sewaged or reduced pipe ends will not be allowed. For all tee joints it is not allowed to make a tee by making a hole in a pipe. All tee joints will have to be made by using separate copper tee fittings.

- Copper pipes will not be joined directly to GI pipes or GI fittings & Dezincification resistant (DZR brass) or Gun metal fitting will be used to join copper pipe to GI fittings or GI pipe. This is to avoid galvanic corrosion which occurs when 2 dissimilar metals are joined together in the galvanic series.

Capillary Fittings:

In these type of fittings a joint is made by the flow of solder due to capillary action along the annular space between the outside of the tube and the inside of the fittings socket.
There are two kinds of capillary fittings :

i) Integral Solder Ring Type (ISR) :

These fittings contain enough amount of lead-free solder in a recess/cavity of the fitting itself and there is no need to endfeed any solder from outside. On being heated with an ordinary blow lamp the solder in these fitting melts and flows into both sides, due to capillary action, forming a joint in the area of contract between

the pipe and fitting. These fittings have a burst pressure of 5000 PSI. A 15mm OD x 0.7mm WT copper pipe will burst at its burst pressure of 3480 PSI, but a solder ring joint will not leak.

ii) Endfeed Type (Endex) :

In these fittings solder is to be end fed from outside. After heating the fitting, solder wire is end fed from the edge of the fitting enabling necessary action to take place.

DZR Fitting (De-Zincification Resistant):

It is very essential to use DZR Fittings for installation as explained above to avoid corrosion of the weaker metal before or after the Copper Plumbing System.

Above fittings are manufactured to BS 864 : part-2.

9.3 LAYING AND JOINTING OF COPPER PIPES AND CAPILLARY FITTINGS:

The copper pipes and fittings shall run in wall chase or ceiling or as specified. The fixing shall be done by means of standard pattern holder bat clamps keeping the pipes about 1.5 cm clear of the wall where to be laid on surface. Where it is specified to conceal the pipes, chasing may be adopted or pipes fixed in the shafts, ducts etc. provided there is a sufficient space to work on the pipes with the usual tools. As far as possible, pipes may be buried for short distances provided adequate protection is given against damage and where so required special care to be taken at joints. Where directed by the Owner's Site Representative/Architect, pipe sleeves shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. In case of pipe is embedded in walls or floors it shall be covered with a protective tape wrapped around the pipes and fittings.

Copper pipes shall be jointed using fittings conforming to BS 864 Part 2. Care shall be taken to remove any burr from the end of the pipes after cutting. Only fittings of the size suitable to the pipe shall be used. The ends of the tube shall be cut to the correct size using a tube cutter or a fine blade hacksaw. Care shall be taken to ensure that the ends of the tube are cut perpendicular to the axis of the tube and that the ends remain undamaged and free of burrs. Any burrs remaining shall be removed with a smooth file. Clean the outside surface of the tube that shall go into the fitting ensuring even and uniform application. Insert the tube into the fittings and push home until the stop is reached. Wipe off excess flux with a soft cloth. Now the assembled joint shall be heated with a blow torch or any similar appliance that emits a clean, blue, spot free flame. The heat shall be turned off once a complete ring of solder has appeared around the mouth of the fitting.

The joints shall be allowed to cool without disturbance.

All copper pipes to G.I. pipe and connection with the valves and faucets shall be with De-zincified Resistance fittings (DZR).

Piping Installation :

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

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

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. Risers shall be supported at each floor with Galvanised steel clamps. To permit free movement of common piping support shall be from a common hanger bar fabricated from Galvanised steel sections.

Pipe hangers shall be provided at the following maximum spacings.

Size of Pipe (O.D) (mm)	For vertical runs (m)	For horizontal runs (m)
15	1.8	1.2
22	2.4	1.8
28	2.4	1.8
35	3	2.4
42	3	2.4
54	3	2.7
67	3.6	3
76.1	3.6	3
108	3.6	3
133	3.6	3
159	4.2	

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

All pipe work shall be carried out in a proper workman like manner, causing minimum disturbance to the existing services, buildings roads and structure. The entire piping work shall be organized in consultation with other agencies work, so that area can be carried out in one stretch.

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

Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes passes through walls and slab and annular space filled with fiberglass and finished with retainer rings.

The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified/approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size gate valves. Automatic air valves shall be provided on hot water risers.

Discharge from the air valves shall be piped through a galvanized steel pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

In jointing copper pipes and fittings following procedure should be followed :-

i) Cut the copper tube square, remove burr inside and out side.

ii) Properly clean the outside portion of the pipe which has to go inside the fittings and also inside of the fitting. Remove all dirt, oxide film grease and oils.

iii) Apply flux to the cleaned surface and insert pipe firmly upto the pipe stop. A small twist shall be given for even spreading of the flux.

iv) Apply heat evenly around the fittings with oxyacetylene torch until a complete ring of solder alloy appears round the mouth of the socket. Heating shall then be stopped and joint allowed to cool without disturbance.

9.4 TESTING CRITERIA FOR COPPER PIPES:

i) To check joints of installed copper pipes & to ensure that joints from 15mm to 35mm copper pipes are done by soft soldering & copper pipes from 42mm & above are joined by the method of brazing.

ii) To check the copper pipes at a minimum hydraulic pressure of 500 PSI to ensure that no joints are leaking. Pressure to be maintained for 30 minutes & the reading to be stagnant through out the testing period. You may also test the copper pipe work at 1000 PSI if desired but that may not be necessary.

iii) All copper pipes to be to other copper pipes with the use of couplings. It is not allowed to join one copper pipe into another copper pipe by flaring one end & inserting another copper pipe into it. Likewise no fabricating of fittings are allowed at site & tees and elbows must be used either equal or reducing for bends / branches.

iv) It must also be checked that any excessive flux is removed after soft soldering on the outside of the joints for size 15mm to 35mm where a chemical flux is required for soft soldering. This is necessary so that flux does not remain in the pipe line after installation & then starts corroding the copper pipe or the joint. Like wise the entire system must be flushed with water before closing for atleast 10 minutes so that any excessive flux in the ID the tube is washed away.

v) It must be noted there that flux is water soluble.

10.0 POLYBUTYLENE (PB) PIPE AND FITTING:

10.1 General

Providing and fixing of Polybutylene (PB) pipes and fittings for hot and cold water distribution system as per the BS 7291 with corresponding tee's , elbows, sockets, brass adaptors (Male and Female) with hot fusion jointing technology as specified by the manufacturer. All terminations points should be brass only for connection with faucets.

The Polybutylene system shall be made by PB 1 4237 grey or equal.

Polybutylene (PB) pipe work fittings shall be used for the conveyance of Hot and Cold water distribution system and should comply with the requirements specified in (BS 7291(Parts 1 and 2) class 'S'.
The whole of the PB pipe work installation should be installed and tested in accordance with the requirements as with the relevant manufacturer's instructions.

Care should be exercised while off- Loading, storing and transporting about the site and while installing the pipes and fittings to ensure that no accidental damage occurs to the pipes or fittings.

10.2 Pipes

All PB piping should be to EN ISO 15876 – 1,2,3 (BS 7291: Part 182 or DIN 16968/DIN 16969.)

10.3 Pipe fittings:

Unless specified other wise, all associated pipe fittings (viz. Manifolds, unions and flanges) should be of PB manufacture generally in accordance with (BS 7291 : Parts 1 and 2) and brass fittings manufactured generally in accordance with EN ISO 15876 -1,2,3 (BS 864, Part 2,) and be fully compatible with the pipe system they are to be installed with.

Valves for PB work should be fully compatible with the pipe system to which they are to be connected, comprising variously.

Brass valves should be suitable for connection with PB pipe directly, or with adaptors to flanged or threaded connectors.

Only pipe cleaner and sealant specifically approved by the pipe end fittings manufacturer should be .

10.4 SELECTION OF PB PIPE SYSTEMS:

OUTER & INTERNAL DIAMETER:

S.NO.	OUTER DIAMETER	INNER DIAMETER
1	16	11.6
2	20	14.4
3	25	20.4
4	32	26.0
5	40	32.6
6	50	40.8
7	63	51.4
8	75	61.4
9	90	73.6
10	110	90.0

HORIZONTAL SUPPORT SPACING:

All PB pipe work sizes stated on the drawings refer to outside diameter.

S.NO.	External Diameter	Temperature of the Flowing Water in Degree Centigrade					
		20	30	40	50	60	80
1	16 mm	75 cm	70 cm	70 cm	65 cm	65 cm	55 cm
2	20 mm	80cm	75cm	70cm	70 cm	65 cm	60 cm
3	25 mm	85 cm	85 cm	85 cm	80 cm	75 cm	70 cm
4	32 mm	100 cm	100 cm	95 cm	90 cm	85 cm	75 cm
5	40 mm	110 cm	110 cm	105 cm	100 cm	95 cm	85 cm

6	50 mm	125 cm	125 cm	115 cm	110 cm	105 cm	90 cm
7	63 mm	140 cm	140 cm	130 cm	125 cm	120 cm	105 cm
8	75 mm	155 cm	155 cm	145 cm	135 cm	130 cm	115 cm
9	90 mm	170 cm	170 cm	160 cm	155 cm	150 cm	145 cm
10	110 mm	190 cm	190 cm	180 cm	175 cm	160 cm	

10.5 **WORKMANSHIP, FINISH AND APPERANCE:-**

The finished tube shall be smooth, free of internal and external mechanical imperfections and internally shall have smooth appearance.

10.6 PIPE JOINTS:

The pipe and fittings should be entirely compatible with each other and the jointing should be carried out in strict accordance with the manufacturer's printed instructions.

Unless indicated otherwise, the pipe joints in PB pipe work should be made by electro fusion. The assembly of these should be carried out in strict accordance with the manufacture's instructions.

Only fully trained installers should be used for assembling PB pipe systems. Trained and Certified by Manufacturer.

10.7 JOINTING PROCEDURE:-

The Polybutylene pipes and fittings are joined through a hot fusion welding machine and the below mentioned.

Steps need to be adhered to while installing the system:

STEP 1: First the pipe need to be cut through a sharp cutter and the two end of the pipe need to be cleaned with the tangit cleaner provided by the manufacturer. The pipe cut should be a proper square cut only. Then the corresponding. Fitting to be connected with the fitting should also be cleaned with the same tangit cleaner. Cleaning removes all the dust particles on the pipe and the fitting for proper jointing. Then use the chamfering tool on the pipe to peal off a thin layer out of the pipe.

STEP 2: Then the corresponding heating dyes should be mounted on the machine and tightened properly. Connect the machine with the mains of 220 volt and wait for 3 minutes for the machine to attain the temperature of 260 degree centrigrade. As soon as it attains this temperature, the cut off in the machine will give the indication in terms of red light blinking which give the indication that machine is ready for operation.

STEP 3: Then hold the pipe in one hand and fitting in another and insert the pipe and the fitting simultaneously in the repective dyes Hold it for some seconds and remove it and insert the melted portion of the pipe into the fitting and insert it deep till you get the two melted rings joined together. If the two rings are uniform, the joint made with be a hundred percent leak proff joint. Hold this operation for few seconds till it cools off completely.

10.8 **Testing**:
Once the assembly is made pressure test it at double the working pressure so as to confirm the leakproff jointing of the system.

This pressure testing should be done for 12 hours and then put into operation on regular basis.Required Depths, fusion time, holding time and cooling time for the elements of PB system

External diameter	Depth of weld	Fusion Time	Holding time	Cooling time
16mm	17mm	6 sec	15sec	2sec
20mm	17mm	7sec	15sec	2sec
25mm	20mm	7sec	15sec	2sec
32mm	22mm	10sec	20sec	4sec
40mm	24mm	14sec	20sec	4sec
50mm	28mm	18sec	30sec	4sec
63mm	32mm	22sec	30sec	4sed
75mm	36mm	28sec	30sec	6sec
90mm	38mm	35sec	35sec	6sec
110mm	42mm	37sec	35sec	8sec

10.9 INSTALLING THE PIPE WORK SYSTEM:

The Contractor should:-

(i) Check that the exterior of the piping is marked at intervals not exceeding one meter with the manufacturer's name, type of material, pipe size and standard with which it complies.

(ii) Check that all the piping and fittings supplied are uniform in colour density.

(iii) Exercise particular care in their storage, handling and installation to avoid deterioration due to ultraviolet light and impact damage.

The piping manufacturer's printed instructions should be rigidly adhered to in all respects of storage, stacking, handling and installation. The pipe work should be supported as indicated upon the drawings and as detailed within the contract documents.

It is essential that cleaners are correctly applied to the pipe ends and sockets prior to fusion and electro fusion jointing with cleaning pads changed regularly in accordance with manufacture's instructions. After fusion jointing, a ring of Polubutylene will be visible on the outside of the pipe as evidence that a joint has been completed. After electro fusion an indicator pipe will raise above the surface of the fitting as evidence that a joint has been completed.

Grease care should be taken to ensure that only the manufacturer's installation procedures are followed and , in particular, that the full cooling period is maintained before any joint is considered to be complete.

No pipe work, or section thereof, shall have wafer pressure applied until the manufacturer's stipulated setting period has elapsed (a minimum of at least one hour after the last fusion point).

Where an existing heat source has to be maintained, with pipes either running parallel or crossing each either, thermal insulation should be applied.

On no account should ladders scaffold or either building items be propped up against the PB pipe work installation.

Changes in direction can be achieved using the pipes flexibility, in accordance with the manufacturer's instructions. No thermally induced bending of PB pipes through the application of local heating should be permitted.

All PB pipes should be supported by pipe clips or supports brackets, the spacing of which should not exceed the maximum intervals as advised end confirmed by the pipe manufacturer.

Where a pipe clip or support bracket is being used to support a number of pipes, of different materials and sizes, the spacing interval between such clips end brackets should not exceed the smallest of the maximum intervals stated or advised for each of the pipes being supported.

PB pipe work in exposed positions (or where distortion is likely to occur should be supported using the piping manufacture's standard pipe clip or support pipe carriers.

Where PB piping is supported using other that standard PB pipe clips, the supports should comprise steel split pipe rings with rubber insert, napping rod nuts and washers with back plate as required, either fixed to rail support or building fabric.

The test pressure should be maintained throughout the period of time of not less than one hour and not less than one and a half times working pressure.

There should be no loss of pressure above that detailed in the manufacturer's handbook, to allow for the expansion and the setting in period of PB pipes, during the period, the test is being carried out. The results of the pressure test should be recorded on the log sheet.

10.10 EXPANSION:

Expansion Loops or changes in pipe direction should be allowed for regular intervals in accordance with manufacturer's guidelines.

Where expansion Loops and changes in direction are impractical fixed point assembly may be used on pipes up to 75mm diameter to prevent the PB pipes from expanding or contracting, in accordance with manufacturer's guidelines.

If fixed point brackets are being used to avoid longitudinal expansion of PB pipes, the installation instruction of both the pipe and bracket manufacturers should be adhered to. Fixed point brackets should be located at fittings and must grip the pipe on both sides of the fittings, or according to manufacturer's instructions.

Fixed point supports should be located at fusion or electo fusion fittings and meet with the manufacturer's requirements, to absorb forces and transfer them to the structure. Fixed points should not be located more than a maximum of 6m apart.

Pipe support carriers must be used to support the pipes between fixed points, to prevent buckling. Normal supports for the pipes and carrier, between fixed points should not be more than 1.5m apart, in accordance with the manufacturer's guidelines.

Pipe support carriers shall be of semicircular shape to closely match the pipes outside diameter. Manufactured from gal vanished
or size plated steel. The coating inside and outside are to be of the same standard. The finish is to be smooth along the surfaces and edges to prevent damaged to the pipes. When cut the edges of the carrier are to be filed smooth. The carrier is to be attached to the pipe by approved cable ties suitable to support the forces, at intervals recommended by the manufacturer's (never more than 500mm). The carrier is not to be run over fittings, but to terminate 10-15mm short both sides with adequate support through cable ties and brackets.

11.0 INSULATION WORK:

11.1 SCOPE :

Scope of this section comprises the supply and installation of all insulation work for equipment and piping.

11.2 INSULATION OF HOT WATER PIPES(CPVC):

Specification for Thermal insulation for Hot water pipes in Shaft/Plant Room above False Ceiling and in Trench

i) MATERIAL

Insulation shall be made of thermoplastic elastomeric foam(TPE) Thermal conductivity of material shall not exceed 0.036 W/M^{o}K at an average temperature of 40^{0}C. The material should have a density in the range of 25-35 kgs/cu. Mts. Temperature range shall be - 80^{0}C to + 95^{0}C

ii) PIPING INSULATION:

All hot water piping shall be insulated in the manner specified herein. Before applying insulation, all pipe shall be brushed and cleaned. Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity.

Thickness of Insulation :

Pipe size (mm)	Thickness of Insulation
15 mm to 42 mm	9 mm
42 mm to 108 mm	13 mm
133 mm to 159 mm	19 mm

Insulating materiel in tube form shall be sleeved on the pipes. On existing piping – opened tube from insulating material shall be placed over the pipe and adhesive (as recommended by the manufacturer) shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre.

Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. The insulation shall be continuous over the entire run of piping, fittings and valve. All valves, fittings, joints, strainers etc. in hot water piping shall be insulted to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

11.1 Piping in the Trench:

- Bush and clean all piping and fittings to remove all dust, dirt, mortar and oil
- Apply pipe sections over the pipe before the adhesive dries up and apply Starbond 30-36 as a tack coat over the PUF insulation surface evenly by brush or roller.

- Wrap/embed fiber glass cloth over the surface while coating is wet.50 mm overlap in longitudinal and transverse joints. Fiber cloth fiber shall be install gently to avoid wrinkles and wait until tack coat is cured. It will take 1 to 2 hours depending upon the weather conditions.

- Apply 1st coat of Starbond 30-36 evenly by brush or roller. It will take 3 to 4 hours to cure depending upon the weather conditions.

- Apply 2st coat of Starbond 30-36 evenly by brush, roller or spray once 1st is cure.

11.2 Exposed Piping:

- Bush and clean all piping and fittings to remove all dust, dirt, mortar and oil

- provide 26 G aluminum sheet and fix the same with self tapping

11.2 INSULATION OF HOT WATER PIPES (MS/GI/ SS IN THE PLANT ROOM):

11.2.1 All pipes and equipment operating at higher than ambient temperature shall be insulated in the manner specified hereinafter.

11.2.2 Insulating material shall be fiber glass/rockwool having density of 24 kg m^3/100 Kg/m^3 minimum with 'K' valve of not more than 0.038 W/MK at 100^oC mean temp.

11.2.3 No insulation shall be applied until the pipe is satisfactorily pressure tested.

11.2.4 Thickness of insulation shall be 50mm for all hot water pipes.

11.2.5 Pipe insulation shall be applied as follows :-

a) Pipes shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease and applied with two coats of anti-rust paint.

b) Pipes in false ceiling/Shaft/Exposed :

i) Insulation shall be fixed tightly to the surface taking care to seal all joints with 50 mm wide aluminium adhesive tape (transverse and circumferential).

ii) The insulation shall be tied with PVC band not less than 6 mm width and 24 gauge 4 bands per meter or equivalent plastic band using G.I. sheet clamp crimped at the joints.

iii) The insulation shall be covered with 24 gauge aluminium cladding screwed at the joints with cadmium coated self-tapping screws. Joints shall be overlapped minimum 12mm wide.

11.3 All valves, fittings, strainers etc. shall also be insulated in the same manner as piping.

11.4 INSULATION OF TANKS:

Heat exchanger and hot water missing tanks shall be insulated as follows :-

The insulation shall be 50mm thick slab of Rockwool density not less than 100 Kg/M^3.

11.5 CHIMNEY INSULATION:

Breaching and chimney shall be fully insulated as follows :

a) Insulation shall be of 50 mm thick rockwool minimum density of 100 Kg/M^3 matresses or equivalent.

b) The insulation shall be provided with 24G aluminium cladding screwed to the steel frame with cadmium coated self-tapping screw

11.6 CHILLED WATER PIPES INSULATIONS:

11.6.1 The insulation for chilled/hot water and drain piping shall be carried out from performed pipe section of rigid Expanded polystyrene TF quality having thermal conductivity 0.023 K Kcal/Hr. Sqmt/deg C at mean temperature of 10 deg C and a density of 18 kg/cubic M.

Preformed pipe section shall be used for pipes up to and including 250 mm dia.

Thickness of insulation:

Pipe Size

a) Up to 25mm dia.	:	25mm
b) 32 mm dia. to 80 mm dia.	:	40 mm
c) 100 mm dia. & above	:	50 mm

Application:

All chilled water and drain pipe shall be insulated after pressure tested as follows:-

Indoor Piping

a. Brush and clean all piping and fittings to remove all dust, dirt, mortar, and oil and then provide 2 coats of zinc chromate primer of ASIAN PAINTS or approved equal.

b. Apply 2 coats of cold setting adhesive compound.

c. Apply premoulded pipe sections over the pipe before the adhesive dries up and seal all longitudinal and transverse joints with adhesive compound.

d. Wrap 500g polythene sheet over the surface with 50mm overlap in longitudinal and transverse joints. All joints shall be sealed by 75mm wide PVC adhesive tape or hot bitumen.

e. Final finish shall be made by cladding the chilled water pipe with 26 gauge aluminium sheet.

d. Insulated pipes shall be marked with arrows to indicate the direction of flow.

11.6.2 Underground/Outdoor Piping:

a. Brush and clean all piping and fittings to remove all dust, dirt, mortar, and oil and then provide 2 coats of zinc chromate primer of ASIAN PAINTS or approved equal.

b. Apply 2 coats of black Japan paint.

c. Apply 2 coats of cold setting adhesive compound.

d. Apply premoulded pipe sections over the pipe before the adhesive dries up and seal all longitudinal and transverse joints with adhesive compound.

e. Wrap 500g polythene sheet over the surface with 50mm overlap in longitudinal and transverse joints. All joints shall be sealed by 75mm wide PVC adhesive tape or hot bitumen.

f. Fix ¾" x 24 SWG hexagonal wire netting on pipe section with G.I. wire.

g. Finishing with 2 coats of 12 mm thick sand cement plaster in 1:3 ratio trowelled to a smooth finish. A water proofing compound shall be added before it is applied on the insulation material.

b. Paint of approved colour as per code.

11.6.3 PUMP INSULATION:

All chilled water pump shall be insulated with 50mm thick expanded polystyrene in the manner specified herein. Two specified box made of 20 gauge galvanized steel sheet shall be provided around each horizontally split casing pump. All sheet joints shall be sealed with bitumen from inside. The insulation impaled over pins welded/riveted to GI sheet and secured with speed washers.

Lower section of box shall cover the pump volute, bearings and portion of the base under volute and bearing. Joints shall be sealed with bitumen. Insulation and finishing of upper section shall be similar to the lower section, thermally lines and insulated as described above. Upper section shall be easily removable to provide easy access to the pump sand to bearings. After assembling the box valves, gap at the joining interfaces shall be sealed with self adhesive aluminium tape.

11.6.4 Expansion tank shall be insulated with 50 mm thick expanded polystyrene in similar manner as described above for pumps.

12.0 TESTING :

12.1 Piping shall tested as follows :

a. Piping shall be cleaned thoroughly, to remove the rust, welding flux/dust, etc.. by flushing several times.

b. Piping shall be tested to hydrostatic test pressure at least 1.5 times the max. working pressure for a period of 24 hours. However, the min. test pressure shall be 10 bar piping. The defects in joints and leaks observed during the test shall be rectified to the entire satisfaction of the Construction Manager and piping shall again be subjected to pressure test as stated above. The testing of piping system shall be conducted in presence of employer's representatives. No insulation shall be carried out till the satisfactory completion of pressure testing. The contractor shall furnish all the necessary equipment, tools, instruments & labour to perform the pressure testing of piping.

13.0 MEASUREMENT AND RATES:

13.1 GI PIPES / M.S. PIPE / CPVC/CPOOER/PB/S.S. PIPE:

Pipes above ground shall be measured per linear metre (to the nearest cm) along the centre line of the pipe and shall be inclusive of all fittings e.g. couplings, tees, bends, elbows, unions, flanges, etc. Deduction for valves shall be made. Rates quoted shall be inclusive of all fittings, clamps, cutting holes chases and making good the same and all other items mentioned in the specifications and Schedule of Quantities.

13.2 Valves, Strainers, Moisture Separators :

Valves shall be measured by numbers. However, wherein these items are included as integral part of an assembly and described as such in the B.O.Q., these will not be prescribed and paid for separately.

13.3 Flanges for Nozzles:

Flanges for nozzles shall be measured by in pipe lengths only no extra payment will be made.

13.4 Piping / Pipe Protection / Insulation:

Unless otherwise specified painting / Pipe protection / Insulation for pipes shall be measured and paid for separately. These shall be measured per linear metre along the centre line of the pipe over the finished surface and shall include all valves and fittings for which no special rates shall be applicable.

14.0 ELECTRICAL WORKS

14.1 SCOPE:

The scope of this section comprises of Design, Manufacturing, supply, erection, testing and commissioning of Electrical Power/ control panels, wiring and earthing of all 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.

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

14.2 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.

14.3 WIRING SYSTEM:

All power wiring shall be carried out with 1100 volt grade XLPE insulated, armoured, overall, PVC sheathed (outer sheath shall be FRLS compounded) aluminium/Copper 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.

14.4 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.

14.5 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.

14.6 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.

14.7 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. Bus Bar shall be sized at 0.8 Amp/sqmm of the cross sectional area of aluminium conductor.

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.

14.8 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.

14.9 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.

14.10 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.

14.11 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) MOULDED CASE CIRCUIT BREAKERS (MCCB):

MCCBs shall satisfy the requirements of IS-13947 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.

b) 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: 13703 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:13947 as amended to date.

c) 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.

d) 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.

e) 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.

f) 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: 13947 - Part 3. 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.

g) HRC Fuses:

Fuses shall be high Rupturing capacity and shall be in accordance with relevant ISS 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.

h) Starters:

Each motor shall be provided with a starter of suitable rating. Starter shall be in accordance with the relevant ISS. 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.

i) CONTACTORS:

The contactors shall meet with the requirements of IS: 13947, Part 4.

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.

j) 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.

k) Current Transformers:

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

l). 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.

m) 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.

n) 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.

o) Toggle Switch:

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

p) 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.

q) Cables:

M.V. cables shall be XLPE insulated PVC sheathed, (outer sheath shall be FRLS compounded) 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.

r) Wires:

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

14.12 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.

14.13 WIRE SIZES:

For all single phase/3 phase wiring, 1100 volts grade XLPE insulated copper conductor cables shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of PVC 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 conductor armoured cables.
iii.	From 12.5HPto15 HP motors	2 x 3 x 16 Sq.mm Copper armoured cables.conductor.
iv.	From 20 HP to 25 HP motors.	2 x 3 x 16 Sq.mm Copper conductor armoured cables.
v.	From 30 HP to 35 HP motors.	2 x 3 x 25 Sq.mm Copper conductor armoured cables.
vi.	From 40 HP to 50 HP motors.	2 x 3 x 35 Sq.mm Aluminium conductor armoured cables.
vii.	From 60 HP to 75 HP motors (Auto Transformer starter)	3 x 70 Sq.mm. aluminium conductor armoured cables.
viii.	100 HP motor (Auto Transformer Starter) 1 No.	3 x 150 Sq.mm aluminium armoured conductor.cables.
ix.	200 HP motor (Auto Transformer Starter)1 No.	3 x 225 Sq.mm aluminium conductor armoured cables.
x.	300 HP motor (Auto Transfo-rmer Starter). 2 Nos.	3 x 240 Sq.mm aluminium conductor armoured cables.
xi.	400 HP motor (Auto Transfo-rmer Starter). 2 Nos.	3 x 300 Sq.mm aluminium conductor 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:

S.No	Motor Capacity	Type of Starter	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

S.No	Motor Capacity	Type of Starter	Contactor Current capacity (in Amps) (AC3 duty)	Overload relay range (in Amps)
3.	10 HP	DOL	32	13-21
4.	12.5HP	STAR DELTA	25	9-14
5.	15HP	STAR DELTA	25	10-16
6.	20 HP	STAR DELTA	32	14-23
7.	25 HP	STAR DELTA	32	14-23
8.	30 HP	STAR DELTA	45	20-32
9.	35 HP	STAR DELTA	45	20-32
10.	40 HP	STAR DELTA	45	30-50
11.	45 HP	STAR DELTA	65	30-50
12.	50 HP	STAR DELTA	65	30-50
13.	60 HP	AUTO TRANSFORMER / reduced Volt	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. OPERATED 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-

S.No	Motor Capacity	Type of Starter	Contactor Current capacity (in Amps) (AC3 duty)	Overload relay range (in Amps)
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-

14.14 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
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 control panel 63 Amps to 100 Amps rating.	2 Nos. 8mm dia GI wires
iii.	3 phase switches and control panels 125 Amps to 200 Amps rating.	2 Nos. 25 x 3mm GI tapes.
iv.	3 phase switches and control panels, bus ducts above 200 Amps rating.	2 Nos. 25mm x 6mm GI tapes.

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 including 10 HP rating.	2 Nos. 3mm dia copper wire
ii.	Motors 12.5 HP to 40 HP capacity	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 wires.

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

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

14.15 MOTORS:

All motors shall be confirming to energy efficient motors. IS : 12615 – 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.

14.16 DRAWINGS:

Shop drawings for control panels and wiring of equipment showing the route of conduit/cable shall be submitted by the contractor for approval of Architect/Consultant

before starting the fabrication of panel and starting the work. On completion, four sets of completion "As-installed" drawings incorporating all details like, conduit routes, number of wires in conduit, location of panels, switches, junction/pull and cable route etc. shall be furnished by the Contractor.

14.17 TESTING:

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

14.18 PAINTING:

All sheet steel work shall under go a process of degreasing, through cleaning, and painting with a high corrosion resistant primer. All panels shall then be backed in an over the finishing treatment shall be by application of synthetic enamel paint of approved shade.

15.0 TECHNICAL DATA SHEETS:

Contractor shall fill in detailed technical data sheets for each equipment.

A) TECHNICAL DATA FOR HOT WATER GENERATOR:

1.1 GENERAL:

a) Model No. :

b) Heat output :

c) Rated outlet temp. :

d) Efficiency :

e) Rated outlet pressure :

f) Water flow rate :

g) Fuel :

1.2 HEAT TRANSFER ZONE:

a) No. of flue gas passes :

b) Average flue gas temp. :

c) Tube material :

1.3 BURNER:

a) Type :

b) Make :

c) Fuel consumption :

1.4 FUEL OIL PUMP:

a) Manufacturer :

b) Gear Pump No. :

c) Capacity :

d) Material of construction

i) Casing :

ii) Gear :

e) Motor make :

f) Nozzle- Suction/delivery :

1.5 FUEL OIL FILTERS:

a) Type and make :
b) Capacity :
c) Quantity :
d) Type of filter medium :

1.6 HOT WATER CIRCULATION PUMPS:

a) Manufacturer :
b) Type :
c) Quantity :
d) Motor rating :
e) Material of construction

i) Casing :
ii) Impeller :

f) Motor Make :

1.7 COMBUSTION AIR FAN:

a) Make :

b) Type :

c) Quantity :

d) Capacity :

e) Fan speed :

f) Motor rating :

g) Motor make :

h) Suction filter :

i) Construction Material of Blower :

1.8 FLUE GAS:

a) Co2 % :

b) Density at NTP :

c) Outlet Temp. :

d) Flue gas duct size :

e) Flue gas flow :

B) HEAT PUMP:

a)	Model No.	:
b)	Heat output (KW)	:
c)	Outlet temp.	:
d)	Inlet temp.	:
e)	Pressure drop(Cond)	:
f)	Hot Water flow rate	:
g)	Chilled Water (TR)	:
c)	Outlet temp.	:
d)	Inlet temp.	:
e)	Pressure drop.(Evop.)	:
f)	Child Water flow rate	:
g)	Refrigent Type	:
h)	COP at design Conditions	:
i)	Size of Unit	:
k)	Weight	:
l)	Noise Level at 3.0 Mt.	:
m)	Type of Compressor	:
n)	Type of Chiller	
o)	Type of Condenser	:
p)	Power Consumption	:

C) PUMPS

Make :

Model :

No. of Stages :

Head/Stage :

Power Requirement :

Efficiency :

Discharge in l.p.s. :

Total Head :

Suction end I.D. :

Delivery end I.D. :

MATERIAL:

a) Body :

b) Impeller :

c) Shaft :

Type of impeller :

MOTOR:

Make :

Model :

R.PM :

Rating :

Over Load Capacity :

Class of Insulation :

Details of Additional protection in winding :

Motor Efficiency :

D) PLATE HEAT EXCHANGER:

Make :

Model :

Material of Plates :

Thickness :

Total Heat Transfer Area :

	Design Flow	Design Pressure Drop	Design Temperature	
			In	Out
Primary Side				
Secondary Side				

Note : Vendor shall submit the performance curve, catalogue, dimension detail, installation details along with Tender document.

III) LIST OF APPROVED MAKES FOR MECHANICAL WORKS:

S. NO	ITEM DESCRIPTION	MAKES
1.	Hot Water Generator	Thermax/ Forbes Marshall
2.	Heat Pump	Climaveneta /Blue Box
3.	GI Pipes	TATA / Jindal (Hissar)
4.	G.I. Pipe Fittings	Unik/Zoloto 'M'
5.	M.S. Pipes	Jindle Hissar
6.	SS Piping	Viega/Remi/Jai Ambe/Equivalent
7.	Pumps	Grundfoss/ ITT/
8.	PHE	GE / Alfa Level`
9.	Ball Valves	Zoloto/Audco
10.	Butterfly Valves	Zoloto/ Audco/Advance
11.	Non Return Valves	Zoloto/Advance`
12.	Auto Air Vent Valve	Spirax/ Thermax
13.	3- Way Valve/Solenoid Valves	
14.	Insulation	
a)	For Hot Water piping in the Plant Room	Lloyd/Rockwool
b)	For Hot Water Pipe (CPVC)	Thermaxlex/ Trocellen
15.	Level Controller	Minilec/Technika
16.	Pressure Gauges	H Guru/Feibig
17.	Dial Thermometers	H Guru/Feibig
18.	Y Strainers	Sant/ Maharaj/ Zoloto
19.	Tanks	Fabricated
20.	Chimney	Fabricated
21.	Water Flow Meter	Kent/Shlumburger
22.	Anti Vibration Mounting	Resistoflex
23.	Softener with Brine Tank	Thermax / Ion Exchange

S. NO	ITEM DESCRIPTION	MAKES
24.	Anti Corrosion Tape	Pypkote/Coatek
25.	Strainer (Y Strainer/Bucket Strainer)	Zoloto/Emerald/Maharaja Casting.
B)	**ELECTRICAL WORKS**	
1.	MV Boards, MCCs	Adlec /Tricolite/SPC/Milestone
2.	MCB Distribution Boards	L&T (Hager) /Siemens/ABB/ Legrand
3.	ACB	L&T (U-Power) / ABB (E-max) / Siemens (3WL)/Schneider(Master Pact-NW)
4.	Moulded Case Circuit Breaker	L&T(D-sine)/ABB (T-Max) /Siemens (3VL)/ Schneider(N.S. Series)
5.	Miniature Circuit Breaker	L&T(Hager)/Siemens/ABB / Legrand
6.	Switch Fuse & Fuse Switch Units	L&T/HH-Elcon / Seimens/ ABB
7.	Contactors and Starters	L&T/Siemens / ABB / Schneider
8.	Change over Switches	HPL Sochomech/ L&T/Havells/Tricolite
9.	Voltage Transformer	Kappa / Precise / C & S
10.	Current Transformer	Kappa / Precise / C & S / Gilbert & Maxwell
11.	ELCB/RCCB	L&T/Neptune/ ABB/ Scheneider / Legrand
12.	Timers	L&T/BCH/Siemens
13.	Push Buttons	L&T/Siemens/BCH
14.	Indicating Lamps	L&T/BCH/Siemens
15.	Fuses & Fuse bases	L&T/GE/Siemens
16.	Digital KWH Meters with RS 485 Ports	Neptune (Ducatti)/ Conserv
17.	Selector Switches and Rotary Switches	Kaycee/L&T
18.	Indicating Instruments (Analogue)	AE/Rishabh/ Neptune / Conserv
19.	Terminals	Elmex/Wago
20.	LT Cables (Power & Control)	Universal/KEI/Nicco/Polycab
21.	PVC insulated Copper Wires	Finolex/ Polycab/RR/ Skyline
22.	Cable Glands Single/Double Compression	Comet/Dowells

S. NO	ITEM DESCRIPTION	MAKES
23.	PVC rigid conduits	AKG/BEC/Poly Pack
24.	MS Conduits (ISI Mark)	AKG/BEC
25.	Switches, Sockets, Plugs etc	North West /Crab Tree/ ABB/Siemens / Legrand
26.	Industrial sockets in sheet steel enclosure with MCB	Bals / Merlin Gerin / Legrand
C	**Miss. Items**	
1	Water Treatment Plant	Ion Exchange/Thermax
2.	Gear Pump	Rotodel
3.	Level Controller	Minilec
4.	CPVC Pipe Class 10Kg./Cm2	Astral-Flow-gard/Supreme/Jain pipes
5.	Portable Fire Extinguishers	Vijay Fire/Steelage/Minimax

PROJECT: CONSTRUCTION/EXTENSION OF GURU RAMDASS LANGER HALL AT SHIHARMINDER SAHAB, AMRITSAR

IV) LIST OF DRAWINGS

S. No.	Description	Drawing No.
1.	PLANT ROOM LAYOUT	HWS-1
2.	HOT WATER SYSTEM SCHEMATIC	HWS-2

PROJECT : CONSTRUCTION/EXTENSI0N OF GURU RAMDAS LANGAR HALL AT SRI HARMINDER SHAB, AMRITSAR

V) SUMMARY OF COST FOR HOT WATER SYSTEM

21.5.2022

S.No.	Description	Amount (Rs.)
1.0	HEAT PUMPS	
2.0	HOT WATER GENERATORS	
3.0	MECHNICAL WORKS	
4.0	ELECTRICAL WORKS	
	TOTAL (Rs.)	

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
2.0	**HOT WATER GENERATRS**				
2.1	Supply and Commissionning including the cost to include freight up to site, all taxes & duties etc.				
a)	Coil type (horizontal type) factory supplied HSD fired hot water generator, non storage type of 6,00,000 Kcal/Hr. capacity complete as per specifications with circulating pump including following accessories.				
b)	Built-in electrical panel as per specifications.				
c)	All mounting fittings and safety valves with all accessories. Flue gas sampling point, digital type thermometer at inlet (0-100 ºC) and at outlet (0-100 ºC), pressure gauge (0-10) Kg/cm² and temperature controller (0-200 ºC) at inlet & outlet as required.				
d)	Field mounted temperature gauge for flue gas. Flue gas damper with proximity (limit) switch.				
e)	All interconnecting wiring / cabling between hot water generator and electrical panel.				
f)	Valves & fittings on hot water inlet & outlet.				
g)	HWG inlet & outlet butterfly valve [2 Nos]				
h)	Non return valve [1 No.]				
i)	Y type strainer [1 No.]				
j)	Pressure gauge [2 Nos.]				
k)	Thermometer [2 Nos.]				
l)	HSD fired modulating/on-off burner with accessories as required.				
m)	Constant voltage stabilizer (For control circuit only).				
n)	The Hot Water Generator shall have in-built facility to stop /start on demand from the hot water tank's thermostat as required.				
	Quantity	Nos.	1		
2.2	**APPROVAL FROM AUTHORITY :**				
	Preparation of Hot Water Generators Room layout plan, Schematic diagram, piping layout and obtaining provisional approval from local authority before procurement of material and obtaining final approval of 2 Nos.Hot Water Generators and piping network & accessories.	Lot	RO	0	
2.3	Obtaining provisional approval and final license for Hot Water Generators	Each	RO	0	
	TOTAL CARRIED OVER TO SUMMARY				

PROJECT : CONSTRUCTION/EXTENSI0N OF GURU RAMDAS LANGAR HALL AT SRI HARMINDER SHAB, AMRITSAR

VI) BILL OF QUANTITIES FOR HEAT PUMPS & HOT WATER GENERATORS

21.5.22

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)
1.0	**WATER TO WATER HEAT PUMP TO GENERATE HOT WATER**				
i)	Supply and Commissionning including the cost to include freight up to site, all taxes & duties etc.				
ii)	Water to Water Heat Pump to Generate Hot Water at 60^0 C and simultaneous chilled water as by product to be used for Airconditioning. Screw compressors with R-134a refrigerant or equivelant, complete with open/hermetically sealed refrigerant cooled motor of 415 + 10% volts, 3 phase, 50 Hz AC supply with star delta starter and isolation switch, shell & tube type chiller & condenser with descaling & drain valves, flanged pipe joints, Factory insulated, Electrical Pannel & microprocessor control panel for multiple functions mounted on the machine, along with required accessories etc complete as specified.				
iii)	Suitable Vibration pads & Flow switches for each unit				
iv)	Heating Capacity : 700 KW				
v)	Hot Water Supply Temperature: 60^0 C				
vi)	Coling Capacity : 150 TR				
vii)	Chilled Water Temperature : 12^0 C in/ 7^0 C out				
viii)	Fouling Factor : 0.0005 FPS				
ix)	Cable Terminations : Aluminium				
	Cost				
	a) Cost of Heat Pump (in USD)	*Nos*	*2*		
	b) Cost of Heat Pump (in Rs)	Nos	2		
	c) Custom Duty @38.6%	Nos	2		
	d) Port Clearance, local transportation and commissioning at site	Nos	2		
	e) GST @ 18% on item d)	Nos	2		
1.2	Comperhansive AMC After the expiring of defect liability period				
	a) I^{st} Year	Lot	L.S.		
	b) II^{nd} Year	Lot	L.S.		
	c) III^{rd} Year	Lot	L.S.		
	d) IV^{th} Year	Lot	L.S.		
1.3	Cost of recommended spare parts for 4 years Note: 1USD= Rs. 77.82	Lot	L.S.		
	TOTAL CARRIED OVER TO SUMMARY				

PROJECT : CONSTRUCTION/EXTENSI0N OF GURU RAMD AS LANGAR HALL AT SRI HARMINDER SHAB, AMRITSAR

3) BILL OF QUANTITIES FOR MECHANICAL WORKS

21.5.2022

S. No.	Description	Qty	Unit	Rate	Amount
A.	**HOT WATER SYSTEM EQUIPMENT:**				
1.0	**HEAT PUMPS:**				
1.1	Unloading, leading, Installation, Testing and Commissioning of Water to Water Heat Pump to Generate Hot Water at 60^0 C and simultaneous chilled water as by product to be used for Airconditioning. Screw compressors with R-134a refrigerant or equivelant, complete with open/hermetically sealed refrigerant cooled motor of 415 + 10% volts, 3 phase, 50 Hz AC supply with star delta starter and isolation switch, shell & tube type chiller & condenser with descaling & drain valves, flanged pipe joints, Electrical Pannel & microprocessor control panel for multiple functions mounted on the machine, along with required accessories etc complete as specified.				
a)	700 KW Water to Water Heat Pumps	Set	2 (2W+0S)		
b)	Supply, installation, Testing & Commissioning of Insulated Valves and Fitting with Flanges				
	Chiled Water Side				
i)	Butterfly Valve 125 mm dia	Nos.	4		
ii)	Balancing Valve 125 mm dia	Nos.	2		
iii)	Y-Strainer 125 mm dia	Nos.	2		
iv)	Ball Valve 25 mm dia (Drain Valve)	Nos.	2		
v)	Dial Type Pressure Gauge with gun metal Isolation cock	Nos.	4		
vi)	Thermometer	Nos.	4		
	Hot Water Side				
i)	Butterfly Valve 150mm dia	Nos.	4		
ii)	Balancing Valve 150 mm dia	Nos.	2		
iii)	Y-Strainer 150 mm dia	Nos.	2		
iv)	Ball Valve 25 mm dia (Drain Valve)	Nos.	4		
v)	Dial Type Pressure Gauge with gun metal Isolation cock	Nos.	4		
vi)	Thermometer	Nos.	4		
2.0	**HOT WATER GENERATOR:**				
1.1	Unloading, leading, Installation, Testing and Commissioning of coil type factory supplied H.S.D./ L.D.O. fired Hot Water generator rated for 6,00,000 kcal/hr with built in econmizer with drain valve, circulating water pump inclusive of following accessories.				
a)	Hot Water Generator:	Set	1 (S)		
b)	Supply, installation, Testing & Commissioning of insulated Valves and Fitting on Hot Water Inlet & Outlet.with Flanges				
i)	Butterfly Valve 80 mm dia	Nos.	2		
ii)	Check Valve 80 mm dia	Nos.	2		

S. No.	Description	Qty	Unit	Rate	Amount
iii)	Y-Strainer 80 mm dia	Nos.	1		
iv)	Ball Valve 25 mm dia	Nos.	1		
v)	CVT for Boiler Control (Supply & Installation)	Nos.	1		
3.0	**HOT WATER TANK - DOMESTIC WATER SYSTEM:**				
3.1	Supply, installation, testing & commissioning of SS 304 vertical hot water storage tank (Capacity 6000 Lts) suitable for minimum operating pressure. The tank shall be fabricated out of 6 mm S.S. 304 Sheets for shell and 8 mm thick for dish ends 9 (minimum). Tank shall be provided inlet / outlet, overflow / drain connection with MH cover (450 mm I.D.) pressure relief valves, pressure gauge at inlet / outlet with isolation cock, thermometer at inlet / outlet. All the valves & accessories shall be suitable for an operating pressure as given below.				
	Tank shall be insulated as per specification, including 24 gauge aluminium cladding. (inlet temperature to hot water storage tank 55-60 deg.C). The flanges shall be machined from SS304 sheets with dimensions confirming to ANSI, B 16.5 No. 150. The nozzles shall be SS pipes. (Tank shall be fabricated as per unfired pressure vessel code IS 2825-1969, IS 226 / IS 2062).				
a)	Hot Water Mixing Tank working pressure 10 kg/cm²	Nos	2		
b)	Supply, installation, Testing & Commissioning of insulated Valves and Fitting With Flanges (For 2 Nos. Tanks)				
1	Cold Water Inlet Ball Valve 50 mm dia	Nos.	2		
2	Check Valve in Cold Water inlet line 50 mm dia	Nos.	2		
3	Hot Water Outlet Secondary side Butterfly Valve 100mm dia	Nos.	2		
4	Hot Water Inlet Secondary side Butterfly Valve 100 mm dia	Nos.	1		
5	Hot Water Return Inlet Ball Valve 40 mm dia	Nos.	2		
6	Hot Water Return Check Valve 40 mm dia	Nos.	2		
11	Hot Water Outlet Butterfly Valve 50 mm dia	Nos.	2		
12	Hot Water Outlet Check Valve 50 mm dia	Nos.	2		
13	Tank Drain Conn. Butterfly Valve 50 mm dia	Nos.	2		
14	Pressure Gauge	Nos.	2		
15	Dia Type Thermometer	Nos.	2		
16	Pressure Relief Valve	Nos.	2		
17	Safety Valve	Nos.	2		
18	Spare Butterfly Valve 50 mm dia	Nos.	2		
19	Temperature Controller	Set	2		
20	Insulation	Set	2		
4.0	**MAKE UP WATER TANK**				
a)	Supply, Installation, testing & commissioning of Mahe up Water Feed Tank of 500 ltrs. made out of 5 mm thick M.S. Sheets.	Nos.	1		
b)	Supply, installation, Testing & Commissioning of insulated Valves and Fittings with Flanges				
I)	Soft Water inlet Ball Valve 25 mm dia	Nos.	1		
ii)	Soft Water Inlet Float Valve 25 mm dia	Nos.	1		
iii)	Hot Water Generator Expansion line butterfly valve 50 mm dia	Nos.	1		
iv)	Y Strainer 50 mm dia	Nos.	1		

S. No.	Description	Qty	Unit	Rate	Amount
v)	Glass level indicator along with accessories and stop cocks	Nos.	1		
vi)	Drain Line Ball Valve 40 mm dia	Nos.	1		
vii)	Ball Valve 25 mm dia	Nos.	2		
viii)	Vent	Nos.	1		
5.0	**INSULATED EXPANSION TANKS**				
a)	Supply, installation, testing and commissioning of insulated expansion tank made out of 3 MS plate. The tank shall be complete with copper piping, fittings, float valve, drain and make up connections with valve duly insulated with 13mm thick insulation and protective coating.				
i)	900 x 900 x 900 mm high For Chilled Water on the Terrace	No.	1		
ii)	750 x 750 x 600 mm high For Chilled Water in the Plant Room	No.	1		
b)	Supply, installation, Testing & Commissioning of insulated Valves and Fittings with Flanges (For 2 Nos. Tanks)				
i)	Water outlet Ball Valve 40 mm dia	Nos.	2		
ii)	Make up Water inlet Ball Valve 25 mm dia	Nos.	2		
iii)	Make Up Water Inlet Float Valve 25 mm dia	Nos.	2		
iv)	Glass level indicator along with accessories and stop cocks	Nos.	2		
v)	Drain Line Ball Valve 25 mm dia & Over flow connection	Nos.	2		
vi)	Vent 25mm Dia	Nos.	2		
6.0	**HEAT EXCHANGERS:**				
6.1	For Hot Water Generators System of 60000 kcal/hr. Each	Nos.	2 (2W-0S)		
	Hot Water Flow in primary circuit 35294 LPH				
	Water Flow in secondary circuit 17142 LPH				
	Temp. Primary Circuit Inlet - 90 Deg. C Outlet - 73 Deg. C				
	Temp. Secondary Circuit Inlet - 25 Deg. C Outlet - 60 Deg. C				
6.1.1	Supply, installation, Testing & Commissioning of insulated Valve & Fittings with Flanges for 2 Nos. PHEs				
i)	Butterfly Valve 80 mm dia	Nos.	4		
	Buterfly Valve 65 mm dia	Nos.	4		
ii)	Non Return Valve 80 mm dia	Nos.	2		
	Non Return Valve 65 mm dia	Nos.	2		
iii)	Dial Type Thermometer	Nos.	8		
iv)	Pressure Gauges	Nos.	8		

S. No.	Description	Qty	Unit	Rate	Amount
6.2	For Heat Pumps System of 600000 kcal/hr.Each Flow in primary circuit 120000 LPH Flow in secondary circuit 40000 LPH Temp. Primary Circuit Inlet - 60 Deg. C Outlet - 55 Deg. C Temp. Secondary Circuit Inlet - 40 Deg. C Outlet - 55 Deg. C	Nos.	2 (2W-0S)		
6.2.1	Supply, installation, Testing & Commissioning of insulated Valve & Fittings with Flanges for 2 Nos. PHEs				
i)	Butterfly Valve 150 mm dia Butterfly Valve 80 mm dia	Nos. Nos.	2 2		
ii)	Non Return Valve 150 mm dia Non Return Valve 80 mm dia	Nos. Nos.	1 1		
iii)	Dial Type Thermometer	Nos.	4		
iv)	Pressure Gauges	Nos.	4		
7.0	**Pumps**				
	Providing, installation, testing and commissioning of following insulated pumps suitable for 415 Volts connected with T.E.F.C. induction motor, M.S.channel, base plate complete with vibration isolators, isolating valve on suction and discharge, non return valve on discharge, pressure gauges with stop cock and dial type thermometer on suction or discharge. The pump shall have mechanical seal. The pump shall be SS casing, impeller, shaft and CI (Epoxy coated) base. Each pump shall be suitable for automatic/manual operation (suitable for Hot Water circulation system).				

S. No.	Description	Qty	Unit	Rate	Amount
7.1	**Domestic Hot Water Return Pumps**				
a)	Pump Flow - 30 GPM Head - 25 mtrs Speed-2900 RPM Quantaty -	Nos.	2 (1W+1S)		
b)	Valves / Fittings :				
	Butterfly Valves 50 mm dia	Nos.	4		
	Check Valve 50 mm dia	Nos.	2		
	Y-Strainer 50 mm dia	No.	2		
	Dial Type Pressure Gauge with gun metal Isolation cock	Nos.	4		
	Thermometer	Nos.	4		
7.2	**Secondary Hot Water Pumps for Hot Water Generators**				
a)	Pump Flow - 150 GPM Head - 20mtrs Speed-1450 RPM Quantaty -	Nos.	2 (1W+1S)		
b)	Valves / Fittings :				
	Butterfly Valves - 80 mm dia	Nos.	4		
	Check Valve - 80 mm dia	Nos.	2		
	Y-Strainer - 80 mm dia	No.	2		
	Dial Type Pressure Gauge with gun metal Isolation cock	Nos.	4		
	Thermometer	Nos.	4		
3.3	**Secondary Hot Water Pumps for Heat Pumps**				
a)	Pump - Flow - 352 GPM Head - 00 mtrs Speed-1450 RPM Quantaty -	Nos.	2 (1W+1S)		
b)	Valves / Fittings :				
	Ball Valves - 100 mm dia	Nos.	4		
	Check Valve - 100 mm dia	Nos.	2		
	Y-Strainer - 100 mm dia	Nos.	2		
	Dial Type Pressure Gauge with gun metal Isolation cock	Nos.	4		
	Thermometer	Nos.	4		
4.4	**Hot/Condenser Water Pumps for Heat Pump(HP)**				
a)	Pump - Flow - 590 GPM Head - 22 Mtrs. Speed-1450 RPM Quantaty -	Nos.	3 (2W+1S)		
b)	Valves				
	Butterfly Valve - 150mm dia	Nos.	6		
	Non Return Valve - 150 mm dia	Nos.	3		
	"Y" type Strainer - 150 mm dia	Nos.	3		
	Dial Type Pressure Gauge with gun metal Isolation cock	Nos.	6		
	Thermometer	Nos.	6		

S. No.	Description	Qty	Unit	Rate	Amount
4.5	**Chilled Water Insulated Pumps for Heat Pump(HP)**				
a)	Pump - Flow - 412GPM Head - 24 Mtrs. Speed-1450 RPM Quantaty -	Nos.	3 (2W+1S)		
b)	Valves				
	Butterfly Valve - 125 mm dia	Nos.	6		
	Non Return Valve - 125 mm dia	Nos.	3		
	"Y" type Strainer - 125 mm dia	Nos.	3		
	Dial Type Pressure Gauge with gun metal Isolation cock	Nos.	6		
	Thermometer	Nos.	6		
	TOTAL OF - A				
B.	**WATER PIPING & ACCESSORIES:**				
1.0	**HOT WATER PIPING:**				
1.1	Supply, laying, fixing, testing & commissioning of MS class 'C' Hot water pipes complete with all necessary fittings such as bends, tees, reducers, flanges etc and supports such as clamps, anti-vibration hangers etc duly insulated with rockwool pipe sections100Kg/Cum density with Al cladding of 26 G in accordance with specifications and drawings. Painting of legends with direction arrow on insulation.				
a)	200 mm dia x 6mm (50mm Thick Insulation)	RM	24		
b)	150 mm dia (50mm Thick Insulation)	RM	25		
c)	100 mm dia (50mm Thick Insulation)	RM	30		
d)	80 mm dia (50mm Thick Insulation)	RM	30		
e)	65 mm dia (50mm Thick Insulation)	RM	20		
f)	50 mm dia (50mm Thick Insulation)	RM	15		
g)	40 mm dia (50mm Thick Insulation)	RM	24		
h)	32 mm dia (50mm Thick Insulation)	RM	24		
i)	25 mm dia (50mm Thick Insulation)	RM	12		
j)	20 mm dia (50mm Thick Insulation)	RM	12		
k)	15 mm dia (50mm Thick Insulation)	RM	12		
1.2	Providing, fixing, jointing and testing in position the following dia of **S.S.304 sch. 40 seamless pipes** dimension as per ANSI B 36-10 with fittings such as tees, crosses, elbows, reducers etc. insulated with rockwool pipe sections100Kg/Cum density with Al cladding of 26 G in accordance with specifications and drawings. Painting of legends with direction arrow on insulation.				
a)	100 mm dia (50mm Thick Insulation)	RM	100		
b)	80 mm dia (50mm Thick Insulation)	RM	30		
c)	65 mm dia (50mm Thick Insulation)	RM	40		
d)	50 mm dia (50mm Thick Insulation)	RM	50		
e)	40 mm dia (50mm Thick Insulation)	RM	15		
f)	32 mm dia (50mm Thick Insulation)	RM	25		
g)	25 mm dia (50mm Thick Insulation)	RM	R.O		
h)	20 mm dia (50mm Thick Insulation)	RM	48		
i)	15 mm dia (50mm Thick Insulation)	RM	R.O		

S. No.	Description	Qty	Unit	Rate	Amount
1.3	Supply, laying, fixing, testing & commissioning of GI class 'C' Hot water pipes complete with all necessary fittings such as bends, tees, reducers, flanges etc and supports such as clamps, anti-vibration hangers etc duly insulated with rockwool pipe sections100Kg/Cum density with Al cladding of 26 G in accordance with specifications and drawings. Painting of legends with direction arrow on insulation.				
a)	200 mm dia (50mm Thick Insulation)	RM	24		
b)	150 mm dia (50mm Thick Insulation)	RM	25		
c)	100 mm dia (50mm Thick Insulation)	RM	26		
d)	80 mm dia (50mm Thick Insulation)	RM	30		
e)	65 mm dia (50mm Thick Insulation)	RM	10		
f)	50 mm dia (50mm Thick Insulation)	RM	25		
g)	40 mm dia (50mm Thick Insulation)	RM	5		
h)	32 mm dia (50mm Thick Insulation)	RM	2		
i)	25 mm dia (50mm Thick Insulation)	RM	2		
j)	20 mm dia (50mm Thick Insulation)	RM	2		
k)	15 mm dia (50mm Thick Insulation)	RM	2		
1.4	Providing and fixing insulatted Butterfly/Balll valves with flanges of following sizes as per specifications and drawings.				
a)	125mm dia	RM	R.O		
b)	100 mm dia	RM	R.O		
c)	80 mm dia	RM	R.O		
d)	65 mm dia	RM	R.O		
e)	50 mm dia	Nos.	R.O		
f)	40 mm dia	Nos.	R.O		
g)	32 mm dia	Nos.	R.O		
h)	25 mm dia	Nos.	R.O		
i)	20 mm dia	Nos.	R.O		
j)	15 mm dia	Nos.	R.O		
1.5	Providing, fixing, testing and commissioning pressure gauge of 150 mm dia with bronze stop cock and single piece U-syphon complete.	Nos,	2		
1.6	Providing in bulb thermometers in brass casing of immersion type in the thermometers pockets:				
a)	Range : 0ºC - 100ºC	Nos.	2		
	Range : 0ºC - 600ºC	Nos.	2		
2.0	**CHILLED WATER PIPING**				
	Supply, laying, fixing, testing & commissioning of MS class 'C' chilled water pipes complete with all necessary fittings such as bends, tees, reducers, flanges etc and supports such as clamps, anti-vibration hangers etc duly insulated with expanded polystyrene TF quality density shall bot be less than 18 Kg/m3 complete complete with 26G. Aluminium sheets per specifications and drawings. Painting of legends with direction arrow on insulation.				

S. No.	Description	Qty	Unit	Rate	Amount
a)	**For Internal Pipes (Insulated)**				
i)	200 mm dia (50mm Thick Insulation)	RM	50		
ii)	150 mm dia (50mm Thick Insulation)	RM	170		
iii)	125 mm dia (50mm Thick Insulation)	RM	200		
iv)	100 mm dia (50mm Thick Insulation)	RM	90		
v)	80 mm dia (40mm Thick Insulation)	RM	130		
vi)	65 mm dia (40mm Thick Insulation)	RM	65		
vii)	50 mm dia (40mm Thick Insulation)	RM	95		
viii)	40 mm dia (40mm Thick Insulation)	RM	25		
ix)	32 mm dia (40mm Thick Insulation)	RM	20		
x)	25 mm dia (25mm Thick Insulation)	RM	5		
xi)	20 mm dia (25mm Thick Insulation)	RM	5		
b)	**For Exposed Pipes on Terrace (Insulated)**				
i)	125 mm dia (50mm Thick Insulation)	RM	R.O.		
ii)	100 mm dia (50mm Thick Insulation)	RM	R.O.		
iii)	80 mm dia (50mm Thick Insulation)	RM	R.O.		
iv)	65 mm dia (50mm Thick Insulation)	RM	R.O.		
v)	50 mm dia (50mm Thick Insulation)	RM	R.O.		
vi)	40 mm dia (50mm Thick Insulation)	RM	R.O.		
vii)	32 mm dia (50mm Thick Insulation)	RM	R.O.		
viii)	25 mm dia (40mm Thick Insulation)	RM	R.O.		
ix)	20 mm dia (40mm Thick Insulation)	RM	R.O.		
c)	**Condensate Water Pipes** Supplying, laying, fixing, testing & commissioning of PVC pipes of 6 Kg/cm^2, insulation of Nitrite Rubber of thickness 9 mm and complete with all necessary fittings such as elbows, tees, reducers, along with drain trap and supports such as clamps etc as required at site.				
i)	80 mm dia (PVC)	RM	R.O.		
ii)	65 mm dia (PVC)	RM	R.O.		
iii)	50 mm dia (PVC)	RM	R.O.		
iv)	40 mm dia (PVC)	RM	20		
v)	32 mm dia (PVC)	RM	15		
vi)	25 mm dia (PVC)	RM	20		
vii)	20 mm dia (PVC)	RM	20		
2.1	**VALVES (INSULATED)** Supplying, fixing, testing and commissioning in position the following valves, strainer etc. in chilled water pipe line complete with insulation,flanges etc as per specifications & drawings.				
a)	**<u>Butterfly Valves:</u>**				
i)	150 mm dia	Nos.	R.O.		
ii)	125 mm dia	No.	R.O.		
iii)	100 mm dia	No.	R.O.		
iv)	80 mm dia	No.	R.O.		
v)	65 mm dia	Nos.	R.O.		
vi)	50 mm dia	Nos.	3		

S. No.	Description	Qty	Unit	Rate	Amount
b)	**Ball Valves :**				
i)	40 mm dia	Nos.	8		
ii)	32 mm dia	Nos.	2		
iii)	25 mm dia	Nos.	15		
iv)	20 mm dia	Nos.	20		
v)	15 mm dia	Nos.	5		
c)	**Y-Strainers / Suction Screen:**				
i)	50 mm dia	No.	R.O		
ii)	40 mm dia	No.	3		
iii)	32 mm dia	No.	R.O		
d)	**Balancing Valves :**				
i)	150 mm dia	Nos.	2		
ii)	125 mm dia	No.	R.O.		
iii)	100 mm dia	No.	R.O.		
iv)	80 mm dia	No.	R.O.		
v)	65 mm dia	Nos.	R.O.		
vi)	50 mm dia	Nos.	2		
vii)	40 mm dia	Nos.	3		
	TOTAL OF - B				

S. No.	Description	Qty	Unit	Rate	Amount
C.	**HSD OIL STORAGE TANK & SUPPLY SYSTEM:**				
1.0	Supply, installation, testing and commissioning of 900 litres capacity tank fabricated from 5 mm thick MS plates. Cost of Tank shall include provision of 450 mm ID Manhole cover, level indicator & flanged connection for inlet, outlet, vent, boiler return and provision for installing probes of level controller. Tank shall be Tank painted with 2 coats of Red Oxide Primer.				
a)	Buffer Tank	No.	R.O.		
b)	Day Oil Tank Cap 990 Lit	No.	1		
‘	Valves and Fittings with Flanges suitable for 10 Kg/Sqcm complete with accessories as ubder:				
I)	Oil inlet Ball Valve 25 mm dia	No	1		
ii)	Oil outlet Valve 50 mm dia	No	1		
iii)	Y Strainer 50 mm dia	No	1		
iv)	Glass level indicator along with accessories and stop cocks	No	1		
v)	Drain Ball Valve 25mm dia with over flow connection	No	1		
vi)	Air-vent 25mm dia	No	1		
2.0	Supply, installation, testing & commissioning of MS class ‘C’ (heavy duty) pipe & fittings like tees, elbows, junctions, unions, bends, plugs etc. RCC pipe sleeves of larger diameter to the provided wherever the pipes are crossing the wall / slab and sleeves as per Consultant’s requirement, including clamps hangers, nuts, bolts etc for pipe supports from wall / ceiling including cutting and making hole in wall / slab and making good the same. Including a coat of Synthetic enamel paint over two coats of primer complete as required.				
2.1	Location : Inside Plant Room				
a.	25 mm dia	RM	18		
b.	32 mm dia	RM	R.O.		
c.	40 mm dia	RM	R.O.		
d.	50 mm dia	RM	24		
4.0	Supply, installation, testing & commissioning of ball valve of the following sizes suitable for pressure of 10 Kg / Sqcm complete with all necessary fittings.				
a.	25 mm dia	Nos.	R.O.		
b.	32 mm dia	Nos.	R.O.		
c.	40 mm dia	Nos	R.O.		
d.	50 mm dia	Nos.	1		
5.0	Supply, installation, testing & commissioning of C.I. non-return valves of the following sizes suitable for pressure of 10 Kg / Sqcm complete with all necessary fittings.				
a.	25 mm dia	Nos.	R.O.		
b.	32 mm dia	Nos.	R.O.		
c.	50 mm dia	Nos.	R.O.		

S.No.	Description	Unit	Qty	Rate (Rs.)	Amount (Rs.)

Notes :

1 Vendor to provide modulation of Boiler Burner as per Load profile complete in all respect.

2 Bidder to submit Design Drawing of Piping including all accessories required to measure Burner Boiler efficiency.

3 The design detail for the founation will be submitted by the vendor which will be executed by the civil contractor.

4 The structural support where ever required will be included in the cost. No additional will be paid for the structural supports.

S. No.	Description	Qty	Unit	Rate	Amount
6.0	Providing and fixing M.S. Flanges.				
a.	25 mm dia	Nos.	R.O.		
b.	40 mm dia	Nos.	R.O.		
c.	50 mm dia	Nos.	R.O.		
d.	65 mm dia	Nos.	R.O.		
			R.O.		
7.0	Providing and fixing Y strainer for oil supply line				
a.	25 mm dia	Nos.	R.O.		
b.	32 mm dia	Nos.	R.O.		
c.	40 mm dia	Nos.	R.O.		
d.	50 mm dia	Nos.	R.O.		
8.0	Providing and fixing unloading point assembly consisting of 1 No. 3 meter long flexible hose with necessary suitable connection for all oil tanker outlet complete with pipes, flanges, elbow & reducer as required.				
a.	50 mm dia	No.	1		
b	25 mm dia	No.	1		
9.0	Supply of Sami Rotary Oil Pump to(Manual Operated) fill the dayoil Tank	No.	1		
	TOTAL OF - C				
D.	**GENERATORS CHIMNEY & BREACHING:**				
5.1	Hot Water Generators Chimney including dampers, main flue pipe, branch flue pipes, supporting arrangement from wall/shaft cowl at top complete in all respects chimney shall be fabricated from M.S. Plates of 5mm thickness.				
a)	350 mm dia branch flue pipe of M.S. Plate between Hot Water Generator & main flue header complete.	RM	20		
b)	450 mm dia main flue pipe of M.S. Pipe from Generator plant room to terrace floor complete in all respect.	RM	50		
c)	Manually Operated M.S Construction damper suitable for operation at 250 deg C in all respect.				
	i)350 mm dia	Nos.	2		
d)	M.S. Flange - 450 mm dia	Nos.	2		
	TOTAL OF - D				
	TOTAL OF MECHANICAL WORKS (A to D)				

PROJECT : CONSTRUCTION/EXTENSI0N OF GURU RAMD AS LANGAR HALL AT SRI HARMINDER SHAB, AMRITSAR

VII) BILL OF QUANTITIES FOR ELECTRICAL WORKS

21.5.2022

S. No.	Description	Qty	Unit	Rate	Amount
	ELECTRICAL WORK:				
1.0	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 Indoor, 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 and drawings. MCC – HOT WATER GENERATOR **Incoming:** Two (2) nos. 800 amps 36KA 4P MCCBs as incomers: One (1) no. 800 amps 36KA 4P MCCB without protection release as bus coupler: The incomers and bus coupler shall be electrically interlocked so that any two of the three shall be "ON" at a time. **Metering & Indication :** Each incomer to have : One (1) No. digital volt, current & Frequency (VAF) Meter with in built selector switch, 800A/5A CL-1.0,15VA CTs and control fuses. One (1) set of three (3) nos. phase indicating lamps with control MCBs. Bus Bar; Electrolytic high conductivity Aluminium three pole and neutral busbars rated at 1000 amps having a maximum current density of 1.0 amp per sq mm insulated with heat shrinkable PVC sleeves as shown in single line diagram. **Outgoings;** Two (2) nos. 500/630A 36KA TPN MCCBs as heat pump feeders. Two (2) nos. 40A 4P 10KA MCBs "C" curve as hot water generator feeders Four (4) nos. 63A 4P 10KA MCBs "C" curve as spare Three (3) nos. Star Delta starters (15 KW each, 2 working + 1 stand by) with auto/manual switch, short circuit protection device (MPCB / MCCB with magnetic protection only), over load relay, ON/OFF/TRIP indication lamps, ON/OFF push buttons, Timer, contactors suitable for auto/manual, remote/local operation, indication, spare potential free contacts for PLC control and feedback & interlocking, Ammeter with selector switch and suitable ratio CTs etc. as required.				

S. No.	Description	Qty	Unit	Rate	Amount
	Three (3) nos. Star Delta starters (15 KW each, 2 working + 1 stand by) with auto/manual switch, short circuit protection device (MPCB / MCCB with magnetic protection only), over load relay, ON/OFF/TRIP indication lamps, ON/OFF push buttons, Timer, contactors suitable for auto/manual, remote/local operation, indication, spare potential free contacts for PLC control and feedback & interlocking, Ammeter with selector switch and suitable ratio CTs etc. as required. Three (3) nos. Star Delta starters (12 KW each, 2 working + 1 stand by) with auto/manual switch, short circuit protection device (MPCB / MCCB with magnetic protection only), over load relay, ON/OFF/TRIP indication lamps, ON/OFF push buttons, Timer, contactors suitable for auto/manual, remote/local operation, indication, spare potential free contacts for PLC control and feedback & interlocking, Ammeter with selector switch and suitable ratio CTs etc. as required. Two (2) Nos. DOL starters (7.5 KW each, 2 working + 1 stand by) with auto/manual switch, short circuit protection device (MPCB / MCCB with magnetic protection only), over load relay, ON/OFF/TRIP indication lamps, ON/OFF push buttons, contactor suitable for auto/manual, remote/local operation, indication, spare potential free contacts for PLC control and feedback & interlocking, Ammeter with selector switch and suitable ratio CTs etc. as required. Two (2) Nos. DOL starters (3.75 KW each, 2 working + 1 stand by) with auto/manual switch, short circuit protection device (MPCB / MCCB with magnetic protection only), over load relay, ON/OFF/TRIP indication lamps, ON/OFF push buttons, contactor suitable for auto/manual, remote/local operation, indication, spare potential free contacts for PLC control and feedback & interlocking, Ammeter with selector switch and suitable ratio CTs etc. as required. Two (2) Nos. DOL starters (2.3 KW each, 2 working + 1 stand by) with auto/manual switch, short circuit protection device (MPCB / MCCB with magnetic protection only), over load relay, ON/OFF/TRIP indication lamps, ON/OFF push buttons, contactor suitable for auto/manual, remote/local operation, indication, spare potential free contacts for PLC control and feedback & interlocking, Ammeter with selector switch and suitable ratio CTs etc. as required. MCC – Hot water generator as described above **Note :** The MCC shall be IP54 ingress protection. Incomer MCCBs shall be (Ics=100% Icu) with 0.4 - 1 x In adjustable overload protection release. MCCBs/MPCBs for starter feeders shall be provided with magnetic release only for short circuit protection. All outgoing MCCB / MCB feeders (without Starters) shall be provided with thermal magnetic protection releases for short circuit & overload protection. All MCCBs shall be (Ics=100% Icu). All MCCBs shall be provided with spreader terminals, phase barriers and rotary handle operating mechanism. All starter feeders shall have provision of controlling from three locations (i.e from MCC, near motor and remote).	No.	1		

S. No.	Description	Qty	Unit	Rate	Amount
	All starter feeders 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/ status feedback. The bidder shall select the ratings as per type -2 co ordination charts of the make to be used.				
2.0	**1.1 KV Cabling**				
2.1	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	**Aluminium Conductor armoured Cables :**				
a)	3.5 core 300 sqmm XLPE AL cable	RM	RO		
b)	3.5 core 185 sqmm XLPE AL cable	RM	70		
2.1.2	**Copper Conductor armoured Cables :**				
a)	3 core 1.5 sqmm XLPE Cu cable	RM	RO		
b)	3 core 2.5 sqmm XLPE Cu cable	RM	160		
c)	3 core 4 sqmm XLPE Cu cable	RM	700		
d)	3 core 6 sqmm XLPE Cu cable	RM	RO		
e)	4 core 10 sqmm XLPE Cu cable	RM	60		
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				
2.2.1	**Aluminium Conductor armoured Cables :**				
a)	3.5 core 300 sqmm XLPE AL cable	Nos.	RO		
b)	3.5 core 185 sqmm XLPE AL cable	Nos.	4		
2.2.2	**Copper Conductor armoured Cables :**				
a)	3 core 1.5 sqmm XLPE Cu cable	Nos.	RO		
b)	3 core 2.5 sqmm XLPE Cu cable	Nos.	8		
c)	3 core 4 sqmm XLPE Cu cable	Nos.	40		
d)	3 core 6 sqmm XLPE Cu cable	Nos.	RO		
e)	4 core 10 sqmm XLPE Cu cable	Nos.	4		
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)	450 mm x 40 x 40 x 2 mm thick	RM	RO		
b)	300 mm x 40 x 40 x 2 mm thick	RM	30		
c)	150 mm x 25 x 25 x 2 mm thick	RM	60		
d)	75 mm x 25 x 25 x 2 mm thick	RM	80		

S. No.	Description	Qty	Unit	Rate	Amount
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.	500		
3	**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 6 mm strip	RM	100		
b)	8 SWG wire	RM	RO		
c)	10 SWG wire	RM	500		
	TOTAL OF ELECTRICAL WORKS				