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1 INSTRUCTION & SPECIAL CONDITIONS FOR SUBMISSION OF TENDER

Subject: Air-Conditioning & Mechanical Ventilation System for Proposed Building of Ghanta Ghar Plaza at Amritsar, Punjab.

1.1 Equipments & Materials of HVAC System

The HVAC System shall comprise of following Equipments & Materials as specified in BOQ.

A) VRV / VRF Outdoor Unit Cool / Heat Pump Type.

B) Standard VRV / VRF Indoor Unit.

C) Double Skinned VRV / VRF DX AHU.

D) Fans.

E) Normal Hi Wall Unit.

F) Under-deck insulation.

G) G.S.S. Ducting, Duct Insulation, Grill / Diffusers etc.

H) Insulated Copper refrigerant piping.

I) Drain water piping duly insulated.

J) All other items as detailed in **"Schedule of Quantities**."

1.2 General

The special conditions of contract given below shall be read in conjunction with the other documents forming part of the contract. In case of any variance, these conditions shall supersede 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 engineer-in-charge will be binding on the contractor.

All HVAC installations shall be of high quality, complete and dully operational including all necessary items and accessories whether or not specified herein. All HVAC work shall be completed in accordance with the regulations and standard to the satisfaction of the Engineer-in-charge.

1.3 Submissions and Opening of Tenders

The tender shall be submitted in two separate sealed covers duly complete in all respects viz. one for "Technical cum Commercial Bid" & other for "Price Bid." The "Technical & Commercial Bid" & "Price Bid" shall be submitted simultaneously. The name of the work and the words " Technical cum Commercial Bid only", "Price Bid only" as the case may be shall be clearly written on the top of the respective sealed covers.

The Technical Bid shall be complete with the following:

i) The Technical bid & un-priced copy of commercial bid shall be submitted in duplicate.

ii) Complete tender documents as given by the employer duly signed for acceptance of all terms and conditions.

iii) Heat load calculations for all areas to be air-conditioned for Summer, & Monsoon or furnish a guarantee that you shall maintain inside conditions as given in the basis of design in the tender with the equipment selected & offered by you based on the tender.

iv) Deviations / Assumptions, if any from Tender specifications.

v) Complete technical particulars as per appendix Performa enclosed.

vi) A set of technical leaflets and selection charts for all the equipments offered.

vii) Bidder should clearly mention the make of equipments from the approved makes for each equipment they wish to offer and must furnish full technical data for the each make separately.

viii) **Earnest Money Deposit (EMD)** - The E.M.D. amounting to Rs. _____only) mentioned herein should be submitted in the form of Demand Draft in Favour of M/s _____ and be of a Nationalized Bank / Schedule Bank Payable at _____. For the selected Contractor, the E.M.D. will be converted to the part of the Security Deposit / Retention Money. Offer from the AC Contractor shall not be accepted if EMD is not given.

The price bid in a separate sealed cover shall be in the same format of schedule of work as given in the tender document.

Place for Submission of Tender :

Mr. _____
_____
_____
_____

Date of Issue of Tender:

_____

Date of Submission of Tender:

_____

1.4 Validity

The tender shall be valid for acceptance for a period of 90 days from the date of submission of the tender.

1.5 Completion Period

The completion period shall be **_____Months** from the date of Letter of Intent.

1.6 Terms of Payment

The following terms of payment shall be mutually agreed upon.

a) 10 % of the total contract value as mobilization advance along with the order against Bank Guarantee valid till completion period & the same will be recovered on pro-rata basis in the interim bills.

b) 70% of contract value on delivery of equipment / materials on pro-rata basis on receipt of verified bills from the engineer in charge.

c) 20% of contract value on pro-rata erection of equipment / materials.

d) 10% of contract on satisfactory commissioning, capacity testing, handing over of plant, submission of as built drawings & operating manuals against a bank guarantee of equivalent amount from scheduled bank valid till defect liability period.

1.7 Retention Money / Security Deposit

The Contractor shall pay a security deposit equal to 5% percent of total tender amount as per the process given below:

Initial Deposit

The contractor whose tender is accepted and shall be required to furnish a security deposit for ensuring satisfactory fulfillment of his contract. This deposit amount will be 2.5% of the tendered amount including EMD and will be deposited in the form of a Bank Guarantee from any Nationalized Bank as per prescribed format mutually agreed.

Balance Security Deposit

The balance security deposit money will be deducted @ 2.5% of the verified amount from every monthly running bill being claimed and paid to the contractor till the project got completed.

Release of Security Deposit

100% of the total security deposit shall be released after completion of defect liability period.

All security deposit shall not bear any interest.

1.8 Liquidated Damages Clause

For all delays attributed to the contractor in completion of job which do not merit extension of time the contractor shall have to pay 0.5 % per week of delay subject to a maximum of 5% of the Contract Value of work. The liquidated damages shall be recoverable from the payments due to air-conditioning contractor. It may be noted that the deduction of liquidated damages shall not, however, absolve the contractor of his responsibility and obligation under the contract to complete the work in totally as required under the contract.

1.9 Tender Drawings

The drawings issued with the tender documents are only for guidance of the tenderer. The actual & final AC drawings shall be prepared by the successful AC Contractor after due co-ordination with other services & shall be approved by Engineer-in-Charge / AC Consultant / Architect before commencement of site work. The tenderer has to ensure that their proposal will meet with all the current rules & regulations pertaining to the relevant local / national statutory.

1.10 Shop Drawings

On the award of the work, the Contractor shall immediately proceed with the preparation of detailed working drawings showing the detail of each equipment that are to be installed and the ancillary works that are to be carried out. All the works are deemed to be included in various items of bill of quantities as applicable.

Three sets of all such working drawings dully signed by the head of the planning & design department of the tenderer shall be submitted to the Engineer-in-charge 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 Engineer-in-charge for approval within 04 (Four) weeks from the date of award of work. The approval of the drawings by the Consultants / Engineer-in-charge shall in no way relieve the Contractor form his obligations to provide a complete and satisfactory plant installation, testing and commissioning as per

intent and purpose as laid down in the specifications. It will be the responsibility of the AC contractor to ensure that laid down inside conditions are maintained at all times.

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 grills / diffusers) and other materials before placing the order. Contractor shall guarantee the specified inside conditions at specified outside conditions. Prior to the erection of Equipments, the contractor shall furnish to the employer (2) two sets of a comprehensive manual for all equipments etc. describing all components furnishing a list of spare parts and setting forth in details the instructions for the operation and maintenance of the plant.

The Contractor shall also fix in the Operating / Maintenance Room, neatly typed and framed, instructions in details, for the starting and running of the plant.

The AC contractor for approval- shall prepare the following shop drawings

a) AC Equipment Layout along with sectional drawings of each installed equipment.

b) Schematic refrigerant piping layout with pipe size.

c) HVAC layout plans of all floors with sections, support details, position of duct dampers / splitter dampers, insulation, etc.

d) AC equipment foundation layout plans and load data.

e) Electrical panel, power & control wiring drawings.

f) Electrical power requirements on AC Layout Plans along with summary.

g) Individual equipment drawings from equipment manufacturer along with technical data sheets. (For Engineer-in-Charge / Consultant's Approval)

h) Any other shop drawings necessary for the project.

1.11 As Built Drawings

The AC Contractor shall submit six sets of paper prints of the as-built drawings & one soft copy, showing accurate record of the work as installed to the Client for his reference. The contractor shall also submit three copies of an Operating Manuals in ring binder describing the brief write up on the system installed, operating instruction for all equipments, catalogues, maintenance of equipments etc

1.12 Instruction / Maintenance Manual

The Contractor shall prepare and produce instruction, operation and maintenance manuals in English for use, operation and the maintenance of the supplied equipment and installations, and submit to the Engineer-in-charge in three copies 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 catalog.
e) Spare parts list.
f) Trouble shooting charts.
g) Drawings.
h) Type and routine test certificates of major items.
i) Six sets of as built drawings along with soft copy of drawings in CD.

1.13 Discrepancies between Bill of Quantities, Specifications & Drawings

In case of conflicts between Bill of Quantities, Specification & Drawings the Bill of Quantities shall take precedence over the Specification & Drawings, in keeping with the general intent of the scope of work in the contract document. In all such cases, the Engineer-in-Charge / Consultant will interpret the requirements of the design intent & the Contract Documents & their decision shall be final & binding. The contractor shall not be entitled to any extension of time or any compensation due to such determination.

1.14 Prices, Unit Rates & Taxes / Duties etc.

The prices and unit rates quoted by the bidder in the bid shall be firm and deem to be adequate to cover the entire responsibility involved in the execution and completion of work. The rates shall be complete in all respects including cost of materials, erection, fabrication, labour, supervision, tools and plant, transport, contingencies, breakage, wastage, sundries, scaffoldings, insurance.

Please indicate separately the assessable value & quantum / rate of custom duty, CVD, excise duty on each refrigeration equipment separately in your price bid, if applicable.

The contract price quoted shall remain firm till completion of job and handing over the same in working condition to the client.

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 Engineer-In-charge for the execution of works to con-form to good workmanship and sound engineering practice.

The Engineer-In-charge decision to clarify any item under minor changes, minor extras and constructional details shall be final, conclusive and binding on the Contractor.

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 materials and labour will be entertained.

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.

The contractor shall provide all equipments, instruments, labour and such other assistance required by the Engineer-in-charge for measurement of the works, materials etc.

Department reserves the rights to split up the above work between one or more Contractor or award the entire work to one Contractor. Quoted rates should hold good for all such eventualities. No revision in the quoted rates will be entertained at a later date on this account.

1.15 Variation in Quantities & Tender Drawings

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 / Engineer-In charge for any major variation. HVAC drawings issued with the tender are diagrammatic 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. The contract shall be on works contract basis and the Client reserves the right to add / delete any items of work during the currency of contract.

1.16 Performance Bound Contract

The contract will be a performance bound contract and therefore the Bidder shall make their independent check for Heat Load, selection of equipments etc. The drawings enclosed with the tender documents shall be only tentative layout plans and for guidance purpose only. The detailed shop drawings shall be prepared and submitted for approval to the Department / Engineer-in-Charge / Consultant.

The contractor shall guarantee the specified inside condition at specified outside condition considering the fresh air as detailed in the basis of design of the tender documents.

The contractor shall guarantee that the capacity of various equipments as well as the whole system shall be within ± 3% of the specified capacity.

1.17 Guarantee

The AC contractor shall guarantee the inside design conditions as stipulated in the "Basis of Design" Section - 02. The AC contractor shall be responsible for maintaining the desired inside conditions with the equipments selected & offered by him and shall not deprive him of the responsibility if selection of equipment given in the tender document is not thoroughly checked. In case of shortfall the AC contractor shall replace / modify equipment for achieving desired parameter without any extra cost to Department / employer. The contractor would be bound to replace the equipment / equipments selected by him if design condition is not achieved by the AC System offered & installed by him. The contractor shall guarantee the complete AC system for a period of 12 months from the date of handing over the plant after successful commissioning. They shall also guarantee that the performance of the various equipments individually / jointly shall not be less than the specified ratings when working under operating conditions for the complete installation.

1.18 Repairs / Replacement of Parts During Guarantee

Any defects or other faults which may appear within defect liability / guarantee period of twelve months from the date of handing over the plant in a satisfactory working conditions to the Department (except for normal wear and tear) arising in the plant from material or workmanship not in accordance with the contract specification will be rectified by the contractors free of cost & nothing shall be paid extra on any account.

Complaints:- The contractor shall receive all calls for any or all problems experienced in the operation of the system under this contract & shall attend these within 24 Hours of receiving the complaints & shall take steps to immediately correct any deficiencies that may exist.

1.19 Quiet Operation & Vibration Isolation of AC System

All HVAC equipments shall operate under all varying / part load conditions without any objectionable sound or vibration as specified in the section Noise & Vibration Control or in the opinion of the Department / consultant. In case of rotating machinery sound or vibration noticeable outside / inside the room in which it is installed shall be considered objectionable & shall be rectified by the contractor at his own expense up to the satisfaction of consultant / Department.

1.20 Testing

All testing instruments, velocity meter, digital / electronic electric energy meter, digital thermometer, pyschrometer, measuring steel tapes, tools, scaffolding and ladders etc., that may be required for taking measurements shall be arranged by air-conditioning contractor at his own cost.

All types of specified & routine tests of the equipments shall be carried out at the works of the Contractor or the manufacturers of the components. The Department shall be free to witness any or all tests, if they so desired. The Contractor has to inform to the Client before dispatch of any material / equipment.

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 Department / Engineer-in-Charge / Consultants, any defect or short-coming found during the tests shall be speedily rectified or made good by the Contractor at his own expenses. The initial tests shall include, but not be limited to the following:

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

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

c) To check the air distribution system and to provide designed airflow in all areas by adjusting the grills, diffusers and dampers for air-conditioning.

d) To check & balance / adjust the refrigerant / water in the circuit for smooth and noiseless flow.

e) 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.

f) Contractor shall have to submit the capacity test of all equipment at site.

g) On the satisfactory completion of all 'Initial' tests the plant shall be considered 'Virtually Complete' for the purpose of taking over by the Client & balance payment shall be released against BG.

h) In addition to the 'Initial' test the Contractor shall also give summer, monsoon & winter 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. Inside condition as per the contract, performance of each equipment, Airflow etc. shall be as per the requirement of the contract during these tests.

It is clarified that guarantee period shall start after successful completion of commissioning & handing over.

1.21 System Balancing

The contractor shall leave the system operating in complete balance with water and air quantities as shown on drawings. Set stops on all balancing valves and lock all damper quadrants in proper position. Secure all automatic damper and valve linkage in proper positions to provide correct operating ranges. Proper damper positions shall be marked on ducts with permanent indication.

1.22 Operation of Plant

The tenderer shall arrange to operate the plant for a period of ONE MONTH from the date of commissioning of plant and successful completion of initial test free of cost.

1.23 Training of Personal

The contractor shall impart training to the minimum three technical staffs appointed by the client free of cost during erection and commissioning of the plant.

1.24 Inspections & Testing

All the major equipments may be got inspected & tested before dispatch if desired by the client at the manufacturers work.

The AC Contractor shall intimate the client minimum 21 days in advance about the date of readiness of equipment for inspection & testing at a date to be mutually agreed upon by the client & the AC Contractor.

The manufacturer of these equipments must have a facility of testing the equipments at the test bed on full load at their works. All the test readings mutually taken shall be recorded & evaluated with the technical data furnished by the AC Contractor.

1.25 Storage of Materials / Equipments

Store room if ready can be used for storage of materials / equipment brought to site by the contractors. Watch and ward of the same shall be the contractor's responsibility. In case the plant room space is not readily available, it shall be contractor's responsibility to make his own temporary structure at site with approved location from the department at his own cost.

1.26 Power & Water Supply

The Department shall provide the power required on chargeable basis for erection purposes at one point at site & the contractor shall make his own arrangements for extending to locations where power will be required for erection purposes by him.

All necessary power meter & switchgear shall be arranged by AC contractor at his own cost. The point where electricity is to be provided would be mutually decided in consultation with contractor.

1.27 Contract Agreement

Contract document for agreement shall be prepared after award of works to the successful bidder. The contract document shall consist of the following:

a) Original tender document issued to the bidder.
b) Addendum/ Corrigendum to tender documents issued, if any.
c) The detailed letter of Acceptance along with Statement of Agreed Variation (if any) and enclosures attached therewith.
d) Contract Agreement on stamp paper of appropriate value.

1.28 Insurance

The contractor shall be responsible for the storage and safe custody of all equipment / materials brought to site from time to time till the plant is taken over by the Department. The contractor is to provide adequate and comprehensive insurance coverage for storage and execution.

The contractor shall be responsibility for all the injury or damage to persons, buildings, structures, property etc., which may arise form any act of omission on part of the contractor of his servants or sub contractors or his employee etc. The contractor shall indemnify and keep indemnified the Department and hold him harmless in all respects of all and any expenditure liability, loss, claims or proceeding arising from any such injury or damage to persons or property as aforesaid.

The contractor shall undertake all risk policy including earthquake risk with an insurance company approved by the Department in the joint names of Department and contractor at his own expense.

The minimum limits of coverage in the policies shall be as follows:

a) Transit and Storage insurance cover for full amount of the contract.

b) Against damage to existing property and to new works full to reinstate all damages and claims for damage to property to third parties.

The contractor shall also indemnify the Department against all claims which may be made by the Department, whether under the workman compensation Act or any other statute in force during the currency of this contract or at common law in respect of any employee of the contractor or subcontractor and shall at his own expense maintain under the completion of contract, with the insurance company approved by the Department, a policy or policies and deposit these with the Department from time to time during the currency of this contract. The insurance cover shall be in the joint names of the Department and the contractor (The name of the Department shall come first)

The contractor shall be responsible for any liability which may not be covered by the insurance policies referred to the above and all other damages to any person or property etc. arising out of an incidental to the negligent or fault execution of this contract, whatever may be reason due to which the damage shall have been caused.

The contractor shall also indemnify and keep indemnified the Department against all and any cost, charges or expenses arising out of any claim or proceedings relating to the works and also in respect of any awards of damages or compensation arising there from without prejudice to the other right of the Department against the Contractor in respect of such default, the Department shall be entitled to deduct from any sum payable to the contractor the amount of any damage, compensation, costs, charges and other expenses paid by the Department and which are payable by the contractor under this clause.

The provision contained within this article are not intended and do not impair or in any manner limit the liabilities or obligations assumed by the contractor as may be set forth move fully else where in this agreement.

1.29 Arbitration

Any disputes or difference arising out of, from or relating to anything contained in the resulting document, shall be referred to the sole arbitration of Head. The award made by the sole arbitrator shall be binding on the parties hereto. The provisions of the Arbitration Conciliation Act, 1996 or any statutory modification or re-enactment thereof of the being in force shall govern such arbitration. The venue of the arbitration shall be Amritsar, Punjab.

1.30 Details of Experience

The tenderer should enclose documentary proof to show that he has previous experience in having successfully completed in the recent past works of this nature together with the names of Departments, location of sites and values of contract.

1.31 Signing of Tender

The tender shall contain the name, residence and place of business of person or persons making the tender and shall be signed by the tenderer with his usual signature. Partnership firms furnish the full names of all partners in the tender. It should be signed in the partnership name by all the partners or by duly authorized representative followed by name and designation of the person signing. An authorized representative and a Power of Attorney shall sign tender by corporation in that behalf shall accompany the tender. A copy of constitution of the firm with names of all partners shall be furnished.

1.32 Force Majeure

In the event that the Contractor / vendor or any of its subcontractors or the Purchaser is delayed in performing any of their respective obligations under the Contract, and such delay is caused by Force Majeure, including but not limited to war, civil insurrection, fires, floods, epidemics, earthquakes, quarantine restrictions and freight embargoes, such delay may be excused as provided in Article 12 and the period of such delay may be added to the time of performance of the obligation delayed.

If a Force Majeure situation arises, the Contractor / vendor shall promptly notify the Purchaser in writing of such condition and the cause thereof. Unless otherwise directed by the Purchaser in writing, the Contractor / vendor shall continue to perform its obligations under the Contract as far as is reasonably practical, and shall seek all reasonable alternative means for performance not prevented by the Force Majeure event of such.

1.33 Labour Laws and Safety Regulations

The Contractor will be required to make good for any damage caused during the awarded work. Any injury / casualty to any skilled / unskilled worker during the work execution will be the entire responsibility of the Supplier / Vendor and your labour should be duly insured.

Contractor will be responsible for the compliance of the provisions of the various labour laws (status) applicable to workmen deployed by the contractor party in relation with the subject services. Following rules / regulations may be concerned in particular.

- Employees Provident Fund and Miscellaneous Provisions Act, 1952.
- Employees State Insurance Act, 1948.
- Payment of Wages Act, 1936.
- Minimum Wages Act, 1948.
- Equal Remuneration Act, 1965.
- Contractor Labour (Regulation and Abolition Act), 1970.
- Payment of Bonus Act, 1965.
- The Workmen’s Compensation Act, 1923.

1.34 Comprehensive Annual Maintenance

The Contractor shall quote for Comprehensive Annual Maintenance service contract for the system offered by him for a period of 3 years for all items specified in Bill of Quantities after completion of Guarantee period. Any parts / components consumable whatsoever needs replacement during the above mentioned period shall be supplied and installed by the vendor without extra cost.

Periodical checking for all parameters for machines operation and diagnosis, routine checking and cleaning operations, annual preventive maintenance / overhauling as required for smooth and trouble free operation of the package shall be carried out by the contractor. The contractor shall furnish detailed facilities available with him for executing such contract and also furnish annual charges for the same in the priced part of the Bid. Rates shall be quoted in the Price Bid only.

Note – Price bid shall be evaluated considering the price loading on account of three years AMC charges.

END OF INSTRUCTIONS & SPECIAL CONDITION SECTION

2 BASIS OF DESIGN

2.1 Basis of Design

1. Site Location Amritsar

2. Introduction

A centralised HVAC system shall be designed, installed & commissioned to provide thermally controlled environment for the proposed complex. The HVAC systems shall be designed for automated round the clock year round operation to provide for the Inside environmental conditions as specified below and as per BOQ.

3. Outside design conditions	**DBT °C**	**WBT °C**
Summer	43.30	23.90
Monsoon	35.00	26.70
Winter	07.80	03.90

4. Inside Design Conditions	**DBT °C**	**RH**
Summer / Monsoon	23.89+/-1.00	50%~60%

Winter Heating, if required shall be possible by default with VRV / VRF System - Inside temperature not to fall below 21.0 Deg. C Dry Bulb Temperature.

5. Filtration

For VRV / VRF DX AHU

Pre filters of efficiency 90% down to 10-micron particle size of MERV 5 rating shall be installed.

Filters shall be MERV rated as per ASHRAE 52.2 standard.

For Other AC Unit

Standard filter supplied by Manufactured shall be used only.

6. Exposed Roof

All exposed roof / terraces shall be insulated with 75 mm thick expanded polystyrene or equivalent material by HVAC Contractor to get an overall heat transmission factor of 0.06 BTU/HR/SFT/°F.

7. Power Supply

Stabilised three phase four wire AC supply i.e. 415 Volts ± 10 % & 50 Hz ± 5 % with double earthing shall be made available near Sub Panels of AHUs, Isolators of VRV / VRF Outdoor Unit etc & Single-phase power supply with earthing near each inline fan, Hi Wall Split Unit etc or wherever as required by electrical contractor.

Total HVAC Connected Electrical Load – 205.00 Kw Approx.

8. Make Up Water Requirement

Not required.

9. Fresh Air / Air Change Per Hour

Fresh Air / Air Change Per Hour in the various Air Conditioned areas shall be maintained as per the ASHRAE guidelines.

10. Occupancy

Occupancy in the various areas shall be as per provided Furniture Layout Plan.

11. Light Power Density

Average Light Power Density in the various areas shall be based on 0.50~1.00 Watt / SFT.

12. Floor & Glass Height

Floor to Floor & Glass Height taken shall be based on architectural drawings made available to us.

13. Equipment Load

Equipment Load in the various areas shall be as per practical standard.

14. Thermostat

Each AC Unit shall have provision of Thermostat to set the desired temperature.

15. VRV / VRF System

VRV / VRF System shall have all inverter compressors for variable speed of compressor for actual demand requirement.

COP of VRV / VRF System shall better than the Green Building requirement (COP-4.00) at ARI parameters.

16. Hi Wall Split Unit

Air Cooled Hi Wall Split of 3 Star (Minimum) rating to control the temperature. No control of RH shall be done.

17. Refrigerant

Refrigerant used shall be R-134a / R-407C / R-410 / R-32.

18. Mechanical Ventilation

For Mechanical Ventilation designing, NBC 2005 (National Building Code of India) guidelines shall be followed.

19. Building External Parameters

Followings external parameters have been assumed while detailed working of the proposed building.

i)	Exposed Wall U Factor	- 0.360 in BTU Unit
ii)	Partition Wall U Factor	- 0.320 in BTU Unit
iii)	Floor / Ceiling U Factor	- 0.460 in BTU Unit
iv)	Exposed Insulated Roof U Factor	- 0.120 in BTU Unit
v)	Exposed Glass U Factor	- 0.520 in BTU Unit
vi)	Exposed Glass Solar Gain Factor	- 0.850 Unitless

2.2 Design Parameters

A) Air-handlers / Indoor Unit

a) Maximum Face velocity across cooling coil MPM	:	152.0
b) Maximum face velocity across filters MPM	:	152.0
c) Maximum water pressure drop across the coil in Mt.	:	4.6
d) Maximum water velocity through coil in MPS	:	2.5
e) Maximum Fan outlet velocity MPS	:	10.0

B) Ducting Work

a) Method of Duct Design	:	EFM
b) Maximum air velocity in supply duct (AC) MPM	:	550.0
c) Maximum air velocity in return duct (AC) MPM	:	457.0
d) Friction loss in duct (Maxm.) MM Wg in 100 Mt run.	:	8.33
e) Maximum Velocity at supply air grill outlet (AC) MPM	:	150.00

C) For Air-cooled Outdoor Unit

a) Temperature of air to inlet of condenser ºC : 45.0

2.3 Noise & Vibration Control

The air conditioning contractor must take all necessary precautions to have minimum noise generation and its transmission. Minimum vibration as permitted by IS relevant code shall be ensured. A few points for guidance only are given below:

a) Outdoor Unit

The factory built outdoor unit should be complete with rubber pad of suitable thickness to absorb the vibration generated.

b) Indoor Unit / Other Equipment

All indoor unit / other equipment shall have vibration isolation pads of suitable thickness in consultation with manufacturer for isolation of vibration. Double fire retardant flexible connections shall be provided between the outlet of indoor unit & the duct.

c) Duct, Pipes & other accessories

All items suspended from ceiling shall be isolated on separate hangers. In case of ducts, conduits, pipes & tubes the annular space between construction and penetrating element shall be sealed suitably to isolate vibration transmission. The duct lining shall be provided as shown in the tender drawings to reduce the noise level.

2.4 System Description

Scheme for Air Conditioning System

Based on the parameters given above and deration of outdoor unit at higher temperature, it proposed to install required capacity of VRV / VRF outdoor unit of cool / heat type in capacity of multiple combination to cater the required air conditioning load. Indoor door unit shall be ceiling suspended VRV / VRF DX type AHU or VRV / VRF standard indoor unit as shown on the drawings. Indoor and outdoor unit shall be connected with the help of copper refrigerant piping of suitable sizes duly insulated.

Low side work such as ducting, duct lining, duct insulation, grilles / diffusers shall also be planned in coordination with architect, which shall be executed as per the shop drawings made by AC Contractor & approved by Consultant / Architect / Client.

Electrical work shall comprise Starter Panel for DX AHU, isolators, power and control cabling, conduiting, earthing etc as detailed in Bill of Quantities.

VRV / VRF Outdoor Unit selected above shall not be capable of providing winter heating in Winter Season.

AC with Normal Hi Wall Split Unit have also been considered for the areas as tabulated under ' Parameters of Air Conditioned Area'.

Scheme for Ventilation of Toilets

For toilets, inline fan of required capacity shall be installed in the ceiling of individual toilet. Foul smell collected in the duct from the toilet on each floor shall be connected with the inline fan. Foul smell from the toilet shall be trapped with the help of diffusers / grilles and it shall be carried forward to duct.

Propeller fan have also been considered where-ever possible to suit the architectural layout.

END OF BASIS OF DESIGN SECTION

3 TECHNICAL SPECIFICATION OF EQUIPMENTS

3.1 Double Skinned Air Handling Unit

3.1.1 Scope of Work

The specification for Double Skin Air Handling Units covers the design requirement, constructional feature, supply, installation, testing & commissioning. The floor mounted horizontal / vertical type & ceiling suspended type air handlers shall be of double skin construction, draw through type comprising of various sections such as pre filter section, cooling coil section, fan section etc as per details given in BOQ.

3.1.2 Double Skinned Air Handling Units

a) Double Skinned Casing

The casing shall be self supporting type, factory fabricated & assembled made of extruded anodised aluminum hollow sections to make a rigid frame structure. The frame shall be assembled using pressure die cast aluminum joints. The self supporting unit shall consist of sandwiched panel made out of 0.6mm thick pre-plasticide / pre-coated GI sheet outside & 0.6mm GI sheet inside (0.6 mm polished stainless steel in case of AHU for Operation Theatre) duly factory fabricated insulated with 23 / 48 mm thick PU foam insulation in between as specified in Bill of Quantities. The insulated panels shall be bolted to mainframe with neoprene rubber gaskets held captive in the framed extrusion to make it leak proof. Suitable airtight access doors / panels with pressure die cast aluminum hinges & nylon handles and locks shall be provided for access to various sections for maintenance. The Entire housing shall be mounted on Extruded Aluminum channel framework having pressure die cast aluminum jointers or the framework shall be joined together with corner plates Condensate. Drain Pan shall be constructed of 22 gauge Stainless steel sheet with all corners welded with uniform slope from all sides leading to drain pan ensuring no stagnation of condensate water.

b) Motor & Drive

The fan motors shall be suitable for 415 ± 10% volts, 50 ± 5 % HZ, 3 phases TEFC SQ. Cage induction motor. The motor shall be specially designed for quiet operation & motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt drive arrangement. Belts shall be of oil resistant type only.

c) Fan of Double Skinned Air Handling Units

The casing shall have heavy gauge GI construction forward curved DIDW imported fan statically & dynamically balanced mounted on EN8 solid shaft or C 40 carbon steel. The supply air DIDW fan shall be forward / backward curved as per BOQ. The fan impeller shall be supported to housing with angle

iron frame & pillow block heavy duty ball bearing. The fan shall be selected for a fan outlet velocity below 10 meter / sec. The fan housing with TEFC Sq. Cage motor shall be mounted on a common adjustable base frame on vibration isolators in case the impeller diameter is exceeding 450 mm & rubber turret mounts vibration isolators for fan diameter up to 450mm diameter. The fan motor shall be installed inside the housing of air handling unit to keep low noise level. The fan & motor assembly shall be of aluminum extruded section only.

d) Cooling / Heating Coils

The Cooling coil should be at least 4 row deep or as per BOQ and shall have at least 4.7 fins/cm. The Cooling coil should have aluminium fins and copper tubes mechanically bonded. The unit shall be factory aligned, tested and complete with refrigerant piping connection port, charging valves, thermostatic expansion valve, distributor, liquid strainer, dehydrator, liquid line shut off valve etc.

The cooling coil should be tested for leaks at a hydraulic pressure of at least 10 Kg / sq.cm. for a minimum period of 3 hours at works. The velocity across face should be limited to 152 metre / minute.

e) Filters

Each unit shall be provided with a factory assembled pre-filter section containing washable synthetic tube air filters having extruded aluminum frame. The filtration efficiency shall be 90 % down to 10 micron particle size of MERV 5 rating. Filters shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filters cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels. Face velocity across filters shall not exceed 152 MPM.

3.1.3 Accessories

The following accessories shall be provided with each air handlers

a) Vibration isolators shall be provided with all air handling units. Vibration isolators shall be cushy foot mountings, springs or approved equal type.

END OF AHU SPECIFICATION

3.2 Ventilation Fans

3.2.1 Scope of Work

The specification for supplies & exhaust air blowers for mechanical ventilation covers the design requirement, constructional feature, supply, installation, testing & commissioning.

3.2.2 Type

The blower shall be of Inline fans / Propeller Fans with or without ducting system & shall be of floor mounted / ceiling hung type.

3.2.3 Capacity

The capacity of Inline fans / Propeller Fans, diameter, maximum motor H.P & static pressure etc. shall be according to schedule of quantities.

3.2.4 Propeller Fans

The Propeller Fan blades shall be pressed steel of aerofoil design for high fan efficiency and static pressure. The blades shall be riveted to a central steel hub. The motor and blades assembly shall be mounted in a cast iron / sheet steel frame with steel brackets. Rubber mounts shall be provided between the mounting frames and brackets. The fan motor shall be totally enclosed type.

3.2.5 In-Line Fans

Inline fans shall be complete with centrifugal impeller, casing, direct driven motor, vibration isolators, direction of discharge and rotation position shall be as per the job requirement and shall be marked on the fan assembly. Housing shall be constructed of hot rolled GSS sheet metal construction. Housing metal parts shall be either spot-welded or screwed or mounted together with rivets. Indication showing rotation arrow and make, model number and duty conditions of the fan shall be available on the housing. Fan wheel shall be forward curved type, statically and dynamically balanced. The fan shall be provided with ball bearings can be used in any mounting position at maximum indicated temperature.

3.2.6 Accessories

All necessary accessories shall be provided for proper operation and shall also include as part of Unit Price.

- Dunlop cushy foot vibration isolators for the blowers
- Double canvas connections at the outlets of each fan
- Nuts, Bolts, Shims etc. as required for the grouting of the equipment
- Slide rails for mounting the motor and belt adjust
- Bird Screens in the Inlet

- Detachable and washable fresh air filters at the inlets

3.2.7 Performance Data

All fans shall be selected for the lower operating noise level. Capacity ratings, power consumption, with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation. All the fans should be AMCA certified for sound and performance.

3.2.8 Testing

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current. Contractor has to carry out the field balancing, if required.

END OF FAN SPECIFICATION

3.3 Air Cooled Hi Wall Split Unit

3.3.1 Scope of Work

The specification for hi wall split unit covers the general design, materials, constructional features, supply, installation, testing, commissioning & carrying out performance test at site.

3.3.2 Codes & Standards

The design, materials, manufacture, inspection, testing & performance of Hi Wall Split Unit shall comply with all currently applicable codes, regulation & standards in the locality where the equipment is to be installed.

3.3.3 Cabinet of Indoor Unit

The cabinet of Indoor units shall be fabricated as per the standard of manufacturer and finishes shall be attractive. The cabinet shall have removable panels to allow easy servicing of unit, giving easy access into the unit.

3.3.4 Compressor

The compressor shall be hermetically sealed rotary / reciprocating compressor. The compressor should be suitable to withstand voltages varying from 180 to 240 volts.

3.3.5 Air Cooled Condenser

The Air cooled condenser should have high efficiency condenser coils having copper tubes & collared aluminium fins with serrated edges & wavy airways to ensure sub cooling. The air cooled condenser should be housed in factory finished cabinet duly enamel painted. The air cooled condenser should have aluminium fins mechanically bonded with copper tubes.

The fan of the air-cooled condenser shall be statically / dynamically balanced and driven by single phase motor of suitable horse power.

3.3.6 Cooling Coil

The Cooling coil should be at least 2 Row deep and shall have at least 4.7 fins/cm. The Cooling coil should have aluminium fins and copper tubes mechanically bonded. The unit shall be factory aligned, tested and complete with refrigerant piping, complete with charging valves, thermostatic expansion valve, distributor, liquid strainer, dehydrator, liquid line shut off valve etc.

The fan & fan motor should be able to take static pressure drop in coil, filters etc.

The unit should be factory wired and tested.

The air filter should have large surface and dust holding capacity which must be easily removable type for cleaning purposes.

END OF AIR COOLED HI WALL UNIT SPECIFICATION

3.4 VRV / VRF Outdoor Unit

3.4.1 Scope of Work

The specification for VRV / VRF Units covers the general design, materials, constructional features, supply, installation, testing, commissioning & carrying out performance test at site.

3.4.2 Codes & Standard

The design, materials, manufacture, inspection, testing & performance of VRV / VRF shall comply with all currently applicable codes, regulation & standards in the locality where the equipment is to be installed.

3.4.3 General

Each VRV / VRF Unit shall be air cooled, split type multi-system air conditioner consisting of outdoor units and number of indoor units, each having capability to cool for the requirements of the individual area to be air-conditioned. The VRV / VRF unit should be capable of connecting minimum ten different type of indoor units to one refrigerant circuit and controlled individually.

Each VRV / VRF unit shall have minimum two number scroll compressor and out of two number Compressors one shall be inverter Compressor (With inverter controller) or digital compressor with and without vapour injection technology and capable of changing the rotating speed to follow variations in cooling loads. Each indoor units having capability to cool or heat for the requirement of the rooms.

Compressor shall be inverter controlled or digital controlled. Compressor installed in each outdoor module unit shall be equipped with at least one inverter compressor in bigger (if modular) machines for higher reliability, improved life, better backup and duty cycling purpose. The system shall be capable of changing the rotating speed of inverter compressor by inverter controller to follow variations in cooling and heating load.

The Outdoor units shall be suitable for mix-match connection of following type.

- Ceiling mounted cassette type (Double flow)
- Ceiling mounted cassette type (Multi flow)
- Ceiling mounted duct type.
- Ceiling suspended type.
- Wall mounted type
- Floor standing type
- Concealed floor standing type.

Please note that the refrigerant piping shall be capable of extending up to 150m with 50m level difference without any oil traps.

Both indoor and outdoor units shall be factory assembled, tested and filled with first charge of refrigerant. These being very hi-tech in construction with lots of factory checks being conducted, hence no sub assembly should be done at site preferably.

3.4.4 Outdoor Unit

The outdoor unit shall be factory assembled, weather proof casing, constructed from heavy gauge mild steel panels and coated with baked enamel finish. The unit should be completely factory wired, tested with all necessary controls tested prior to dispatch conforming to the following specifications.

a) All outdoor units shall consist of minimum two scroll compressors, preferable one with inverter drive, capable to operate even when one compressor is unserviceable.

b) Outdoor units when consisting of more than 1 module (e.g. 22 HP = 10 Hp +12 HP), each should have one separate inverter driven compressors.

c) In such case, the units shall be provided with duty cycling arrangement for multiple inverter compressors.

d) The outdoor unit shall be modular in design to facilitate installation one after another close to each other. Preference would be given to compact units having smaller footprint.

e) Outdoor units should be rugged of anti-corrosion design and should have strong base plate for easy mounting of unit.

f) The outdoor unit shall comprise of sub-cooling feature to effectively use the entire coil surface through proper circuit/bridge in order to prevent flushing of refrigerant owing to large length of piping.

g) The condensing unit shall be provided with state-of-the-art microprocessor based control panel.

h) The outdoor unit shall be provided with provided with Aero spiral design fan exhibiting low noise level characteristics complete with aero fitting grille to facilitate spiral discharge of airflow to effect reduction in pressure losses. The fan should be capable to respond to external static pressure of 5mm.

i) Motor shall be speed controlled to ensure a stable operation for varying ambient, by a factory fitted direct acting head pressure activated variable speed drive for at least 15 steps to give precise discharge pressure and minimum power consumption of condenser fan motor.

j) The condenser shall be complete with provisions for refrigerant piping connections, shut off valves and any other standard accessories necessary with the equipment supplied.

The condensing unit shall be designed to facilitate fail safe operation when connected to multiple indoor units. If possible, the system should work on standard operating parameters like discharge pressures of not more than 300 PSI as the ref. Piping will be moving around within a residential house, otherwise on any misfortune of any leakage it will act like a bullet on higher pressures. If working on higher operating pressures, vendor to comply with all safety codes of high pressure safety & testing as recommended by Japanese (being Japanese design product) and give 2 sets of special tools to handle such equipment at site. All brazing should be done by only qualified trained person who had training on HIGH PRESSURE brazing, special tools & procedures.

3.4.5 Scroll Compressor

The scroll compressor shall be an industrial quality rugged, cast iron, direct hermetic compressor with scroll plates, suction & discharge service valves. The compressor shall be completely enclosed in a chamber with no leakage path and providing the capability for scroll plates to separate. The compressor shall be provided with industrial solid motor mounts internal motor protection and vibration isolation pads. Each compressor shall be independently wired and piped to its own circuit for efficient operation & ease of maintenance. The compressor speed shall not exceed 3000 RPM.

The compressor shall be highly efficient digital scroll type or inverter control. The inverter compressor shall change the speed in accordance to the variation in cooling or heating load requirement:

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

b) Oil heater shall be provided in the compressor casing.

c) The inverter compressor shall preferably be efficient & reliable inverter compressor.

3.4.6 Heat Exchanger

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

a) The aluminum fins shall be covered by anti-corrosion resin film.

b) The unit should be with heat exchanger to optimize the path of heat exchanger and for better efficiency of condenser.

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

3.4.7 Refrigerant Circuit

The refrigerant circuit shall include liquid & gas shut-off valves and a solenoid valves at condenser end. The equipment must have inbuilt refrigerant stabilization control for proper refrigerant distribution.

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

3.4.8 Refrigerant

The VRV / VRF units shall be selected on R410 refrigerant only. The units should be fully factory charged with refrigerant & oil & spare refrigerant & oil must be sent along with the machine for topping up of gas & oil as may be required.

3.4.9 Safety Devices

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

Following safety devices shall be integral part of the out door unit :

High pressure switch
Fan drive overload protection switch
Fusible plug
Overload relay including overload protection for inverter driven compressor.

3.4.10 Oil Recovery System

Entire system shall be designed and capable of oil recovery to ensure stable operation with long refrigeration piping lengths.

The system should have inbuilt (avoid external) oil balancing circuit to avoid poor lubrication.

3.4.11 Transit Damage

The unit shall be restored to original conditions in case of any transit damages by the contractor at his own cost.

3.4.12 Technical Requirement of VRV / VRF Unit

S/N	Description	Unit	Condition of Service
a)	Type	--	Cool / Heat Type
b)	Capacity (cooling)	HP (Nominal)	As per BOQ
c)	Quantity	Nos.	As per BOQ
d)	Connectable No. of possible indoor unit	Nos.	Refer Drawings
e)	Air entering condenser	Deg. C DB	45.0
f)	Electric Supply	--	415 V/3 Ph/50 Hz
g)	Maximum Refrigerant Piping Length For One Unit	--	150 RMT

END OF VRV / VRF OUTDOOR UNIT SPECIFICATION

3.5 VRV / VRF Indoor Unit

3.5.1 Scope of Work

This section deals with supply, erection, testing and commissioning of Various Type Of Indoor Units confirming to general specification and suitable for the duty selected. The type, capacity and size of indoor units shall be as specified in Schedule of Quantities.

3.5.2 General

Indoor units shall be either ceiling mounted cassette type, or ceiling mounted ductable type or floor standing type or wall mounted type or other as specified in BOQ. Each unit shall have electronic control valve to control refrigerant flow rate respond to load variations of the room.

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

b) In case of centralized control, it shall be set by liquid crystal remote controller

The fan shall be dual suction, aerodynamically designed turbo, multi blade type, statically & dynamically balanced to ensure low noise and vibration free operation of the system. The fan shall be direct driven type, mounted directly on motor shaft having supported from housing.

The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/ mechanically expanded for minimum thermal contact resistance with fins. Each coils shall be factory tested at 21kg/sqm air pressure under water.

Unit shall have cleanable type filter fixed to an integrally moulded plastic frame. The filter shall be slide away type and neatly inserted.

Each indoor unit shall have computerized PID control for maintaining design room temperature. Each unit shall be provided with microprocessor thermostat for cooling or cooling and heating.

Each unit shall be with wired LCD type remote controller. The remote controller shall memorize the latest malfunction code for easy maintenance. The controller shall have self-diagnostic features for easy and quick maintenance and service. The controller shall be able to change fan speed and angle of swing flap individually as per requirement.

3.5.3 Ceiling Mounted Cassette Type Unit (Multi Flow Type)

The unit shall be ceiling mounted type. The unit shall include pre-filter, fan section and DX-coil section. The housing of the unit shall be powder coated galvanized steel. The body shall be light in weight and shall be able to suspend from four corners. The fan shall be aerodynamically designed diffuser turbo fan type. Also Units shall have an external attractive panel for supply and return air. Unit shall have four way supply air grilles on sides and return air grille in center.

Each unit shall have high lift drain pump, fresh air intake provision (if specified) and very low operating sound.

All the indoor units regardless of their difference in capacity should have **same decorative panel size** for harmonious aesthetic point of view. It should have provision of connecting branch ducts.

3.5.4 Ceiling Mounted Ductable Type Unit

Unit shall be suitable for ceiling mounted type. The unit shall include pre filter, fan section & DX coil section .The housing of unit shall be light weight powder coated galvanized steel. The unit shall have high static fan for Ductable arrangement.

3.5.5 Ceiling Suspended Type

Unit shall be suitable for ceiling suspended arrangement below false ceiling. The unit include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

3.5.6 Hi Wall Mounted Unit

The units shall be wall-mounted type. The unit includes pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

Unit shall have an attractive external casing for supply and return air.

3.5.7 Floor Standing Type

Unit shall be suitable for floor standing arrangement. The unit include pre filter, fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel.

3.5.8 Centralized Type Remote Controller

A multifunctional compact centralized controller shall be provided with the system.

The controller should be LCD remote controller to act as an advanced air-conditioning management system to give complete control of VRV / VRF air-conditioning Equipment, It should have ease of use for the user and must have a user friendly panely and LCD display.

It shall be able to control up to minimum 64 indoor units with the following functions:-

a) Starting/stopping of Air-conditioners as a zone or group or individual unit.

b) Temperature settling for each indoor unit or zone.

c) Switching between temperature control modes, switching of fan speed and direction of airflow, enabling/disabling of individual remote controller operation.

d) Monitoring of operation status such as operation mode & temperature setting of individual indoor units, maintenance information, trouble shooting information.

e) OPTIONAL-Display of air conditioner operation history.

f) OPERATIONAL-Daily management automation through yearly schedule function with possibility of various schedules.

The controller shall have wide screen user friendly LCD display and can be wired by a non polar 2 wire transmission cable to a distance of 1 km. away from indoor unit.

3.5.9 Colour

The colour of indoor units should be white or to suit interiors as designed by the architects / clients.

END OF VRV / VRF INDOOR UNIT SPECIFICATION

4 TECHNICAL SPECIFICATION FOR ELECTRICAL ITEMS

4.1 Electrical Motors

4.1.1 Scope of Work

The scope of this section comprises the supply, installation, testing & commissioning of all types of motors used for HVAC Units conforming to these specifications and in accordance with Schedule of Quantities. The motor installation, wiring & its control shall be carried out in accordance with the specifications as detailed below.

4.1.2 Motors

The motor shall be of the following design and should run at all loads without any appreciable noise or hum.

Totally enclosed fan cooled Sq. Cage.

Enclosure and type of motor shall depend upon duty and usage unless otherwise specified.

a) The winding of motors shall be class 'B' insulation and suitable for local conditions. The insulation of motors shall confirm to IS:325/1978.

b) All motors shall comply with IS:325, IEC-34.1 or BS – 2313, IEC-72.1 for foot mounted motors.

c) The rating of the motor shall be as indicated in the Schedule of Quantities. The motors shall be selected on the basis of ambient temperatures and allowable maximum temperature rise.

d) Motor above 1HP shall be three phase unless otherwise specified.

e) All motors shall be rated for continuous duty as per IS:325. Motor shall be suitable for operation on 415 volts ± 10% volts, 50 ± 5% Hz three phase AC supply (or 230 ± 10% volts, 50 ± 5% Hz for single phase AC supply).

f) Motors shall be provided with cable box to receive Aluminum conductors, PVC insulated, PVC sheathed and armored cables.

g) All motors shall be provided with combination of 'Ball and Roller Bearing'. Suitable grease nipples for regreasing the bearing shall be provided.

h) Motors above 0.25 HP shall be provided with overload protection. Motors above 100 HP shall be provided with thermal protection and thermistor detector in the stater winding.

i) The starter current and the type of starter to be used shall be as follows (unless otherwise specified)

	Type of motor	Starting Current	Starting method
a)	Sq. Cage motor up to 7.5 HP	600% of full load current	D.O.L
b)	Above 7.5 HP up to 60 hp	250% of full load current	Star / Delta
c)	75 HP & above	200% of full load current	Closed transition Star / Delta or Double Star

4.1.3 Motor Starters

a) All starter shall confirm to IS: 13947. The starter shall be enclosed in sheet metal enclosure, which would be dust vermin proof.

b) All starter should have suitable range of voltage and frequency.

c) All starter shall have integral stop/start push button of international colour code.

d) Contactor shall have number of poles as required for appropriate duty. Contacts should be made of solid silver faced & shall be suitable for at least 40 contacts per hours.

e) In event of power failure, the starter should automatically disconnect.

f) All starters shall be provided with thermal over load relay.

g) All star delta starters shall have adjustable timers.

h) Terminal blocks with integral insulating barrier shall be provided for each starter.

i) All starters shall be provided as specified in Schedule of Quantities. All starter shall be compatible to the drive and driven equipment.

j) Extra contact for interlocking purpose shall be provided in the starter.

k) All starter shall be compatible for Auto / Manual operation (BMS Compatible)

l) All starter shall have separate single phasing preventer.

4.1.4 Installation of Motors

a) The motor and drive machine shall be fixed on slide rails to facilitate belt and other adjustments.

b) Vibration isolation arrangement shall be provided.

c) The installation of motor shall be carried out as per IS:900.

d) The motor with driving equipment shall be mounted on foundation and connected to each other with flexible coupling with guard in condenser & chilled water pumps.

e) All motor shall be wired as per specifications. Earthing of motor frame shall be done with GI strips as specified in 'Schedule of Quantities'.

f) All motors shall be tested at manufacturer's works as per I.S. standard and test certificates shall be furnished.

g) All motors after AC contractor shall test installation at site for vibrations, heating and electrical insulation resistance.

END OF ELECTRICAL MOTORS SPECIFICATION

4.2 Motor Control Centre, Ventilation Sub Panel, Power & Control Cabling, Earthing etc.

4.2.1 Scope of Work

The scope of this section comprises the supply, installation, testing & commissioning of Motor Control Centre, Ventilation Panels, AHU Sub Panel, power / control cabling & earthing work shall be carried out as per the specification given below and in accordance with Schedule of Quantities. All work shall confirm to Indian Electricity Act (amended up to date), I.S. code of practices, local rules and regulations etc. The codes & standard to be followed shall be as given below:-

- BIS 13947 (Part 4) - AC contactors up to 1000V
- BIS 13947 - AC Circuit Breakers
- BIS 2705 - Current Transformers
- BIS 3156 & 4146 - Potential Transformers
- BIS 4064 - Air break switches for voltage not exceeding 1000V
- BIS 13947 - Control switches
- BIS 1822 - Motor duty Switches
- BIS 12021 - Specification for control transformer
- BIS 8623 - Factory built assembly of switchgear & control gear
- BIS 13947 (Part I) - Degree of protection for enclosure
- BIS 3842 - Specification for electrical relays for AC system
- BIS 13707 - Specification for HRC fuses
- BIS 5082 - Wrought Al. and Aluminium alloys, bars, rods, tube and sections for electrical purposes
- BIS 13947 (Part 1) - General requirement for switchgear & control gear for voltage not exceeding 1000V
- BIS 3231 - Electrical relays for power system protection

4.2.2 Motor Control Centre / Ventilation Sub-Panel

Motor control centre shall be floor mounted extendable type bolted construction & Ventilation sub-panel shall be wall mounted type. The sheet steel (CRCA) used for fabrication shall be of 2.0mm for load bearing members and 1.6mm for non-load bearing members. The panels shall be supplied with required base channels. These panels shall be cubical sectionalized type, totally enclosed dust & vermin proof. Gaskets shall be provided in all joints to prevent dust to reach the internals of the panels to make it completely dust proof. The degree of protections for panels shall be IP 52 for indoor applications and IP 65 for outdoor applications as per IS:2147.

These panel (MV) shall be suitable for voltages up to 500 volts, three phase 50 Hz, 4 wire supply capable of functioning satisfactorily in temperature ranging up to 45 to 50 degree centigrade and rupturing capacity suitable for connected load & design should be type tested for 42 KA fault level. All joints

of panels shall be welded and braced as necessary to provide a rigid support for all components. The base channel provided in the floor mounted MV panel shall be 100mm x 50mm x 6mm & a clear space of 200mm between the floor and the bottom most part of the unit shall be provided. The panel shall be correctly positioned. Self- threading screws shall not be used in the construction of control panels. Appropriate knock-out holes of proper sizes shall be provided for incoming and outgoing cables. The facility for bottom or top entry of cables in the panels shall be provided. Necessary cables clamps shall provided for holding the cables in position.

All power/control wiring inside the panel shall be colour coded and control wiring ferruled for identification purpose. All labeling shall be provided in engraved anodized aluminum strips on the front face of the panel.

Each circuit breaker shall be housed in separate compartments. It shall have steel sheets on top and bottom of compartment. The steel sheet hinged door shall be interlocked with the circuit breaker on the “ON” position. When the breaker is on the “ON” position, suitable preventive measures shall be provided, such as interlocks, to prevent the breaker from being drawn out. When the breaker is in “ON” position steel sheet shall be provided between the tiers in the vertical section. The door of this compartment shall not form part of the draw out arrangements.

4.2.3 Bus-Bars

The bus-bar and its connections shall be aluminum Electrolytic grade E-91 as per IS: 5082 and shall be of rectangular section. These should be suitable for full load current for phase bus-bar and neutral bus-bar shall be of half rated current capacity. The bus-bar should have provision on either side for extension. The bus-bar should be sleeved with colour coded heat shrinkable PVC sleeve. Bus-bar supports shall be of fibre glass reinforced thermosetting polyester having in built and tracking barriers to break the path of conducting dust through moulded ribs.

In panels bus-bar connections shall be done by drilling holes with cadmium coated bolts and nuts. Extra cross section shall be provided to compensate drilling of the holes. Insulated aluminum strips of suitable size of full rated current capacity shall be used for interconnecting bus-bar and breaker.

A horizontal / vertical wire way shall be provided for interconnecting control wiring between different vertical sections.

The terminal blocks shall be used for outgoing terminals and neutral link at a suitable located place in the control panel. Separate compartments for outgoing and incoming cable shall be provided. The current transformers of all instruments shall be mounted with terminal blocks.

All live parts including incoming and outgoing link / terminals should be totally shrouded by means of non hygroscopic and fire retardant material.

4.2.4 Air Circuit Breakers

The circuit breaker shall be capable of making and breaking the specified fault currents without straining or damaging any part of the switchgear. The breakers shall be air break, motorized / manually operated as specified in BOQ and draw out type. All feeders of rating 800A and above shall be ACB and of fully draw out type. The circuit breaker shall be stored energy closing type, manual/electrically operated with tripping mechanism. The circuit breaker shall be provided with 4 NO + 4 NC of auxiliary potential free contacts required for indication, control, interlocking and other purposes. All contacts shall be wired to a terminal block. Circuit breakers with stored energy closing mechanism shall be capable of making the rated short-circuit current, when the stored energy is suitably charged by a spring. It shall also be capable of closing on no-load without suffering undue mechanical deterioration. The maximum make- time shall also not be exceeded.

The direction of motion of the handle, for manual spring charging shall be marked. A device indicating when the spring is charged fully shall also be provided. Motors and their electrically operated auxiliary equipment for charging a spring shall operate satisfactorily between 85% and 110% of the rated supply voltage. The breaker operating mechanism should store energy for O-C-O operation and shall not, in any case, get stuck in closed position during this cycle. After failure of power supply to the motor, at least one open-close-open operation of the circuit breaker shall be possible. The breaker operating mechanism shall be electrically and mechanically trip-free in all positions.

All ACBs shall be provided with microprocessor based trip unit for protection against overload, short circuit and earth faults. The releases shall be communicable to other systems on an open communication protocol. The Communication Port shall be provided in front/back. The circuit breakers shall be suitable for locking in fully isolated condition.
Following interlocks and features shall be provided so that

a) Truck can be moved within panel only when CB is off.

b) CB can be closed only when the test (or) service limit switches permits.

c) Breaker compartment door cannot be opened when the CB is in Service/test position.

d) Breaker cannot be put in to service position with compartment door open.

e) Earth slide beyond the test position till trolley is drawn out.

Closing and tripping coil shall operate satisfactorily under the following conditions of supply voltage variation:

a) Closing coils – 85% to 110% of rated voltage..

b) Trip coils – 70% to 110% of rated voltage.

4.2.5 Moulded Case Circuit Breakers

The MCCBs shall confirm to the latest applicable standards. MCCBs in AC circuits shall be of four pole construction arranged for simultaneous four pole manual closing and opening. Operating mechanism shall be quick-make, quick-break and trip free type. The ON, OFF and TRIP positions of the MCCB shall be clearly indicated and visible to the operator. Operating handle for operating MCCBs from door of board shall be provided. MCCB terminals shall be shrouded and designed to receive cable lugs for cable sizes relevant to circuit ratings. MCCBs shall incorporate time delay devices to ensure that it will tolerate harmless transient overload unless this is well in excess of 25% of its rated value for a sustained period. The circuit breaker shall be provided with 2 NO + 2 NC of auxiliary potential free contacts required for indication, control, interlocking and other purposes. All contacts shall be wired to a terminal block. The breaking capacity of MCCB's shall be as per the design requirements.

4.2.6 Miniature Circuit Breakers

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 230/415 VAC 50 Hz applications with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting be type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values. The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP and TPN miniature circuit breakers shall have a common trip bar.

4.2.7 Rotary Switch / Selector Switch / Switches / HRC Fuses / Starters / Single Phase Preventers / Toggle Switch

These shall be of approved make and conforming to relevant ISI standard. The rupturing capacity of HRC fuses should not less than 80 KA and in case of switches it should be 60 Amps maximum.

4.2.8 Current Transformer

The current transformers shall have accuracy of class I and 5P10 / 10P10 and suitable VA burden for operation of the connected meters and relays.

4.2.9 Overload Relays

All the motors shall have overload relay protections conforming to relevant IS.

4.2.10 Time Delay Relays

These shall be adjustable type with time delay adjustments of 0-180 or as per manufacturers standards.

4.2.11 Indicating Lamps And Metering

These shall confirm to BS37 & BS39. All meters shall be flush mounted and draw-out type. The indicating lamp shall be filament type and with very low burden & economy resistor.

4.2.12 Voltmeter And Ammeters

Motor Control Centre (MV Panel) shall have flush type voltmeter & ammeter of size 96 x 96 mm.

4.2.13 Push Button Stations

These shall be suitable for panel mounting and accessible from front without opening. These shall be provided for manual starting and stopping of motors/equipments as per normal practices. The contacts shall be suitable for 6AMP current capacity.

4.2.14 Name Plate

Suitable anodized Aluminium name plate of 1.2 mm thick shall be provided on all the Switchboards and individual compartments.

4.2.15 Conduits

These shall be preferable made of mild steel, stove enameled from inside and outside with minimum wall thickness of 1.6 mm for conduits up to dia of 25mm and 2 mm for conduits above 25 mm diameter.

4.2.16 Cables

Cable shall be supplied inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Indian Standards Specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drum.

The cables shall comply with the latest edition of the following standards

- BIS: 7098 (PART-I) - XLPE Cables - LT
- BIS: 8130 - Conductors for insulated electric cables & flexible cords.
- BIS: 3975 - Mild steel wires, strips & tapes for armouring of cables.
- BIS: 10418 - Wooden drums for electric cables.
- BIS: 10810 (PART 58) - Oxygen Index test

The material of cable shall be as follows:-

a) The MV power cable of 660/1100 V. grade shall be XLPE insulated Aluminium conductor armoured cable.

b) The MV control cables shall be PVC insulated copper conductor armoured stranded cable.

c) The HT power cable of 415 V grade shall be XLPE insulated Aluminium conductor armoured cable.

4.2.17 Laying Of Cables

These shall be laid as Indian Standard code of practice. All cables shall be laid on 16G GI Perforated U shaped Channel 40mm x 20mm cable trays. In case more than one cable is running, then proper space in between the two cables shall be provided to avoid loss of current carrying capacity. While cables are running on walls, proper saddles must be provided.

4.2.18 Wire Sizes

Single stand PVC-copper conductor wires shall be used inside the control panel for interconnecting different components. All wires shall be neatly dressed and coloured beads shall be provided for easy identification in control wiring. The minimum size of control wiring shall be 1.5sq.mm. Testing of panels as per code of practice shall be done at works by Employer / Architect before inspection & dispatch to site.

4.2.19 Drawings

Necessary drawings of all control panels and wiring of equipment etc., shall be submitted by the contractor for approval of the Engineer in Charge. On final completion of job and before handing over of AC System As Built Drawings shall be submitted to the Department.

4.2.20 Testing

All equipment and components supplied may be subjected to inspection and tests by the client / consultant or his authorized representatives during manufacture, erection / installation and after completion. No tolerances shall be allowed other than the tolerances specified or permitted in the relevant approved Standards, unless otherwise stated. If the guaranteed performance of any item of equipment is not met and / or if any item fails to comply with the specification requirement in any respect whatsoever at any stage of manufacture, test or erection, the client / consultant may reject the item, or defective component thereof, whichever he considers necessary.

The complete electrical installation shall be tested in accordance with relevant IS codes in presence of Electrical Supervisor of the client before commissioning of plant.

4.2.21 Painting of Panels

All sheet metal enclosures shall be powder coated only after de-rusting & hot-dip phosphating degreasing etc. at works only.

NOTE: Rubber mats of 1100 volts shall be laid in front of all switch boards.

4.2.22 Sizes of Power Cabling

The following size of power cabling shall be used only or as per BOQ.

	HP of Motors	Cable size
a)	Up to 5 HP	3c x 4sq.mm aluminium conductor armoured cable.
b)	5 to 7.5 HP	3c x 6sq.mm aluminium conductor armoured cable.
c)	10 to 15 HP	2no. 3c x 6sq.mm aluminum conductor armoured cable.
d)	20 to 25 HP	2 Nos.,. 3 x 16sq.mm aluminum conductor armoured cable.
e)	30 to 35 HP	2 Nos.,. 3c x 25sq.mm aluminum conductor armoured cable.
f)	40 to 50 HP	2 Nos.,. 3c x 35sq.mm aluminum conductor armoured cable.
g)	60 HP	2 Nos.,. 3c x 50sq.mm aluminum conductor armoured cable.
h)	75 HP	2 Nos.,. 3cx 70sq.mm aluminum conductor armoured cable.
i)	100 HP	2 Nos.,. 3cx 95sq.mm aluminum conductor armoured cable.
j)	125 HP	2 Nos.,. 3cx 120sq.mm aluminum conductor armoured cable.

4.2.23 Capacity of Relays And Contacts

The following capacity relays and contacts shall be used for various rating of motors or as per BOQ.

Type of Starter Contactor Overload Relay

			Contactor	Phase Relay Range
a)	50/60 HP Motor	Star Delta Starter	70 Amp.	30 - 50 Amp.
b)	40 HP Motor	Star Delta Starter	45 Amp.	20-33 Amp.
c)	30 HP Motor	Star Delta Starter	45 Amp.	20-33 Amp.
d)	25 HP Motor	Star Delta Starter	32 Amp.	14-23 Amp.
e)	20 HP Motor	Star Delta Starter	32 Amp.	14-23 Amp.
f)	15 HP Motor	Star Delta Starter	25 Amp.	9-15 Amp.
g)	10 HP Motor	Star Delta Starter	16 Amp.	6-10 Amp.

h)	7.5 HP Motor	D.O.L. Starter	16 Amp.	9-15 Amp.
i)	5 HP Motor	D.O.L. Starter	16 Amp	6-10 Amp.

4.2.24 Earthing

The earthing of all equipments shall be carried out by Copper strips / wires as mentioned in Bill of Quantities. All panels / three phase motors shall be earthed with two number distinct and independent Copper strips / wires of the following sizes or as per BOQ.

1.	Motor upto 5.5 KW	3 sq. mm Copper Wire	4 mm dia GI Wire
2.	Motor 7.5 to 18.75 KW	4 sq. mm Copper Wire	6 mm dia GI Wire
3.	Motor 18.75 to 50 KW	25x3 mm Copper Strip	25x6 mm GI Strip
4.	Motor 51 to 89 KW	25x6 mm Copper Strip	32x6 mm GI Strip

The earthing connections shall be connected to main earth station or main earth grid. The earth connections shall be connected to equipments after removal of paint, grease etc.

END OF MCC, SUB PANEL, POWER & CONTROL CABLING, EARTHING SPECIFICATION

5 SERVICES SPECIFICATION

5.1 Air Distribution

5.1.1 Scope of Works

The scope of this section comprises supply, fabrication, installation & testing of all sheet metal GI ducts as well as supply, installation, testing & balancing of all grills, diffusers & other accessories in accordance with these specification & Schedule of Quantities.

5.1.2 GI Duct (Site Fabricated)

The duct shall be fabricated out of galvanized sheet, class VIII (Zinc coating 120 gm/m² as per the parameters given below which are conforming to IS 655-1963.

Maximum Side	Thickness of GI / AL Sheet	Type of Transverse Joint Connections	Bracing
(1)	(2)	(3)	(4)
Mm	Mm		
Up to 300	0.63 / 0.80	S-drive, pocket or bar slips, on 2.5m centers	None
301 to 600	0.63 / 0.80	S-drive, pocket or bar slips, on 2.5m centres	None
601 to 750		S-drive, 25mm pocket or 25 mm bar slips on 2.5m centers.	25 x 25 x 3 mm angles, 1.2m from joint
751 to 1000	0.80 / 1.00	Drive, 25-mm pocket or 25mm bar slips, on 2.5 m centres 40 x 40 mm angle connections,	25 x 25 x 3 mm angles, 1.2 m from joint
1001 to 1500		or 40-mm bar slips, with 35 x 3 mm bar reinforcing on 2.5 m centres.	40 x 40 x 3 mm angles, 1.2 m from joints
1501 to 2250	1.00 / 1.25	40 x 40 mm angle conn sections, or 40-mm bar slips, 1 m maximum centres with 35 x 3 mm bar reinforcing.	40 x 40 x 3 mm diagonal angles, or 40 x 40 x 3 mm angle 60 cm from joint.
2250 to above*	1.25 / 1.50	50 x 50 mm angle connections, or 40 mm pocket or 40 mm bar slips, 1 m max. centres with 35 x 3 mm bar reinforcing.	40 x 40 x 4 mm diagonal angles, or 40 x 40 x 3 mm angles, 60 cm From joint.

* Ducts 2250 mm and larger require special field study for hanging and supporting methods.

In addition to above the following points should be also taken into account while fabrication of ducts.

a) All ducts of size larger than 450mm shall be cross broken.

b) All ducts shall be supported from the ceiling / slab by means of MS rods of dia 9mm with MS angle of size 40 x 40 x 5 mm at the bottom with neoprene pad in between the duct & MS angle. The ducts shall be suspended from the ceiling with the help of dash fasteners. The contractor shall arrange provision for necessary ancillary materials required for hanging the ducts.

c) The vanes shall be provided wherever required and shall be securely fastened to prevent noise & vibration.

d) The rubber gasket shall be installed between duct flanges in all connections and joints.

e) All flanges and supports should be primer coated.

f) The flexible joints shall be fitted to the delivery side of AHU fans with Fire Retardant Double canvass. The length of flexible joints should not be less than 150 mm and not more than 300 mm between faces.

g) The ducting work can be modified if deemed necessary in consultation with the Engineer in Charge to suit actual site conditions in the building.

5.1.3 Box Type Dampers & Splitters

These dampers shall be provided in the ducting work for proper control and balancing of air distribution. All dampers shall be louver type robust construction. These dampers shall be fitted with easily accessible operating mechanism, complete with links, levers, quadrant for proper control and setting in a desired position. The position of the handle of the damper operating mechanism shall be clearly visible and shall indicate the position of the damper in the duct. All dampers, splitters shall be fabricated out of G.S. sheet of two gauges higher than the duct piece having these fittings. Dampers shall be installed in duct at all required locations. No extra payment shall be made separately since these form part of Air Circulation System.

NOTE : In case angle iron supports are not feasible to be installed for supporting the ducts due to height constraint then the contractor shall support the ducts with M.S flats of at least double the thickness of the angle iron supports.

5.1.4 Supply And Return Air Grills And Ceiling Diffusers

The supply and return air grills and ceiling diffusers shall be made of powder coated extruded aluminum sections. The supply air grills / diffusers shall be provided with screw operated opposed blade volume control device made of MS duly black painted.

All grills / diffusers shall have soft continuous rubber / foam gasket between the periphery of the grills / diffusers and surface on which it has to be mounted. The colour of grills / diffuser shall be as per the approval of the Engineer in Charge.

5.1.5 Linear Supply And Return Grills

The linear continuous supply / return air grills shall be made of powder coated extruded aluminum construction with fixed horizontal bars. The thickness of fixed bar louvers shall be 5mm in front and the flange shall be 20mm wide with round edges. The register shall be suitable for concealed fixing and horizontal bars of the grills shall mechanically crimped from the back to hold them.

The colour of grills shall be as per the approval of the Engineer in Charge.

5.1.6 Front Fixed Bar Rear Adjustable Louvered Grills

The grills shall be made of powder coated extruded aluminum construction with front fixed horizontal bar at 0 degree inclination with one way or two way deflection with rear vertical individually adjustable louvers in black shade mounted on Nylon bushes to hold deflection setting under all conditions of velocity and pressure.

The colour of grills shall be as per the approval of the Engineer in Charge.

5.1.7 Square / Rectangular Ceiling Diffusers

The square / rectangular ceiling diffusers shall be made of powder coated extruded aluminum construction with flush fixed pattern. The diffusers shall have Anti-Smudge ring and spring loaded removable central core in various pattern for air flow direction. The diffusers shall be mounted by concealed screw fixing arrangement. The colour of diffuser shall be as per the approval of the Engineer in Charge.

5.1.8 Volume Control Device

The opposed blade volume control device shall be made of MS duly black painted. Specially designed blade shall have an overlapping lip, which shall ensure a tight closure.

5.1.9 Fresh Air Intake Louvers With Bird Screen

The fresh air intake louvers at least 50mm deep will be made of powder coated extruded aluminum construction. Bird / insect screen will be provided with the intake louvers. The blades shall be inclined at 45 degree on a 40mm blade pitch to minimize water ingress. The lowest blade of the assembly shall be extended out slightly to facilitate disposal of rain water without falling on door / wall on which it is mounted.

The intake louvers shall be provided with factory fitted volume control dampers in black finish.

5.1.10 Painting

All ducts collar / shoot behind the grills / diffuser shall be given at least two coats oil black enamel paints.

5.1.11 Testing

The complete duct system shall be tested for air leakage & complete air distribution system shall be balanced in accordance with air quantities indicated on the approved drawing.

END OF AIR DISTRIBUTION SYSTEM SPECIFICATION

5.2 Fire Dampers

5.2.1 Scope of Work

The scope of this section comprises the supply, installation, testing & commissioning of fire dampers conforming to these specifications and in accordance with Schedule of Quantities.

5.2.2 Motorized Combined Smoke & Fire Dampers - Spring Return Type

a) All supply air Ducts in AHU room crossing shall be provided with approved make fire and smoke dampers of at least 90 minutes fire rating certified by CBRI, Roorkee as per UL555:1973.

b) The fire damper blades & outer frame shall be formed of 1.6 mm galvanized steel sheet. The damper blade shall be pivoted on both ends using chrome-plated spindles in self-lubricating bushes. Stop seals shall be provided on top & bottom of the damper housing made of 16G Galvanized steel sheet. For preventing smoke leakage side seals will be provided.

In normal operating conditions damper blade shall be held in open position with the help of a 24 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

c) The damper shall be actuated through electric actuator. The actuator shall be energized with the help of a signal from smoke detector installed in AHU Room / R. A. Duct. The fire damper shall close due to temperature rise in S. A. Ducts through the electric temperature sensor, which is factory set at 165 °F.

d) Each motorized smoke cum fire damper shall have its own panel which will incorporate necessary circuit required to step down voltage available from UPS or emergency power supply to show status of the damper (open or close), to allow remote testing of damper, indication in event of damper closure due to signal from smoke sensor / temp. sensor & reset button. Additional terminal will be provided to have audio cum video signal in Central Control Room.

e) Damper actuator shall be such that it should close the damper in the event of power failure automatically and open in the same in case of Power being restored.

f) The fire Damper shall be mounted in fire rated wall with a duct sleeve 600 MM long. The sleeve shall be factory fitted on fire damper. The joints at sleeve end shall be slip on type. Minimum thickness of GI Sheet shall be 18G.

g) The damper shall be installed in accordance with the installation method recommended by the manufacturer.

h) Hinged access doors of suitable size complete with airtight gaskets shall be provided in all fire dampers & plenums.

END OF FIRE DAMPERS SPECIFICATION

5.3 Insulation / Lining Work

5.3.1 Scope of Works

The scope of this section comprises supply & fixing of thermal / acoustic insulation of ducts, pipes etc. as per the specification given below & in accordance with Schedule of Quantities.

5.3.2 Material & Process of Acoustic Insulation of Duct / AHU Room

a) Resin Bonded Fibre Glass Wool

The Thermal conductivity values in W/m.K of fibre glass shall confirm to following:

Mean Temperature ^{0}C	Density In Kg / Cmt.	Thermal Conductivity W/m.k
25^{0}C	32/48	0.030

Acoustic Lining of Duct

The material to be used for duct lining shall be 12 / 25 mm thick resin bonded fibre glass rigid board having a density of 48 Kg/m³ & covered with 0.5 mm thick perforated aluminum sheet. The lining of initial length of the duct shall be done as shown in the tender layout drawings & shall be carried out as follows.

a) Clean the duct piece thoroughly,

b) Fix the board of suitable thickness inside the duct & cover with fibre glass tissue paper.

c) Cover the insulation board with 0.5mm thick perforated aluminum sheet with atleast 20% perforation.

d) Secure the insulation board & aluminum sheet with cadmium coated bolts nuts & cup washers / steel screws.

f) Finally seal the ends completely, so that no lining material is exposed.

Acoustic Lining of AHU Room

The four walls and ceiling of AHU Rooms shall be provided with acoustic lining of thermal insulation as per following specifications & as specified in the Schedule of Quantities.

a) Clean the surface.

b) A 610 x 610 mm frame work of 25 x 50 x 50 x 50 x 50 x 25 mm 'U' shape channel made of 0.6 mm. thick G.S.S. shall be fixed on to walls

by means of rawl plug in walls & dash fasteners in ceiling. Before fixing channel shall be filled with fibre glass.

c) Fix the resin bonded glass wool having density of 32 Kg/cmt.in the frame.

d) Finally, finish it by covering the surface with 0.5 mm thick perforated aluminium sheet with brass screws. Before fixing aluminium sheet, fibre glass tissue paper must be sandwitched.

e) All horizontal and vertical joints shall be covered with at least 25 mm. wide, 1mm aluminium strips held in position by steel or brass screws.

5.3.3 Material & Process of Thermal Insulation of Pipes / AC Equipments

Material

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber.
- Density of Material shall be between 60+/-10% Kg/m^3.
- Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/m^0K at an average temperature of 0^0C.
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.
- Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10-14 Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor or 'μ' value should be minimum 7000.

Thickness of the insulation shall be as specified for the individual application.

Pipe Insulation

All chilled water, refrigerant and condensate drain pipe shall be insulated in the manner specified herein. An air gap of 25 mm shall be present between adjacent insulation surfaces carrying chilled water or refrigerant. Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shall be free from dirt, dust, mortar, grease, oil, etc. Nitrile Rubber insulation shall be applied as follows:

- Insulating material in tube form shall be sleeved on the pipes.
- On existing piping, slit opened tube of the insulating material (slit with a very sharp knife in a straight line) shall be placed over the pipe and adhesive shall be applied as suggested by the manufacturer.
- Adhesive must be allowed to tack dry and then press surface firmly together starting from butt ends 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 valves.
- All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated 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.

The detailed application specifications are as mentioned separately. The manufacturer's trained installer should only be used for installation.

Recommended Adhesive

In all cases, the manufacturer's recommended Adhesive (SR-998) should be used for the specified purpose.

Installation Exposed Directly to Sunlight

For installations exposed to sunlight, after giving 36 hours curing time for the adhesive apply manufacturer's recommended UV/Mechanical Protection. Please refer the separate detailed guidelines on UV/Mechanical Protection. FRP coating should be provided for protection from sun light.

Parameters for Selection of Thickness

a) Design Basis: Condensation Control

b) Region: Non Costal Area

c) Application: Outdoor & Indoor

Thickness of Insulation

a) Drain Water Pipe Line Temperature 15.0 Deg. C

Up To 50 mm Pipe Size - 13 mm Thick Insulation

b) Refrigerant Pipe Line Temperature 3.0 Deg. C

Up To 50 mm Pipe Size - 25 mm Thick Insulation
Above 50 mm & Up To 100 mm Pipe Size - 32 mm Thick Insulation

or as per BOQ but stringent one shall be followed.

Mechanical Protection for Piping (with Adhesive and Glass Cloth /CSM)

It's a two component composite system of woven glass cloth and manufacturer approved adhesive.

Procedure:

1. Apply adhesive liberally on Insulation.
2. Immediately spread the 7 mil woven glass cloth on insulation without allowing adhesive to dry.
3. Immediately apply another coat of adhesive liberally on woven glass cloth.
4. Even out with brush and allow it to dry for 2-3 hours.

Note:

a) Mechanical Protection should be applied after 36 hours of Curing of adhesive. It is the minimum time required for complete curing of adhesive.

b) For UV protection apply two coats of special UV resistant paint after the above process.

5.3.4 Material & Process of Thermal Insulation of Ducts

Duct insulation: Chemically Cross Linked Closed Cell Polyethylene FR-XPE Fire Retardant grade in roll form density not less than 33±3kg/cum and thermal conductivity 0.0319w/mk at mean temperature of 0ºC. Supply and Return air ducts shall be insulated as shown in the drawing/as specified in the bill of quantities

CASE-1 Supply Air (SA) Duct. (When Return Air is being taken through the False-Ceiling)
Supply Air - 9 mm thick

CASE-2 Supply Air (SA) & Return Air (RA) Duct (When both are in the Non-Conditioned area)
Supply Air – 18 mm thick
Return Air – 9 mm thick

CASE-3 Supply Air (SA) & Return Air (RA) Duct (When both the Ducts are above False Ceiling of Air-conditioned Area)
Supply Air – 13 mm thick
Return Air – 9 mm thick

Or as per BOQ but stringent one shall be followed.

Insulation for duct shall be applied as follows:

UNEXPOSED DUCT

NORMAL TYPE: (For zones over false-ceiling with plain sheet)

a) Clean the duct surface to be insulated and apply a thin film of adhesive (Pidilite SR 998) and leave it for 2-3 min. for drying. Once the adhesive is dry but tacky to touch, place the insulation sheet in designed position.
b) Press the sheets in position and butt the joints well together.
c) Apply 50mm wide self adhesive tape on both longitudinal and transverse joints.

5.3.5 Under deck Insulation with Expanded Polystyrene with Overlap Edge

Ceiling of exposed roof shall be provided with under deck insulation as per following specifications & as specified in the Schedule of Quantities.

a) Clean the surface & apply the adhesive on it.
b) Fix 75 mm Expanded Polystyrene with Overlap Edge of density 20 Kg/CMT with the help of adhesive.
c) Apply adhesive between all longitudinal and transverse joints of Expanded Polystyrene.
d) Fix the Expanded Polystyrene finally with the help of rawl plug & dash fasteners in ceiling.

END OF INSULATION / LINING SPECIFICATION

5.4 Condensate Drain Piping Work

5.4.1 Scope of Works

The scope of this section comprises supply, installation, testing & commissioning of drain water pipes, pipe fittings and valves etc. as detailed below in specifications. All pipes, fittings and valves etc. shall conform to relevant Indian standards.

5.4.2 Drain Water Piping

The pipes, fittings and valves shall be of approved make given in the tender.

Drain water / make up water pipes shall be "B" Class GI Pipe & shall Conform to IS: 4736 or threaded PPR or Hard PVC pipe as per BOQ.

The pipes shall be sized for individual liquid flow & shall ensure smooth noiseless balanced circulation of fluid.

All piping and their steel supports shall be throughly cleaned and primer coated before installation.

5.4.3 Pipe Fittings

The pipe fittings for screwed piping shall be malleable iron and for piping with welded joints shall of weldable quality. Also the fittings shall be suitable for same pressure ratings as for the piping system.

All bends up to sizes 150 mm dia shall be ready made of heavy duty wrought steel of appropriate class.

All bends in sizes 200 mm and above shall be fabricated from the same dia and thickness of pipe in at least four sections and having a center in radius of at least 1.5 times diameter of pipes. Fittings such as tees, reducers etc. shall be fabricated from the same pipe and its length shall be at least twice the diameter of the pipe.

The dead ends shall be formed with flanged joints & shall have 6mm thick blank between flange pair for 150 mm and over.

5.4.4 Flanges

All flanges shall be of mild steel as per IS : 6392 / 71 (with latest amendments) & shall be slip on type welded to the pipes. Flanged thickness shall be to suit Class II pressure. 3 mm thick gasket shall be used in between the flanges.

Flanged pair shall be used on all such equipments which are required to be isolated or removed for service for example condenser / chilled water pumps, chilling m/c, AHU etc.

5.4.5 Installation of Water Piping

a) All pipes shall be securely supported or suspended on stands, hangers, clamps etc. as required. The Air-conditioning contractor shall design all brackets, saddles, anchors, clamps etc. & shall be responsible for structural adequacy.

b) All pipe supports shall be of steel, coated with two coats of anti-corrosive paint and finally finished with paint.

c) The pipe spacing shall be as follows :

Dia of Pipe	Spacing between supports
Up to 25mm	1.5 mt
30 mm to 50 mm	2.0 mt
65 mm to 75 mm	2.5 mt
100 mm to 125 mm	3.0 mt
150 mm	3.5 mt
200 mm & above	4.0 mt

d) The vertical rises shall run parallel to walls and should be straight to wall duly checked with plumb line.

e) In case pipes with/ without insulation while passing through the wall / slab, shall be provided with sleeve 50mm higher in size than the pipe with / without insulation.

f) Wherever insulated pipes are running, it should be supported in such a way that no undue pressure is exerted on the insulated pipe.

g) The expansion-joints or expansion-loops shall be provided to take care of the expansion and contraction in pipes due to temperature rises.

5.4.6 Testing of Pipe System

a) All tools, tackles, labours etc. shall be arranged by A/C Contractor.

b) All pipes shall be tested hydraulically at 1.5 times the maximum operating pressure for a period of 24 hours. All leaks occurring during testing shall be rectified to the satisfaction of the Engineer in Charge. After repairs of leak it shall be tested again at the same pressure.

c) In case piping is tested in parts, these sections shall be securely sealed and capped during testing.

d) The A/C Contractor should ensure that there should be minimum vibration / noise in the chilled water / condenser water circuit due to water turbulence.

5.4.7 Air-Vents

Air vents for purging of air trapped in piping system shall be provided at the highest point. Globe valves of the size as indicated below shall be provided & **no additional price shall be paid**.

Pipe Size	**Valve Size**
Upto 100mm	25mm dia
Above 100mm to 300mm	40mm dia

END OF CONDENSATE DRAIN PIPING WORK SPECIFICATION

5.5 VRV / VRF Refrigerant Piping

5.5.1 Scope of Works

The scope of this section comprises supply, installation, testing & commissioning of refrigerant piping as detailed below in specifications.

5.5.2 Refrigerant Piping

All refrigerant piping for the air conditioning system shall be constructed from soft seamless up to 19.1mm and hard drawn copper refrigerant pipes for above 19.1mm with copper fittings and silver-soldered joints. The refrigerant piping arrangements shall be in accordance with good practice within the air conditioning industry, and are to include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.

All joints in copper piping shall be sweat joints using low temperature brazing and or silver solder. Before jointing any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 20Kg per sq.cm and 10 Kg per sq.cm (low side). Pressure shall be maintained in the system for 24 hours. The system shall then be evacuated to minimum vacuum if 700mm hg and held for 24 hours.

The air-conditioning system supplier shall be design sizes and erect proper interconnections of the complete refrigerant circuit.

The thickness of copper piping shall not be less than 20gauge for pipes up to 19.1mm and 18 guage for bigger sizes

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

The OD & wall thickness size of copper refrigerant piping shall be as per VRV / VRF manufacturer standard. **The Following are for guidance only.**

	Outside Diameter (mm)	**Wall Thickness (G)**
a)	41.3	18
b)	34.9	18
c)	19.1	20
d)	15.90	20
e)	12.70	20
f)	9.5	20
g)	6.4	20

END OF VRV / VRF REFRIGERANT PIPING SPECIFICATION

6 NOISE & VIBRATION CONTROL

6.1 Scope of Work

This section deals with design, supply, installation, testing and commissioning of noise and vibration control equipment and accessories.

6.2 Standards

The testing of all noise control equipment and the methods used in measuring the noise rating of air conditioning plant and equipment shall be in accordance with the relevant sections of the following British Standards, unless otherwise stated:

BS 4718: 1971	Methods of Test of Silencers for Air Distribution Systems
BS 2750:	Laboratory and Field Measurement of Airborne Sound
Parts 1-9:1980	Insulation of Various Building Elements
	Recommendations for Field Laboratory Measurement of Airborne and Impact Sound Transmission in Buildings
BS 3638: 1987	Methods of Measurement of Sound Adsorption in a Reverberation Room
BS 4773:	Acoustic Testing.
Part 2: 1976	
BS 4856:	Acoustic performance without additional ducting of forced
Part 2: 1976	fan convection equipment.
Part 5: 1976	Acoustic performance with additional ducting of forced fan convection equipment
BS 4857:	Acoustic Testing and Rating of High Pressure Terminal
Par 2:1978 (1983)	Reheat Units.
BS 4954:	Acoustic Testing and Rating of Induction Units.
Par 2:1978 (1987)	
BS 5643:	1984 Glossary of Refrigeration, Heating, Ventilating and Air Conditioning Terms

6.3 General

The air conditioning contractor must take all necessary precautions to have minimum noise generation and its transmission generated by moving plant and equipment to achieve acceptable limits for occupied areas. In addition to the noise level criteria particular attention must be given to the following details at time of ordering plant and equipment and their installation :-

All moving plant / equipment shall be statically and dynamically balanced at manufacturers works and certificates issued.

The isolation of moving plant, machinery and apparatus including lines equipment from the building structure.

Where duct work and pipe work services pass through walls, floors and ceilings, or wherever supported shall be surrounded with a resilient acoustic absorbing material to prevent contact with the structure and minimise the outbreak of noise from plant rooms.

The reduction of noise breakout from plant rooms and the selection of externally mounted equipment and plant to meet ambient noise level requirements of the Specifications.

Electrical conduits and connections to all moving plant and equipment shall be carried out in flexible conduit and cables to prevent the transmission of vibration to the structure and nullify the provisions of anti-vibration mountings.

All duct connections to fans shall incorporate flexible connections, except in cases where these are fitted integral within air handling units.

All resilient acoustic absorbing materials shall be non flammable, vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.

Where practicable, attenuators shall be built into walls and floors to prevent the flanking of noise the duct work systems and their penetrations sealed in the manner previously described. Where this is not feasible, the exposed surface of the duct work between the attenuators and the wall subjected to noise infiltration shall be acoustically clad as specified.

Ambient noise from cooling tower also shall be assessed to determine the suitable attenuators that can reduce the noise so as not affecting the adjoining public area.

6.4 Anti-vibration Mountings

All items of rotating and reciprocating plant and equipment shall be isolated from the structure by the use of anti-vibration materials, mountings or spring loaded supports fixed to either concrete bases, inertia blocks or support steels.

Centrifugal fans and motors within air handling units shall be isolated from the frame of the air handling unit by suitable anti-vibration mountings. Fan discharge air connections shall be fitted with approved flexible connections.

Axial flow fans shall be mounted on steel legs as diaphragm plates supported on neoprene in shear anti-vibration mountings, or suspended using spring loaded hangers to suite the application.

The construction of the anti-vibration mountings shall generally comply with the following: -

Enclosed Spring Mounting (Caged or Restrained Springs)

Each mounting shall consist of cast or fabricated telescopic top and bottom housing enclosing one or more helical steel springs as the principle isolation elements, and shall incorporate a built- in leveling device.

The springs shall have an outside diameter of not less than 75% of the operating height, and be selected to have at least 50% overload capacity before becoming coil bound.

The bottom plate of each mounting shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

Mountings incorporating snobbery of restraining devices shall be designed so that the snubbing damping or restraining mechanism, is capable of being adjusted to have no significant effect during the normal running of the isolated machine.

The manufacturers shall provide restrained isolator on chillers subject to approval.

6.5 Open Spring Mountings

Each mounting shall consist of one or more helical steel springs as the principal isolation elements, and shall incorporate a built-in leveling device. The spring shall be fixed or otherwise securely located to cast or fabricated top and bottom plates, and shall have an outside diameter of not less than 75% of the operating height, and shall be selected to have at least 50% overload capacity before becoming coil-bound.

The bottom plate shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

6.6 Neoprene-in-Shear Mountings

Each mounting shall consist of a steel top plate and base plate completely embedded in oil resistant neoprene. Each mounting shall be capable of being fitted with a leveling device, and bolt holes in the base plate and tapped holes in the top plate so that they may be bolted to the floor and equipment where required.

END OF NOISE & VIBRATION CONTROL SPECIFICATION

7 MODE OF MEASUREMENT

The following measurement code shall apply to the Contract:

7.1 Sheet Metal Work

7.1.1 Ducting

a) The final finished sheet area in sq. mt shall be measured only.

b) Vanes, splitters, flanges, access doors etc. shall not be separately measured. These shall be treated as part of duct work.

c) Bends, Elbows, Transformation, pieces etc. shall be measured along the centre line and measured as per duct work.

d) Canvas connections, Duct Supports, Stiffening members, frames etc. shall not be measured separately and shall form part of duct work / equipment.

7.1.2 Grills / Diffusers / Fire Dampers

All Grills / Diffusers / Fire Damper areas will be measured in terms of effective area (Neck Area). Any Extruded aluminum grill / diffusers having an area less than 0.1 sq.mt shall be accounted as 0.1 sq.mt.

7.1.3 Box Dampers

a) Duct dampers shall be measured in Sq. Mt. in terms of effective area.

b) Fresh air dampers shall be measured as effective areas only. No separate measurements for bird screen inlet / outlet louvers shall be done.

7.2 Piping Work

a) The length of piping accessories & fittings shall be measured along its centre line in meters and no measurements for bends, elbows, tees etc. shall be made. All such fittings / accessories shall be treated as part of the piping work.

b) Flanges shall not be measured, as they form part of piping work.

c) For thermometer wells & pressure gauge sockets no measurement shall be done separately.

d) All kinds of supports, hangers etc shall be part of piping work & no extra measurements shall be done.

e) No additional price for installation of purge & de-scaling valves as required at site shall be paid.

7.3 Insulation

7.3.1 Insulation of Duct

This shall be measured on the basis of bare duct surface area i.e. the area of duct insulation & area of duct shall be same.

7.3.2 Insulation of Chilled Water / Drain Water Pipes.

i) Insulation of pipes shall be measured in terms of linear length of pipe for each size.

ii) For insulation of bends, elbows, tees etc. it shall be measured along with the center line of insulation and shall be measured in meters.

iii) Insulation of valves shall be separately accounted as per bill of quantities.

7.3.3 Insulation of Chiller / Expansion Tank / Suction Line

The insulation of the above equipments shall be deemed to form part of equipment and no separate measurements for insulation of such items will be accounted for.

7.3.4 Acoustic Lining of Duct & Plenum

This shall be measured on the basis of bare duct surface area i.e. the area of duct lining & area of duct shall be same.

7.4 Electrical Cabling Work

a) All power cables / controls cables shall be measured on linear basis in meters.

b) No extra price shall be paid on account of end termination of cables which includes thimble, gland etc.

7.5 Structural Supports

No extra price shall be paid on account of structural supports required for piping, ducting & cabling work.

Note:- The items not specified above or not specified in BOQ & Specification but technically required shall be part of that particular equipment / material.

7.6 Flexible Pipe Connector

Flexible pipe connector wherever required are part of the equipment & are specified in BOQ with the equipment. No extra price shall be paid on account of this.

END OF MODES OF MEASUREMENT SPECIFICATION

8 SCHEDULE OF APPROVED MAKES

1.	VRV / VRF Outdoor Unit	-	Daikin / Samsung / LG / Mitshubishi Electric / Panasonic / Toshiba
2.	VRV / VRF Indoor Unit	-	Daikin / Samsung / LG / Mitshubishi Electric / Panasonic / Toshiba
3.	Y-Joints & Fittings	-	Daikin / Samsung / LG / Mitshubishi Electric / Panasonic / Toshiba
4.	Central & Remote Controller	-	Daikin / Samsung / LG / Mitshubishi Electric / Panasonic / Toshiba
5.	Double Skinned VRV DX AHU	-	Waves / Edgetech / Zeco
6.	Cooling & Heating Coil (AHU)	-	Waves / Edgetech / Zeco
7.	AHU Fans	-	Kruger / Comferi / Greenheck
8.	Accoustic Insulated Inline Fans	-	Airflow / Caryaire / System Air
9.	Three phase motors	-	ABB / CG / Siemens
10.	Water Piping	-	Tata / SAIL / Jindal Hissar
11.	Globe valve	-	Leader / Sant
12.	Auto Air Vent Valve	-	Anergy / Rapid Cool
13.	GSS Sheet	-	Sail / Tata / Jindal
14.	Factory Fabricated Duct	-	Rolastar / Waves / Zeco
15.	Fire & Smoke Damper Spring Type	-	Airflow / Servex / Dynamic
16.	Fire Damper Actuator	-	Belimo / Siemens / Danfoss
17.	Extruded aluminum grills / Diffusers	-	Airflow / Servex / Dynamic

18.	Pre Filters / Fine Filters	-	Thermodyne / Klenzoid / Purolator / Spectrum
19.	Vibration Isolation Spring & Flexible Pipe Connector	-	Resistoflex / Dunlope
20.	Closed Cell Fire Retardant XLPE	-	Paramount / Supreme / Trocylene
21.	Nitrile Rubber Insulation (For Duct / Drain Pipe / Refrigerant Pipe Insulation)	-	Armaflex / K-flex / Eurovatax
22.	Expanded / Extruded Polystyrene (For Underdeck Insulation)	-	Mettur Beardsell / Styrene Packing / Toshiba
23.	Fibre Glass Rigid Board	-	U.P.Twiga / Owen corning / Kimco
24.	Paints	-	ICI / Asian
25.	Tar felt / CPRX compound	-	Shalimar tar product
26.	Dash Fasteners	-	Canon / Fisher / TKS
27.	Welding Rods	-	Advani / L&T
28.	Copper Refrigerant Piping	-	Rajco / Mandev / Shree Shyam
29.	Electrical Sub Panel	-	KEPL / Tricolite / SPC Electrotech
30.	Air-Circuit Breaker	-	L&T / Siemens / GE (Spectronic)
31.	M.C.C.B.	-	L&T / GE / Siemens
32.	MCB	-	L&T / GE / Siemens / MDS
33.	Starters, Contactors, Push Buttons, Overload Relay	-	L&T / GE / Siemens / BCH
34.	Single Phase Preventer	-	L&T / Minilec / Siemens
35.	Current Transformer	-	A.E. / Kappa / Precise/ C & S
36.	Rotary Switches	-	L&T / Siemens / GE / BCH

37.	Selector & Toggle Switch	-	Kaycee / L&T
38.	Change Over Switch	-	Elecon / L&T
39.	HRC Fuse and Fittings	-	L&T / Siemens / GE/ C & S
40.	Voltmeter / Ammeter	-	A.E. / IMP.
41.	Indicating Lamps	-	Siemens / L&T.
42.	Time Delay Device	-	Siemens / L&T/ BCH.
43.	Power Cable & Accessories	-	Havelles / Gemscab / Polycab
44.	Control Cable & Accessories	-	Havelles / Gemscab / Polycab
45.	MS Conduits ISI Approved	-	BEC / Steelcraft
46.	TDRs	-	LT-LK / BCH
47.	MS Conduits ISI Approved	-	BEC / Steelcraft
48.	MS Painted / GI Cable Tray (Factory Fabricated)	-	SLOTCO / PILCO / KEPL / RICCO
49.	Insulated Flexible Duct	-	Caryaire / Atco
50.	Air Cooled Hi Wall Unit	-	Daikin / Carrier / Toshiba / Mitshubishi
51.	Any Missing Item	-	Prior Permission from Client/ HVAC Consultant

NOTE: All makes shall confirm to standard specifications of each items as enclosed with the tender documents.

END OF SCHEDULE OF APPROVED MAKES

9 EXCLUDED ITEMS FROM THE SCOPE OF HVAC CONTRACTOR

a) Housing of equipments.

b) Foundations of all equipments, supporting structure etc.

c) Main incoming stabilised power supply with double earthing in the Main Panel i.e. 415 ±10 % volts, 50 Hz ± 5% AC supply.

d) Any kind of masonry work such as openings in walls/slabs and making good thereof.

e) Any kind of false ceiling work, return air boxing, wooden / aluminium frames for fixing grills / diffuser.

f) Water softening plant if required.

g) Makeup water connections with fittings and valves to make up & expansion tank.

h) Drain points in near each indoor unit.

i) Power and water for erection, testing and commissioning of the HVAC System.

j) Any kind of masonry shafts & trenches for laying pipes / cables / ducts etc.

END OF EXCLUDED ITEMS WORK

10 IDENTIFICATION OF SERVICES

10.1 General

This section comprises of identification of services for each piece of equipment

10.2 Identification of Services

Pipe work and duct work shall be identified by colour bands 150 mm. wide or colour triangles of at least 150 mm. / side. The bands of triangles shall be applied at termination points, junctions, entries and exits of plant rooms, walls, in ceiling spaces, ducts and control points to readily identify the service, but spacing shall not exceed 4.0 metres.

10.2.1 Pipe Work Services

For pipe work services and its insulation the colours of the bands shall comply with BS.1710: 1971.

Basic colours for pipe line identification:

Pipe Line Contents	BS. 4800 Colour Reference	Colour
Water	12 D 45	Green
Steam	10 A 03	Grey
Oils	06 C 39	Brown
Gas	08 C 35	Yellow / Brown
Pipe Line Contents	BS. 4800 Colour Reference	Colour
Air	20 E 51	Blue
Drainage	00 E 53	Black
Electrical	06 E 51	Orange

Colour code indicator bands shall be applied as colour bands over the basic identification colour in the various combinations as listed below :-

Pipe Line Contents	Colour Bands to BS. 4800
Water Services :	
Cooling	00 E 55
Fresh / drinking	18 E 53
Boiler feed	04 D 45/00 E 55 / 04 D 45
Condensate	04 D 45/14 E 53 / 04 D 45
Chilled	00 D 55/14 E 53 / 00 D 45
Central Heating Services :	
Below 100 Deg. C	18 E 55/04 D 45/18 E 53
Above 100 Deg. C	04 D 45/18 E 53 /04 D 45

Pipe Line Contents	Colour Bands to BS. 4800
Cold Water Storage	
Tanks:	00 E 55/18 E 53/00 E 55
Hot Water Supply	00 E 55/04 D 45/00 E 55
Hydraulic Power	04 C 33
Sea / River Untreated	Basic Colour only
Fire Extinguishing	04 E 53
Steam Services :	Basic Colour only
Air : Compressed	Basic Colour only
Vacuum	White
Town Gas : Manufactured	14 E 53
Natural	10 E 53
Oils :	
Diesel	00 E 55
Lubricating	14 E 53
Hydraulic Power	04 C 53
Transformer	04 D 45
Drainage and other fluids :	Basic Colour only
Electrical Services :	Basic Colour only

In addition to the colour bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow, identified as follows:-

High Temperature Hot Water	HTHW
Medium Temperature Hot Water	MTHW
Low Temperature Hot Water	LTHW
Chilled Water	CHW
Condenser Water	CONDW
Steam	ST
Condensate	CN

Pipe shall have the letters F and R added to indicate flow and return respectively as well as directional arrows.

10.2.2 Duct Work Services :

For Duct work services and its insulation the colours of the triangles shall comply with BS.1710 : 1971. The size of the symbol will depend on the size of the duct and the viewing distance but the minimum size should not be less than 150 mm. length per side. One apex of the triangle shall point in the direction of airflow.

Services	Colour	BS.4800 Colour Reference
Conditioned Air	Red and Blue	04 E 53 / 18 E 53
Ward Air	Yellow	10 E 53
Outdoor air	Green	14 E 53
Exhaust / Extract / Recirculated Air	Grey	AA 0 09
Foul Air	Brown	06 C 39
Dual Duct System Hot Supply Air	Red	04 E 53
Cold Supply Air	Blue	18 E 53

In addition to the colour triangles specified above all duct work shall be legibly marked with black or white letters to indicate the type of service, identified as follows:-

Supply Air	S
Return Air	R
Outdoor Air	O
Exhaust Air	E
Smoke Extract Duct	M
Spill Air	A

The colour banding and triangles shall be manufactured from self adhesive cellulose tape, laminated with a layer of transparent ethyl cellulose tape.

END OF IDENTIFICATION OF SERVICES SPECIFICATION

11 LIST OF ABBREVIATIONS

Followings List of Abbreviations shall have been used in preparing the Tender Specifications, Bill of Quantities & Drawings.

AABC	:	AMERICAN AIR BALANCING COUNCIL
ACH	:	AIR CHANGE PER HOUR
AC	:	AIR CONDITIONING
ACMV	:	AIR CONDUCTING AND MECHANICAL VENTILATION
AHU	:	AIR HANDLING UNIT
ANSI	:	AMERICAN NATIONAL STANDARD INSTITUTE
ARI	:	AMERICAN REFRIGERATION INSTITUTE
ASHRAE	:	AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIRCONDITIONING ENGINEER
ASME	:	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTA	:	ASSOC.CIATION OF SHORT - CIRCUIT TESTING AUTHORITIES
ASTM	:	AMERICAN SOCIETY OF TESTING AND MATERIALS
ATG	:	AIR TRANSFER GRILLE
AWS	:	AMERICAN WELDING SOCIETY
BAS	:	BUILDING AUTOMATION SYSTEM
BIS	:	BUREAU OF INDIAN STANDARD
BMS	:	BUILDING MANAGEMENT SYSTEM
BTU	:	BRITISH THERMAL UNIT
CDW	:	CONDENSER WATER
CFM	:	CUBIC FEET PER MINUTE
CHW	:	CHILLED WATER
CMS	:	CENTRAL MONITORING SYSTEM

CRCA	:	COLD ROLLED COLD ANNEALED
CSA	:	CANADIAN STANDARD ASSOC.CIATION
CT	:	COOLING TOWER
CTI	:	COOLING TOWER INSTITUTE
DB	:	DISTRIBUTION BOARD
DDC	:	DIRECT DIGITAL CONTROLLER
DOL	:	DIRECT ON LINE
DFA	:	DELHI FIRE AUTHORITY
DIA	:	DIAMETER
DIDW	:	DOUBLE INLET DOUBLE WIDTH
DX	:	DIRECT EXPANSION
EA	:	EXHAUST AIR
EEPROM	:	ELECTRICAL ERASABLE PROGRAM
ELCB	:	EARTH LEKAGE CIRCUIT BREAKER
ETL	:	ELETRICAL TESTING LABORATORIES
EPA	:	ENVIRONMENTAL PROTECTION ACT
FCU	:	FAN COIL UNIT
F/A	:	FLOOR ABOVE
F/B	:	FLOOR BLOW
FCC	:	FIRE COMMAND CENTRE
FD	:	FIRE DAMPER
FFL	:	FINISHED FLOOR LEVEL
FPM	:	FEET PER MINUTE
FPS	:	FOOT PER SECOND
FRP	:	FIBERGLASS REINFORCED PLASTIC

GI	:	GALVANISED IRON
GPM	:	GALLON PER MINUTE
GSS	:	GALVANIZED STEEL SHEET
H/L	:	HIGH LEVEL
HDG	:	HOT DIP GALVANIZED
HDPE	:	HIGH DENSITY POLY ETHANE
HFC	:	HYDRO FLURO CARBON
HP	:	HORSE POWER
HVAC	:	HEATING, VENTILATION & AIR CONDITIONING
IAQ	:	INDOOR AIR QUALITY
IEC	:	INTERNATIONAL ELECTROCHEMICAL COMMISSION
IKW	:	INDICATED KILO WATT
IPD	:	INITIAL PRESSURE DROP
ISO	:	INTERNATIONAL STANDARD ORGANIZATION
KW	:	KILO WATT
L	:	LITRE
LCD	:	LIQUID CRYSTAL DISPLAY
L/L	:	LOW LEVEL
L/S	:	LITRE PER SECOND
LSZH	:	LOW SMOKE ZERO HALOGEN
LT	:	LOW TENSION
M	:	METER
MAX.	:	MAXIMUM
MCB	:	MINIATURE CIRCUIT BREAKER
MCC	:	MOTOR CONTROL CENTRE

MFD	:	MOTORIZED FIRE DAMPER
MIN	:	MINIMUM
MM	:	MILLIMETER
NBC	:	NATIONAL BUILDING CODE
NC	:	NOISE CRITERIA
NEC	:	NATIONAL ELECTRIC CODE
NFPA	:	NATIONAL FIRE PROTECTION ASSOC.CIATION
NPLV	:	NET PART LOAD VALUE
NIST	:	NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY
NEMA	:	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NPSH	:	NET POSITIVE SUCTION HEAD
NTS	:	NOT TO SCALE
OA	:	OUTDOOR AIR
PHE	:	PUBLIC HEALTH ENGINEERING
PLC	:	PROGRAMMABLE LOGIC CONTROLLER
P.C.	:	PERSONAL COMPUTER
PSIG	:	POUNDS PER SQUARE INCH GAUGE
PUF	:	POLYURETHANE FOAM
RA	:	RETURN AIR
RAD	:	RETURN AIR DUCT
RCC	:	REINFORCED CEMENT CONCRETE
RH	:	RELATIVE HUMIDITY
RPM	:	REVOLUTIONS PER MINUTE
SA	:	SUPPLY AIR

SAD	:	SUPPLY AIR DUCT
SMACNA	:	SHEET METAL & AIR CONDITIONING CONTRACTORS NATIONAL ASSOC.CIATION INC
STD	:	STANDARD
T/A	:	TO ABOVE
TAB	:	TESTING, ADJUSTING AND BALANCING
T/B	:	TO BELOW
TCC	:	TERMINAL CONTROL CENTRE
TFA	:	TREATED FRESH AIR
TOA	:	TREATED OUTDOOR AIR
TP	:	THREE PHASE
TR	:	TONS OF REFRIGERATION
TVOC	:	TOTAL VOLATILE ORGANIC COMPOUNDS
VAV	:	VARIABLE AIR VOLUME
VFD	:	VARIABLE FREQUENCY DRIVES
VIP	:	VIBRATION ISOLATING PAD
VSPS	:	VARIABLE SPEED PUMPING SYSTEM
XLPE	:	CROSS -LINKED POLYETHYLENE
SISW	:	SINGLE INLET SINGLE WIDTH
UL	:	UNDERWRITERS LABORATORIES INC.
WG	:	WATER GAUGE

END OF LIST OF ABBREVIATIONS