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TECHNICAL SPECIFICATION

FOR

HVAC WORKS

REV	DESCRIPTION	PREPARED BY	CHECKED BY	APPROVED BY
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SECTION-01

DUCTING AND INSULATION - TECHNICAL SPECIFICATION

PART 1 GENERAL

1.1 SCOPE

A. Supply, installation, Leakage testing (pressure / smoke test) and commissioning of Factory made Rectangular / Circular GI Ducting made of Lock-forming quality GSS; pressure classes from minus 500 to plus 1000 Pa and having 120GSM coating classification with necessary fittings, wire hangers, supports (like flanges, neoprene gaskets, full threaded rods, fixing support hooks/support clamps with embedded plate, wire ropes, corner saddles, guide vanes, vibration isolators, fire retardant flexible connection in all fan inlet & outlet connections, joints, sealing around the duct at wall crossings, labeling etc) as per SMACNA standards and as per specification furnished in this section.

1.2 RELATED DOCUMENTS

A. Drawings, Bill of Quantities, Conditions prevailing at site and Volume-I General Conditions of Contract / Special Conditions of Contract apply to this Section.

1.3 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by HVAC Consultant. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.4 SUBMITTALS

A. Shop Drawings & Duct Construction Submittals: Tender drawings are provided by the HVAC Consultant. HVAC Consultant has considered general requirements as well as specific requirements while preparing the Tender drawings. However, the HVAC Contractor is responsible for the close co-ordination and preparation of Construction drawings /Shop drawings to meet the site specific requirements after award of contract and any other change that arises during execution of the project.

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.

B. Factory Fabrication quality-control reports.

C. Field quality-control test reports.

D. ***Compliance statement:*** The vendor shall explicitly state all technical deviations of the product, in annexure A. Non-filling of the annexure would be considered as zero-deviation to the scope & technical specifications. Technical / scope deviation indirectly implied by submission of technical literature / documents will not be accepted.

1.5 QUALITY ASSURANCE

A. Comply with Local standards of Galvanized Steel Sheets (Plain & Corrugated) for Ducting materials (120 GSM Zinc Coating).

PART 2 PRODUCTS

2.1 SHEET METAL MATERIALS

A. *Manufacturer & Vendors*:

1. GSS material:
   a. Jindal
   b. SAIL
   c. TATA
2. Rectangular Duct manufacturer:
   a. Rolastar
   b. Shree venus
   c. Western Air Ducts India Pvt Ltd
3. Spiral Duct manufacturer:
   a. Seven Star Aircon Ancillaries Pvt Ltd
   b. Western Air Ducts India Pvt Ltd
   c. GP spiro
4. Wire Hangers:
   a. Gripple Limited, UK.

B. Comply with local standards Galvanized Steel Sheets (Plain & Corrugated) for Ducting materials. Comply with SMACNA's HVAC Duct Construction Standards for Rectangular Duct and spiral duct Standards material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Duct Flanges: Furnish Mild Steel fabricated flanges for spiral ducts with diameter 1000-mm and above. Use 40 x 40 x 3-mm size GI flanges. GI painting is not acceptable.

D. Duct gaskets: Durable materials such as soft elastomeric butyl or extruded forms of sealants should be used in flanged joints.

E. Wire hangers: Wire hangers approved by SMACNA, CSA Standards.

F. Duct Storage & Handling:

1. The duct shall be stored in plain surface
2. The duct shall be stored at least 200mm above the ground level with the support of Wooden sleepers. The maximum spacing between wooden sleepers shall not exceed 1000-mm.
3. The complete ducting shall be completely covered with PVC tarpaulin to protect from duct accumulation, Rain water, wind and weather if the ducts are stored outside the premises.

2.2 DUCT THERMAL INSULATION MATERIAL (AIR-CONDITIONING DUCT INSULATION)

1. Flexible Closed-cell Nitrile Rubber Elastomeric

   Manufacturers:

   a. ALP Aeroflex
   b. Armacell
   c. K-Flex

2. Product

   a. Materials: Closed-cellular polyethylene thermal plastic, preformed sheet insulation with factory applied aluminum foil

   b. Thickness: 9-mm thick for Internal duct & 19-mm thick for outdoor exposed ducts

   c. Thickness: 13-mm thick, for return air duct

   d. Thermal Conductivity (k-Value): 0.034 W/m °k at 24 °C mean temperature.

   e. Density: 24 – 28 Kg/Cu.M

   f. Fire-Hazard Classification Conform to Class Class 0 rating for surface spread of Flame as per BS 476 Part 7.

   g. Adhesive: As recommended by insulation manufacturer.

   h. Sealing of 9-mm thick with Aluminium foil Insulation: Use Aluminum foil tape for sealing the joints.PVC tap / Plastic packaging Tape will not be acceptable

   i. Sealing of 19-mm thick with Aluminium foil Insulation: Use Aluminum foil tape for sealing the joints.PVC tap / Plastic packaging Tape will not be acceptable

   Vendor can choose following type of insulation also, as an alternate:

3. Flexible Closed-cell XLPE

1. Manufacturers:

   - Trocellen
   - Thermobreak

   Materials: Closed-cellular polyethylene thermal plastic, preformed sheet insulation

   - Thickness: 9-mm thick with Aluminium foil for Internal duct & 19-mm thick for outdoor exposed ducts
   - Thermal Conductivity (k-Value): 0.034 W/m °k at 24 °C mean temperature.
   - Density: 24 – 28 Kg/Cu.M
   - Fire-Hazard Classification Conform to Class 0 rating for surface spread of Flame as per BS 476 Part 7.

- Adhesive: As recommended by insulation manufacturer.
- Sealing of 9-mm thick with Aluminium foil Insulation: Use Aliminum foil tape for sealing the joints.PVC tap / Plastic packaging Tape will not be acceptable

Sealing of 19-mm thick with Aluminium foil Insulation: Use Aliminum foil tape for sealing the joints.PVC tap / Plastic packaging Tape will not be acceptable

2.3 DUCT ACOUSTIC INSULATION MATERIAL

B. Flexible Open-cell Nitrile Rubber Elastomeric:

2. Manufacturers:

a. ALP Aeroflex
b. Armacell
c. K-Flex

3. Materials: Open-cellular polyethylene thermal plastic, preformed sheet insulation.

a. Thickness: 15-mm thick.

b. Thermal Conductivity (k-Value): 0.05 W/m °k at 24 °C mean temperature.

c. Density : 140 – 180 Kg/Cu.M

d. Fire-Hazard Classification: Conform to Class 1 rating for surface spread of Flame as per BS 476 Part 7.

e. Adhesive: As recommended by insulation manufacturer.

2.3 HANGERS AND SUPPORTS

A. Building Attachments: Use power-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Use power-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 100-mm thick.
2. Exception: Do not use power-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 100-mm thick.

B. Hanger Materials: Galvanized threaded steel rod & Wire ropes

1. Hangers Installed in Corrosive Atmospheres: Galvanized full threaded rods. The full threaded rods shall be used only in places where the Wire rope cannot be used. However the HVAC contractor shall obtain necessary approval for using full threaded rods.

2.4 RECTANGULAR DUCT FABRICATION

C. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for reinforcing types and intervals, tie-rod applications, and joint types and intervals. Use computerized systems and machines for Fabrication.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

D. Minimum Sheet Thickness: Use 0.6-mm for ducts with longest Side of 0 – 750mm, 0.8-mm for ducts with longer side of 751 – 1500mm, 1.0-mm for ducts with longest side of 1501 – 2200mm, 1.2-mm for ducts with longest side of 2201 and above.

E. Minimum Sheet Thickness for smoke exhaust: Use 1.2 mm thick GI duct material.

F. Reinforcement: Unless otherwise specified or allowed, rectangular ductwork shall be constructed in accordance with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" Tables 1−3 through 1−13 and with details associated with them. However the sheet thickness for various sizes shall be as provided above.

G. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

H. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.

1. Duct Size: Maximum 750-mm wide and up to 500-Pa pressure class.
2. Longitudinal Seams: Pittsburgh lock.

2.5 ROUND DUCT AND FITTING FABRICATION

I. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Use computerized systems and machines for Fabrication.

J. Round, longitudinal Lock-Seam Ducts: Fabricate supply ducts of galvanized steel / Mild Steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Refer to drawing for ducting location.

K. Minimum Sheet Thickness: Use 0.6-mm for ducts with diameter up to 600-mm, 0.8-mm for ducts with diameter up to 900-mm, 1.0-mm for ducts with diameter up to 1400 size.

L. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

M. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

N. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter.

O. The duct joints shall be at every 1000 mm wherever required to complete internal insulation.

2.6 APPLICATION OF THERMAL INSULATION IN SPIRAL DUCTS:

Adhere a single layer of indicated thickness of duct insulation inside the duct with at least 90 percent adhesive coverage at insulation contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.The insulation shall be applied at Factory for good work finish.

2.7 SITE INSPECTION AND ACCEPTANCE FOR FACTORY FABRICATED RECTANGULAR DUCT:

P. Site inspection of Rectangular Duct, before installation, will be carried out in the presence of the owner's representative on each pieces of duct supplied. Material not meeting the requirement will be rejected and the Vendor has to replace with new pieces as indicated in the specification.

PART 3 EXECUTION

3.1 DUCT APPLICATIONS

Q. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Supply Ducts: 750 Pa.
2. Exhaust Ducts (Negative Pressure): 500 Pa.

R. All ducts shall be of galvanized steel material.

3.2 DUCT INSTALLATION

S. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible,"

T. Install ducts with fewest possible joints.

U. Install factory machine fabricated fittings for changes in directions, size, and shape and for connections.

V. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

W. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

X. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

Y. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

Z. Protect duct interiors from the elements and foreign materials until building is enclosed.

AA. Exposed duct insulation to be covered with 0.8 mm thick aluminium cladding.

3.3 SEAM AND JOINT SEALING

AB. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

1. For pressure classes lower than 750 Pa seal transverse joints.
2. Diffuser/Grille dropper.

AC. Seal ducts before external insulation is applied.

3.4 HANGING AND SUPPORTING

AD. Support horizontal ducts within 600-mm of each elbow and within 1200mm of each branch intersection.

AE. Support vertical ducts at maximum intervals of 4m.

AF. Install power-actuated concrete fasteners after concrete is placed and completely cured.

1. Do not use power-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 100 mm thick.

3.5 CONNECTIONS

AG. Make connections to equipment with flexible connectors according to Section "Duct Accessories."

AH. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 MODE OF MEASUREMENT

AI. Rectangular GI Ducts shall be measured by surface area and length of duct shall not include flanges, canvass, volume control dampers and other fittings and accessories.

AJ. Insulation shall be measured by surface area and length of duct shall not include flanges, canvass, volume control dampers and other accessories.

AK. Measurement of wastage is not allowed for any products.

AL. Round ducts shall be measured by unit length. Fittings like bends, tees, reducers, branching connections, duct connectors, flanges shall not be paid extra.

ANNEXURE – A

S.NO	CLAUSE	PG.NO	DEVIATION PARTICULARS	Bidder's remarks

END OF SECTION

SECTION - 02

VRF AIR-CONDITIONING UNIT - TECHNICAL SPECIFICATION

PART 1 - GENERAL

1.1 SCOPE OF THIS SECTION

A Design, supply, installation, testing and commissioning Variable Refrigerant Flow Outdoor Unit consisting ofGI Powder coated Cabinet, Constant Flow Compressors, Variable Flow Compressors, Finned tube Condenser Coil, Condenser fans with motors with variable speed controller, System Controller, Electrical components (Power Contactors, Control Relays, Overload Relays, Wiring etc) necessary mounting brackets, Vibration Isolators, full charge of refrigerant for the system and as per the specification furnished in the section.

B Design, Supply, installation, testing and commissioning of ceiling mounting type, Variable Refrigerant Flow cassette Unit consisting of Thermo plastic Cabinet, Dynamically balanced centrifugal blowers, auto-swinging louvers for air distribution type, fan motors, fresh air port, Direct Expansion type cooling coil, Insulated drain tray, pre-filters, Electronic Refrigerant Flow Control valve, Room temperature sensor & Cordless remote controller, Control module with self-diagnostic features, Inbuilt condensate drain pump, necessary supports, vibration isolators wherever required and per the specification furnished in the section.

C Supply, installation, testing and commissioning Ceiling Suspended, ducted type, Variable Refrigerant Flow Indoor Unit consisting of GI Powder coated Cabinet, Low-Static dynamically balanced centrifugal blowers, fan motors, Direct Expansion type cooling coil, Insulated drain tray, Washable Pre-filters, Electronic Refrigerant Flow Control valve, Room temperature sensor & corded remote controller with extendable cable to locate near guest room bed, Control module with self-diagnostic features, vibration isolators, Fire retardant flexible connection, GI support rods, anchoring and as per the specification furnished in this section.

E Supply, installation, testing and commissioning Ceiling Suspended, ducted type, Variable Refrigerant Flow Indoor Unit consisting of GI Powder coated Cabinet, High-Static dynamically balanced centrifugal blowers, fan motors, Direct Expansion type cooling coil, Insulated drain tray, Washable Pre-filters, Electronic Refrigerant Flow Control valve, Room temperature sensor & corded remote controller with extendable cable to locate near guest room bed, Control module with self-diagnostic features, vibration isolators, Fire retardant flexible connection, GI support rods, anchoring and as per the specification furnished in this section.

D Supply, installation, testing and commissioning wall mounting type, Variable Refrigerant Flow Hi-wall Unit consisting of Thermo plastic Cabinet, Dynamically balanced centrifugal blowers, auto-swinging louvers, fan motors, Direct Expansion type cooling coil, Insulated drain tray, Pre-filters, Electronic Refrigerant Flow Control valve, Room temperature sensor & Cordless remote controller, Control module with self-diagnostic features, necessary supports and as per the specification furnished in the section.

1.2 RELATED DOCUMENTS

A. AC & V Drawings, Bill of Quantities, Conditions prevailing at site and General Conditions of Contract Special Conditions of Contract apply to this Section.

1.3 DEFINITIONS

A. VRF: Variable Refrigerant Flow System.
B. ODU: Outdoor Unit.
C. IDU: Indoor Unit.

1.4 SUBMITTALS – TO BE SUBMITTED ALONG WITH TENDER

A. ***Product Data***: The Annexure “A” shall be filled and the same shall be attached with the Tender documents for all the VRF Outdoor units specified in the Bill of quantities & Tender drawings. The contractor shall furnish the details of specialties, and accessories for each equipment including but not limited to the following
   1. Number of VRF ODUs on a single Refrigerant circuit system.
   2. Capacity of each ODU’s in TR.

3. Maximum indoor to outdoor connectivity for operation.
4. Maximum indoor to outdoor connectivity only for installation.
5. Maximum rated continuous operating hours for ODU.
6. Maximum rated continuous operating hours for inverter / digital scroll compressor.
7. Maximum rated idle hours require before next start of inverter / digital scroll compressor.
8. Number of variable speed inverter / digital scroll compressors per ODU.
9. Capacity of variable speed inverter / digital scroll compressors in TR.
10. Number of fixed speed compressors per ODU.
11. Capacity of fixed speed compressors in TR.
12. De-ration factors used for sizing outdoor units
13. Electrical power requirement & No. of circuit breakers required for ODU.
14. Product printed engineering manual to substantiate the de-ration factors applied.
15. Actual capacity of the outdoor units considering 43 Deg C ambient temperature and 24 Deg C & 55% RH indoor conditions, for required refrigerant piping layout as installed as per drawing.
16. Rated capacity of the indoor units. While selecting the indoor unit, Contractor should not change the quantity of indoor units (Refer : Bill of Quantity and Tender Layout)
17. Actual capacity of the indoor units considering 43 Deg C ambient temperature and 24 Deg C & 55% RH indoor conditions, for required refrigerant piping layout as installed as per drawing.
    NOTE: Single refrigerant circuit system is defined as the refrigerant circuit which is connected to multiple indoor units with multiple outdoor units.

B. ***Equipment General Arrangement (GA) Drawing***: The contractor shall submit General arrangement drawing of the VRF Outdoor & Indoor Unit which shall include (but not limited to)

1. Overall length, overall width, over all height,
2. Service & maintenance space requirements
3. Minimum straight at the inlet & outlet
4. Structural foundation requirements

C. ***Equipment selection Data:*** The contractor shall submit sizing details of VRF Outdoor Unit based on de-ration factors considered as per annexure “B”. Vendor shall submit their printed engineering manual of their product to substantiate their de-ration data.

D. ***Compliance statement:*** The vendor shall explicitly state all technical deviations of the product, in annexure C. Non-filling of the annexure would be considered as zero-deviation to the scope & technical specifications. Technical / scope deviation indirectly implied by submission of technical literature / documents will not be accepted.

1.5 SUBMITTALS – TO BE SUBMITTED AFTER AWARD OF CONTRACT

A All below described documents shall be submitted within 5 days of issue of LOI to the contractor / vendor.

A. ***Product Data***: The Annexure “A” shall be filled and the same shall be attached with the Tender documents for all the VRF Outdoor units specified in the Bill of quantities & Tender drawings. The contractor shall furnish the details of specialties, and accessories for each equipment including but not limited to the following

1. Number of VRF ODUs on a single Refrigerant circuit system.
2. Capacity of each ODU’s in TR.
3. Maximum indoor to outdoor connectivity for operation.
4. Maximum indoor to outdoor connectivity only for installation.
5. Maximum rated continuous operating hours for ODU.
6. Maximum rated continuous operating hours for inverter / digital scroll compressor.
7. Maximum rated idle hours require before next start of inverter / digital scroll compressor.
8. Number of variable speed inverter / digital scroll compressors per ODU.
9. Capacity of variable speed inverter / digital scroll compressors in TR.
10. Number of fixed speed compressors per ODU.
11. Capacity of fixed speed compressors in TR.
12. Rated capacity of the indoor units.

13. Actual capacity of the outdoor units considering 43 Deg C ambient temperature and 24 Deg C & 55% RH indoor conditions, for required refrigerant piping layout as installed as per drawing.
14. Rated capacity of the indoor units. While selecting the indoor unit, Contractor should not change the quantity of indoor units (Refer : Bill of Quantity and Tender Layout)
15. Actual capacity of the indoor units considering 43 Deg C ambient temperature and 24 Deg C & 55% RH indoor conditions, for required refrigerant piping layout as installed as per drawing.

NOTE: Single refrigerant circuit system is defined as the refrigerant circuit which is connected to multiple indoor units with multiple outdoor units.

B. ***Equipment General Arrangement (GA) Drawing***: The contractor shall submit General arrangement drawing of the VRF Outdoor & Indoor Unit which shall include (but not limited to)

1. Overall length, overall width, over all height,
2. Service & maintenance space requirements
3. Minimum straight at the inlet & outlet
4. Structural foundation requirements

C. ***Equipment selection Data:*** The contractor shall submit sizing details of VRF Outdoor Unit based on de-ration factors considered as per annexure “B”. Vendor shall submit their printed engineering manual of their product to substantiate their de-ration data.

D. ***Schematic refrigerant piping diagram:*** The contractor shall submit input data & results from manufacturer selection software along with refrigerant piping diagram.

E. ***System data***: Provide Compressor technical datasheet, compressor rating chart, Evaporator fan datasheet, and Condenser fan datasheet, amount of refrigerant charge required, refrigerant operating pressures and temperatures.

F. ***ShopDrawings***: The contractor shall prepare the shop drawing to scale and coordinated with the following:

1. Structural supports.
2. Ducting requirements.
3. Refrigerant piping
4. Wiring requirements, including spaces reserved for electrical equipment.
5. Access requirements, including working clearances for mechanical controls and electrical equipment, and service clearances.

G. ***Installation manuals***: The contractor shall submit the detailed installation manuals for VRF System as recommended by Manufacturer. The installation manual shall include (but not limited to) the following

1. Storage requirements, procedure and Checklist
2. Moving and rigging requirements, procedure and Checklist
3. Lifting procedure and checklist
4. Unit leveling procedure and checklist
5. Duct connection requirements, procedure and checklist
6. Electrical connection requirements, procedure and checklist

H. ***Pre-commissioning Checklists***: The contractor shall submit the pre-commissioning checklist (Format only) for each piece of equipment proposed in this project.

I. ***Commissioning Checklist:*** The contractor shall submit the commissioning checklist (Format only) for each piece of equipment proposed in this project.

J. ***Functional test Checklist***: The contractor shall submit the Functional Test checklist (Format only) for each piece of equipment proposed in this project.

K. Minimum COP calculations

1.6 SUBMITTALS – TO BE SUBMITTED ALONG WITH PRODUCT SUPPLY

A. ***Performance test report:*** The contractor shall submit the Performance report for each piece of equipment proposed in this project.

B. ***Operation and Maintenance manual****:* The contractor shall include operation and maintenance manual for each VRF Units (Two Copies in Hard/Soft copy format). The maintenance manual shall include but not limited to the following

1. Daily log requirements
2. Weekly maintenance and checklist
3. Monthly maintenance and checklist
4. Quarterly maintenance and checklist
5. Annual maintenance and checklist

C. ***Service manual****:* The contractor shall include service manual for each type of VRF Units (Two Copies in Hard/Soft copy format). The service manual shall include but not limited to the following

1. Trouble shooting procedures
2. Replacement procedure for all the parts of the components (Mechanical, Electrical & Control) of the equipment
3. Service Instruction

D. ***Spares list****:* The contractor shall submit the list of spares required for trouble free operation.

E. ***Source quality-control reports***: The contractor shall furnish the Assembling checklist report etc at the time of delivery of equipment at site.

F. ***Equipment Delivery Packing-list format***: The contractor shall submit the sample format of "Factory Equipment Delivery Packing list" shall be submitted. This document shall include the detailed bill of materials of the proposed equipment/system.

G. ***Onsite Specification Compliance Check:*** The contractor shall show the actual dimensions of VRF units and its parts at site if required by the owner's representative / Consultant as a part of vendor's scope.

H. ***Warranties Certificate****:* The vendor shall submit Warranty certificate shall be submitted up on completion of Performance testing.

Note*:* One copy of complete submittal as specified above (Clause 1.6) shall be submitted to the HVAC consultant for his review and approval. Subsequent to the approval, two numbers of complete submittal shall be prepared submitted to HVAC Consultant/ Client for record purposes.

I. Declaration on minimum COP of the system

J. Declaration on usage of non-CFC refrigerants.

K. Declaration on minimum VOC content in the unit and associated piping.

1.7 QUALITY ASSURANCE

L. *Quality Assurance Plan:* The contractor shall submit the Quality Assurance Plan (QAP) for each equipment to Architects/ Consultant's for approval.

M. Coefficient of Performance: Shall be prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings Or "Energy Conservation Building Code 2007"

N. Units shall be designed to be operated with R-410A refrigerant.

1.8 INTERPRETING OF SPECIFICATION

O. In interpreting the specifications and any clarifications regarding mismatch between contract and construction documents, the following order of increasing importance and binding shall be followed:

1. Technical Specifications
2. Bill of Quantities with brief specifications
3. Approved Technical submittals of Equipment/materials
4. Approved shop drawings

1.9 TRANSPORTATION, DELIVERY, RECEIVING, STORAGE, AND HANDLING

P. The contractor shall ship VRF units with completely assembled from the factory. Safe transportation, receiving and storing shall be contractor's scope.

Q. VRF Units and its parts shall be completely covered with PVC tarpaulin when stored at site before installation by the contractor.

R. Appropriate handling machineries like Hydraulic Cranes shall be used during installation by the contractor.

1.10 COORDINATION

S. The contractor shall coordinate with the civil contractor for the size and location of equipment foundation, necessary wall opening for unit mounting and refrigerant piping. Cast anchor-bolt inserts into bases as required. Concrete, reinforcement, and formwork requirements, wall opening requirements shall be carried out by civil contractor.

1.11 WARRANTY

T. Standard Warranty: Manufacturer's standard form in which manufacturer agrees to do periodic maintenance, repair or replace components of VRF units those fail in materials or workmanship for minimum of **one year** from the date of successful commissioning and handing over.

U. Scope of Warranty:

1. Periodic maintenance: The contractor shall perform the maintenance service as per the manufacturer's specified intervals regularly.
2. Defective part Replacement: As part of warranty scope, the manufacturer should replace/rectify the defective part at free of Cost inclusive of spares and consumables within 24-hours duration from the time of complaint call. The labor charges and travel expenses (To & fro with lodging) of the site/supervisory engineer/staff shall be borne by the contractor.
3. The Vendor shall also quote for a mandatory extension of warranty up to 5 years from the date of successful completion of one-year warranty period, with additional cost.

1.12 ALL INCLUSIVE COMPREHENSIVE MAINTENANCE CONTRACT

V. Applicability: The comprehensive maintenance contract shall be in effect from the date of expiry of first year warranty and for a period of minimum **five** years.

W. The maintenance of Air-conditioning system and all its components as included in the schedule of work is to be carried out round the clock including holidays on comprehensive basis. No material and consumables will be supplied by the Client. The vendor has to adhere to maintenance schedule of each service.

X. The scope of work covers comprehensive maintenance including spare parts like compressor, Controls, Refrigerant and all the parts of the VRF Systems. The contractor shall maintain the equipment as per manufacturer's guidelines and shall use standard components for replacement. Until and unless written orders of the Clients are conveyed, the original specification/ characteristics /features shall not be changed.

Y. All the complaints received shall be attended immediately as follows: (i) Minor faults within 4 working hours, (ii) Major faults within 24 working hours.

Z. If the equipment is required to be transported to the contractors/Manufacturer service workshop for repairs, the same shall be undertaken at the risk and cost of the contractor and standby equipment has to be provided to keep the system operative.

AA. The contractor will not be allowed to charge any extra amount for repair/replacement, if any, after entering in to the contract.

AB. The contractor shall carry out preventive maintenance regularly and shall plan, as per schedule of quantities, so that maintenance is carried out in each equipment at least once in a month or as required intervals whichever is earlier.

1.13 SITE ACCEPTANCE TEST

AC. Site Acceptance Test: The contractor shall test the VRF units at site conditions under exactly identical conditions as indicated in the Tender specification. The following measurements/tests shall be carried out to establish the base data and also to assess the performance of the VRF unit at site.

1. Capacity of the indoor units at 100% load, 75% load, 50% load & 25% load.
2. Power consumption of our door unit at above specified load conditions.
3. Coil inlet and outlet water temperature measurement
4. Vibration and sound pressure level measurement
5. Safety controls
6. 72 hours endurance test

B. Acceptance Criteria: VRF ODU & IDU Capacity in TR (Tons of Refrigeration) shall be computed from temperature readings, air flow measurements at specified temperature and flows. For acceptance, the capacity of VRF ODU & IDUs shall be tested as per ANSI/AHRI Standard 1230 2010 Standard for Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment or as requested by Client / Consultant.

#	MEASUREMENT QUANTITY	NAME OF THE INSTRUMENT	ACCURACY
1	ODU Capacity	Integral Measurement	± 0.5
2	IDU Capacity	Thermometer, Psychrometer & Anemometer, flow hood	± 0.5

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. *Manufacturers*: Subject to compliance with requirements, the contractor shall provide products by one of the following:
   a. Daikin
   b. LG

c. Samsung
d. Toshiba

B. The approved makes provided is only for guidance. Vendor shall select the product only when the product meets all technical requirement, clients' commercial conditions and project schedule.

C. *Special Approval*: Subject to compliance with requirements, the Client Engineer / Consultant have the authority to propose/approve the manufacturer (those not listed above) on later stage of the project if warranted.

2.2 CEILING MOUNTING TYPE CASSETTE EVAPORATOR-FAN COMPONENTS (INDOOR UNIT - IDU)

A. Ceiling mounting type Cassette Unit: Factory fabricated, Ceiling Suspended, Cassette Variable Refrigerant Flow Indoor Unit consisting of Galvanized sheet Cabinet, Removable plastic panels, Condensate Drain pump with controls, Hi-Static dynamically balanced centrifugal blowers, fan motors, fresh air port, Direct Expansion type cooling coil, drain tray with 6-mm thick nitrile rubber insulation, Pre filters 90% efficiency down to 20microns, Electronic Refrigerant Flow Control valve, Refrigerant inlet & outlet temperature detectors, Refrigerant inlet & outlet pressure sensors, Room temperature sensor & Cord-less remote controller, Control module self-diagnostic features, necessary supports etc

B. The VRF indoor unit capacity indicated in schedule of quantities shall at 43 Deg C Outdoor Dry bulb temperature, and 24 Deg C Indoor Dry Bulb Temperature with 55% indoor Relative Humidity at 100% indoor load conditions and site installed actual piping lengths/level differences.

C. Cabinet: Galvanized sheet cabinet with removable plastic panels.

D. Refrigerant Coil: Copper tube material, with mechanically bonded aluminum fins.

E. Electronic Expansion Valve: High efficiency electronic expansion valve to control the refrigerant flow through evaporator.

F. Condensate Drain pump: High efficiency drain pump suitable for 24 x 7 x 300 days operation with necessary piping, electrical and control connections.

G. Fan: Direct drive, centrifugal fan,

H. Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency

I. Filters: Permanent, cleanable, with 90% efficiency down to 10microns.

J. Capacity: Refer to AC & V drawings / Schedule of quantities for various indoor unit capacities and quantities.

2.3 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS (INDOOR UNIT – IDU)

A. Wall mounting type evaporator-fan components: Factory fabricated, wall mounted type, non-ducted type, Variable Refrigerant Flow Indoor Unit consisting of removable plastic panel Cabinet, Hi-Static dynamically balanced centrifugal blowers, fan motors, Direct Expansion type cooling coil, drain tray with 6-mm thick nitrile rubber insulation, Pre filters 90% efficiency down to 10microns, Electronic Refrigerant Flow Control valve, Refrigerant inlet & outlet temperature detectors, Refrigerant inlet & outlet pressure sensors, Room temperature sensor & Cordless remote controller, Control module self-diagnostic features, necessary supports etc

B. The VRF indoor unit capacity indicated in schedule of quantities shall at 43 Deg C outdoor Dry bulb temperature, 27.8 Deg C outdoor Wet Bulb Temperature and 24 Deg C indoor Dry Bulb Temperature with

C. 55% indoor Relative Humidity at 100% indoor load conditions and site installed actual piping lengths/level differences.

D. Cabinet: Removable Plastic panels on front and ends in standard color, bottom discharge, Return air inlet section with filters and drain pans with drain connection.

E. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins with capillary-expansion device. Fan: Direct drive, centrifugal fan, low noise with 3-speed motor (low, medium & high)

F. Filters: Permanent, cleanable, removable through front panel.

G. Drain Pump: Provide ASPEN make condensate drain pumps within the indoor unit.

H. Capacity: Refer to AC & V drawings / Schedule of quantities for Indoor Unit capacities and quantity.

2.4 HIGH-STATIC DUCTABLE EVAPORATOR-FAN COMPONENTS (INDOOR UNIT– IDU)

A. Ceiling Suspended Ductable Unit: Factory fabricated, Ceiling Suspended, ducted type, Variable Refrigerant Flow Indoor Unit consisting of Galvanized sheet Cabinet, High-Static dynamically balanced centrifugal blowers, fan motors, Direct Expansion type cooling coil, drain tray with 6-mm thick nitrile rubber insulation, Pre filters 90% efficiency down to 20microns, Electronic Refrigerant Flow Control valve, Refrigerant inlet & outlet temperature detectors, Refrigerant inlet & outlet pressure sensors, Room temperature sensor & Corded remote controller, Control module self-diagnostic features, necessary supports, Flexible connection in the mouth outlet

B. The VRF indoor unit capacity indicated in schedule of quantities shall at 43 Deg C outdoor Dry bulb temperature, 27.8 Deg C outdoor Wet Bulb Temperature and at 100% indoor load conditions as per section-01, “Basis of Design” and site installed actual piping lengths/level differences.

C. Cabinet: Galvanized sheet cabinet with removable panels.

D. Refrigerant Coil: Copper tube material, with mechanically bonded aluminum fins.

E. Electronic Expansion Valve: High efficiency electronic expansion valve to control the refrigerant flow through evaporator.

F. Fan: Direct drive, centrifugal fan, High-static (20-mm W.C external static pressure minimum).

G. Filters: Permanent, cleanable, with 90% efficiency down to 10microns.

H. Remote-control: The indoor units shall be supplied with corded remote control with following features:
1. 24-hour time control of system stop and start.
2. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
3. Fan-speed selection, including auto setting.

I. The length of the remote-control cord shall be adequate to reach up to operable height (1500 mm) at designated location as per tender drawings.

J. Capacity & ratings: Refer to AC & V drawings / Schedule of quantities for various indoor unit capacities and quantities.

K. Noise Rating for the complete unit assembly with housing: Not to exceed the sound pressure level of 40 dBA measured at 1.5Meter distance.

2.5 VRF, AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS (OUTDOOR UNIT – ODU)

A. Description: Air-cooled Outdoor Unit comprising of fixed speed constant flow compressors, minimum THREE/TWO variable refrigerant flow compressor (Inverter Scroll / Inverter Rotary) per ODU circuit, Inverter control/electrical components, starter components, electrical safeties, Micro-processor controls, GI Powder coated Cabinet, Finned tube Condenser Coil with anti-corrosive Blue-fin coating/ Epoxy coating, Condenser fans with motors with variable speed controller, System Controller, Electrical components (Power Contactors, Control Relays, Overload Relays, Wiring etc) necessary mounting brackets and Vibration isolators etc. The VRF System shall use R410A as refrigerant. The system shall include full charge of refrigerant. The Inverter / digital compressor shall be rated for 24 x 7 x 365 hours operation.

B. The VRF Outdoor unit capacity indicated in schedule of quantities shall at 43 Deg C outdoor Dry bulb temperature, 27.8 Deg C outdoor Wet Bulb Temperature and 24 Deg C indoor Dry Bulb Temperature with 55% indoor Relative Humidity at 100% indoor load conditions and site installed actual piping lengths/level differences.

NOTE: (1) 22TR and less shall have TWO Inverter Scroll / Inverter Rotary / Digital Scroll (2) 23TR and above shall have THREE Inverter Scroll / Inverter Rotary / Digital Scroll.

C. Casing: Steel, finished with baked enamel in color, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

D. Compressor Constant Speed: Hermetically sealed, mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

1. Compressor Type: Rotary / Scroll
2. Refrigerant Charge: R-410A
3. Capacity Control Methods: On-off based on thermal load from indoor units.

E. Compressor Variable Speed DC Inverter Scroll / DC Inverter Rotary / Digital Scroll: Hermetically sealed, mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor, DC Inverter system. In case of Digital Scroll compressor, the ODU shall be equipped with necessary loading and unloading system.

1. Compressor Type: Rotary / Scroll
2. Minimum three compressors per ODU circuit
3. Refrigerant Charge: R-410A
4. Capacity Control Methods: Change in speed of the compressor for DC Inverter Scroll/Rotary, long-life solenoid to loads and unload the scroll members for digital scroll compressors as required to meet the indoor load.

F. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and with liquid sub-cooler.

G. Refrigerant Circuits: Internal refrigerant piping with thermal sensors, sub-cooling heat exchangers with electronic expansion valve, Insulation for complete piping to eliminate external heat gain, service isolation valves with gauge ports.

H. Fan: Aluminum-propeller type directly connected to DC motor for varying speed.

I. Motor: Permanently lubricated, with integral thermal-overload protection.

J. Capacity: Refer to AC & V drawings / Schedule of quantities for various outdoor unit capacities and quantities.

2.6 CONTROLS:

A. Room Thermostat: Wired remote controller, functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection, including auto setting.

B. *Control Panel*: VRF Air-conditioning systems shall be provided with intelligent controls as required to measure the amount of refrigerant required to flow through various indoors, to control the compressor staging, to control the DC inverter compressor speed, to load & unload the scroll members, measure the refrigerant entering and leaving temperatures in condensers and evaporators, to monitor the pressure at condenser and evaporators etc. Stand-alone, microprocessor based (DDC) Controller with LCD display Unit.

C. *Enclosure*: Unit-mounted, enclosure constructed for outdoor use (IP55) to provide a degree of protection to personal against access to hazardous parts and to provide protection of the equipments inside the enclosure against ingress of foreign objects / rain, hinged or lockable; factory wired with a single-point power connection and a separate control circuit.

D. *Status Display:* Multiple-character liquid-crystal display and keypad. Display the following conditions with SYSTEM GRAPHICS:

1. Date and time.
2. Outdoor Unit Operating or alarm status.
3. Outdoor Unit Operating hours.
4. Compressor operating status.
5. Refrigerant Temperature & Pressure at the following location.
   a. Outdoor Unit Condenser inlet and outlet
   b. Compressor inlet & outlet
   c. Evaporator inlet & outlet
   d. Sub-cooler inlet & outlet
6. Inverter Compressor Operating Speed (RPM)
7. Temperature and pressure operating set points
   a. High discharge pressure
   b. Low suction pressure
8. Operating Thermal load.
9. Power consumption by outdoor unit
10. Indoor Unit Run status, operating mode
11. Indoor Unit room temperature & room temperature set-point
12. Indoor Unit Run hours
13. Indoor Unit alarm status
14. Indoor Unit Power Consumption

E. Control Functions:

1. Manual or automatic startup and shutdown based on 24-hours time schedule.
2. Room temperatures control set points.
3. Automatic restart on resume of power.
4. Automatic restart on alarm reset

F. *Manually Reset Safety Controls*: The following conditions shall shut down the and require manual reset:

1. High compressor-discharge temperature / Pressure.
2. Electrical overload.
3. Sensor- or detection-circuit fault.
4. Processor communication loss / failure.

5. Starter fault.
6. Phase loss, phase reversal and phase imbalance

G. *Controller Alarm History*: The controller alarm history shall provide the following:

1. Power failure
2. Low suction pressure of all circuits
3. High discharge pressure of all circuits
4. Hi/Low pressure sensor error
5. Temperature sensor error
6. Ten most recent alarms shall be displayed

H. BMS Integration: the outdoor units shall be provided with all necessary software / hardware components including necessary license, for high level BMS integration through MODBUS RTU. The vendor shall provide read-write provisions for BMS to operate the indoor units.

2.7 COPPER TUBING:

A. Provide 1.2-mm thick Hard-drawn-copper tubes between indoor and outdoor suction and discharge connections. The suction and discharge piping shall be insulated separately with 12-mm thick aluminium foil faced nitrile rubber insulation.

B. Use suitable refrigerant line branching tube for various indoors. The branching tube shall be completely insulated with 12-mm thick aluminium foil faced nitrile rubber insulation.

C. Supports for outdoor exposed piping: Use factory fabricated Zinc coated GI support angles (40 x 40 x 3-mm, hot dip galvanized) for clamping the copper pipes. The support clamps shall be made out of factory fabricated GI clamps (25 x 3-mm thick flat) bolted with GI bolt & nuts. Provide factory made rubber sleeve between piping and clamps. The GI support angles shall be grouted to the wall and roof structure using Anchor fasteners. The maximum spacing between the supports shall not exceed 1200-mm and provide support at each bend additionally. The copper piping shall be completely covered with factory fabricated 1.6-mm thick GI tray on top. Refer to the Tender drawings for piping supporting details.

D. Supports for shaft piping: Use factory fabricated Zinc coated MS support angles (40 x 40 x 3-mm) for clamping the copper pipes. The support clamps shall be made out of factory fabricated GI clamps (25 x 3-mm thick flat) bolted with GI bolt & nuts. Provide factory made rubber sleeve between piping and clamps The support angles shall be grouted to the wall and roof structure using Anchor fasteners. The maximum spacing between the supports shall not exceed 1200-mm and provide support at each bend additionally.

E. Supports for Internal piping: Use factory fabricated Zinc coated MS support angles (40 x 40 x 3-mm) for clamping the copper pipes. The support clamps shall be made out of factory fabricated GI clamps (25 x 3-mm thick flat) bolted with GI bolt & nuts. Provide factory made rubber sleeve between piping and clamps. The GI support angles shall be grouted to the wall and roof structure using Anchor fasteners. The maximum spacing between the supports shall not exceed 1200-mm and provide support at each bend additionally.

F. The vendor shall provide suitable sized PVC sleeves, at no extra cost, wherever the refrigerant pipes cross civil openings. The gap between sleeve and pipes shall be sealed by HVAC vendor with fire sealant, wherever indicated in approved drawings.

2.8 DRAIN PIPING:

A. Provide CPVC drain pipes (6kg/cm²) from indoor unit to nearest drain point shown in the drawing. The drain pipe shall be completely insulated with 6mm thick nitrile rubber tubular insulation.

2.9 CONTROL CABLING:

A. Provide necessary control cabling between the Indoor Unit (IDU) and the Outdoor Unit (ODU) with the following specification. The size of the cable shall be as per manufacturer recommendation.

a) 2C X 1 sq.mm Fine copper wire, PVC insulated and sheathed & shielded, flexible control cable with (a) Construction: Ultra fine wire stranded soft drawn copper; (b) Insulation: Black PVC, numbered cores, plus green/yellow earth; (c) Sheath: Flame retardant, extensively oil resistant, flexible PVC, (d) Characteristics: Nominal Voltage 230VAC/DC, Temperature range: Flexing -5 to 80°C, Bending radius 7.5 x cable diameter.

2.10 GREEN BUILDNG REQUIREMENT

A. VOC of adhesives / sealants used in these units and their associated piping must be low VOC and not exceeding 850 grams/liter less water for sheet applied rubber lining applications, less than 80 g/l less water for fibreglass applications, less than 50g/l less water for plastic foams.

B. The Minimum COP of the whole system shall be 3.4/ EER of 11.6 at ARI condition.

C. All indoor units shall be covered during installation period, to avoid dust gathering.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install unit level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install ground-mounting, compressor-condenser components on 100-mm thick, PCC concrete base; 100 mm larger on each side than unit.

D. Install vibration isolator rubbers.

E. Install and connect charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

F. Install piping adjacent to unit to allow service and maintenance.

G. Ground equipment according to electrical code requirement.

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.3 TESTING, ADJUSTING, BALANCING AND COMMISSIONING

A. Refer to testing, adjusting and balancing section for details.

3.4 MEASUREMENT

A. All outdoor units shall be paid in Nos.

B. All indoor units shall be paid in Nos. Any additional combination of indoor units proposed to meet desired load conditions specified in BOQ item, shall not be paid extra.

C. Vendor shall design the copper pipe & ref-net requirement and specify the quantity & sizes in appropriate rows/columns of BOQ. Until unless the locations of indoor units / outdoor units are changed during shop drawings stage / construction stage, the quantity and amount quoted shall be considered as LOT. Any variation due to vendors error in quantification during tender stage shall be borne by vendor and no variation is payable though vendor shall be required to complete the desired installation.

D. Control cabling shall be measured as part of refrigerant piping and no additional cost is payable.

E. No additional measurement for supports for refrigerant pipes, ref-net joints, indoor units, outdoor units and control cabling shall be considered.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Client engineer's maintenance personnel to adjust, operate, and maintain VRF units.

ANNEXURE – A

VRF OUT DOOR UNIT TECHNICAL DATA SHEET

GENERAL	
Make and Origin :	
Model :	
Capacities of each module & grouping	
CAPACITIES:	
Cooling Capacity (TR) :	
Cooling Input Power (kW) :	
Cooling Mode - Rated Conditions :	
Indoor : 23°C DBT, 55% RH	
Outdoor: 40°C DBT	
Pipe Length : Refer Tender Layout	
Level Difference : Refer Tender Layout	
EER rating at ARI conditions	
EER rating at actual conditions	
OPERATING RANGE:	
Maximum rated continuous operating hours :	
Cooling (Min & Max DBT):	
ODU to IDU Installation Connectivity (%):	
ODU to IDU Operational Connectivity (%):	
COMPRESSOR:	
Type 1:	
Type 2:	
Fixed Ref. Flow Compressor Quantity :	
Fixed Ref. Flow Compressor Capacity :	
Variable Ref. Flow Compressor Quantity :	
Variable Ref. Flow Compressor Capacity :	
Rated continuous operating hours for VRF Compressor:	
Minimum idle hours required before next start of VRF compressor :	
FAN:	
Fan Type x Quantity :	
Fan Motor Power (kW) :	
Air Flow rate (CMH) :	
POWER SUPPLY:	
V/PH/Hz	
Minimum Circuit Amps :	
Maximum Fuse Amps :	
Maximum Starting Current :	
Total Over current Amps :	
REFIRGERANT & PIPING:	
Refrigerant Type / Charge (Kgs) :	
Liquid Piping (Main Line Size) :	
Suction Gas Piping (Main Line Size) :	
UNIT DATA:	
Sound Pressure Level at 1 m :	

ANNEXURE – B

S.No	PARAMETERS	Circuit- 1	Circuit 2
1	ODU TAG		
2	Nominal Capacity(HP)		
3	Specify Room wet bulb temperature in ^{0}C @ nominal capacity		
4	Specify Room wet bulb temperature considered, in ^{0}C @ actual capacity		
5	Specify capacity correction factor for change in room wet bulb temperature		
6	Specify outdoor dry bulb temperature in ^{0}C @ nominal capacity		
7	Specify outdoor dry bulb temperature considered, in ^{0}C @ actual capacity		
8	Specify capacity correction factor for change in outdoor dry bulb temperature		
9	Specify horizontal distance between indoor to outdoor units @ nominal capacity		
10	Specify horizontal distance between indoor to outdoor units @ actual capacity		
11	Specify capacity correction factor for change in horizontal distance between indoor to outdoor units		
12	Specify vertical distance between indoor to outdoor units @ nominal capacity		
13	Specify vertical distance between indoor to outdoor units @ actual capacity		
14	Specify capacity correction factor for change in vertical distance between indoor to outdoor units		
S.No	**PARAMETERS**		
15	Specify indoor unit / outdoor unit connectivity ration (diversity) @ nominal capacity		
16	Specify indoor unit / outdoor unit connectivity ration (diversity) @ actual capacity		

17	Specify capacity correction factor for change in indoor unit / outdoor unit connectivity ration (diversity)		
18	Total capacity correction factor		
19	Actual Capacity(HP)		
20	Proposed Outdoor Unit Model No		

ANNEXURE – C

S.NO	CLAUSE	PG.NO	DEVIATION PARTICULARS	Bidder's remarks

END OF SECTION 02

SECTION - 03
SPECIAL CONDITIONS

1.0 DRAWINGS & DOCUMENTS REQUIREMENT OF CLIENT

1. Contractor shall note that documentation is an important part of this project in order to have effective communication, recording of expectations, managing project execution, tracking progress and recording the achieved objectives. The required documents during the project duration are discussed in this part and this is indicative list only and not limited. Client / Consultants reserve the right to decide the requirement any document as per project needs. Also Clients / Consultants reserve the right to decide the quantity quality nature of any documents and frequency of updates required from contractors. The required documents are detailed below. This list is indicative and not limited to change by Clients according to project needs.

- **Tender Stage:**

a) Priced BOQ: Contractor shall provide their prices in the format given by consultant only. Contractor shall also send their prices in electronic version (MS excel 2007). Contractor shall provide any break up prices of any equipment / materials, if demanded by Clients / consultants.

b) Technical Submittals of proposed equipment: Contractor shall provide technical details of proposed equipment / materials as per the details demanded technical specification section. Contractor shall also provide more details if demanded.

c) Other documents asked in the tender

- **Project Initiation Stage:**

a) Site Organization chart: The chart shall contain all contact details (direct no, mobile no, e-mail) of project execution team.

b) Escalation matrix: The matrix shall contain contact details (direct no, mobile no, e-mail) of senior management up to the level of Company's director.

c) Shop drawings: The Contractor shall be deemed to have allowed for the cost of performing the required shop drawings for this package in the manners and to the specification detailed within this Section and as described elsewhere in the Contract Documents, and no extra payment shall be granted for such.

- Shop Drawings shall be submitted at least 14 working days in advance of requirement.
- The maximum scale for any "Plan" shall be 1:50 and the minimum scale for any plan shall be 1:100. The maximum scale for any "Section" shall be 1:20 and the minimum scale for any "Section" shall be 1:75.
- All shop drawings are to be prepared using AutoCAD 2006 or higher version and submitted as three hard copies (max A0 size or sizes suitable to scale of drawings) during each revision and electronic copies as both AutoCAD 2006 / higher version and PDF versions. All shop drawings prepared by the Contractor shall be based on current design drawings, the tenderer submission design drawings, actual physical measurements of site conditions and actual physical measurement of the intended materials.
- Upon approval of the drawings by Consultants / Clients, Contractor shall submit FIVE copies of each approved drawing; the size of drawing shall be as per above point. TWO copies will be retained with consultant and one copy shall be submitted to client by contractor. One set of original copy of approved drawings shall be kept by contractor at site

always. Contractor's site team shall use photocopy of approved drawings for daily usage at site. No drawing without symbol of consultant approval shall be used by contractor's site team. Failing to comply with this clause, Consultants reserve the right to demand changing of site management team.

Following list the minimum shop drawings that are to be produced by the vendor. However clients reserve the right to demand additional shop drawings related to HVAC, BMS & associated electrical works:

Sl.No	**Name of drawings**
1	Title page & List of drawings
2	Typical installation details
3	Shop drawing
A	Ducting layout
B	Drain piping layout

d) *Technical submittals:* Within 2 days of receipt of letter of intent, the contractor shall submit dimensional, accurate technical details and installation details of each equipment for approval of Consultants, prior to ordering of material / equipment. Any general approval of technical approval will not relieve the vendor of their obligations in technical specifications. Contractor shall notify the consultants in a separate communication if there is any deviation from technical specifications and same shall be approved by consultants explicitly. Contractor shall provide all technical, dimensional details of the products elaborately and approval of a submittal by consultants cannot be assumed for a detail which was not provided by contractor. TWO copies of technical details of each equipment / material shall be submitted in hard biding for approval of consultants during each submission. Upon receiving approval of consultants, contactor shall make FOUR copies of technical submittals, compiled in single bind. Two copies will be retained by consultants, two copies will be retained by contractors and one copy shall be submitted to client by contractor. Contractor shall keep one approved copy of technical submittal at site always. The basic required elements to be made available in a typical technical submittal are given below; however these are indicative only and not limited. The extent of details required shall be decided by consultants and contractor shall provide the demanded details.

1. Title page
2. Contact details of suppliers / manufacturer
3. Summary of equipment capacity and areas served
4. Equipment ratings, model no, country of origin
5. GA drawings of equipment (the drawings shall be as per scale; non-proportional drawings and drawings without dimensions would not be accepted)
6. Manufacturer's catalogue
7. Manufacturing practices
8. Material of construction
9. Performance ratings
10. Performance curves
11. Methods of installation
12. Methods of operation
13. Safety practices during installation and operation
14. Electrical connection details
15. Electrical power requirement
16. Other services requirement
17. List of accessories
18. Certificates of previous installations, performance

The bidder shall note that Consultant / Clients reserve the right to ask the bidder to resubmit the technical submittal for lack of any above specified details / deviation. Any delay owing to repeated submission and approval procedures, during this approval process will be on bidder's account.

e) *Micro level project schedule:* Within 3 days of receipt of letter of intent, contractor shall produce the project schedule for client / consultant approval in MS project / Primavera formats as well as in PDF versions. The micro level project schedule shall be updated by vendor generally biweekly. However, Clients / Consultants reserve the right to demand the frequency of updating based on project requirement and contractor shall update. Contractor shall provide break-up the activities of execution to the micro level area wise and package wise. Clients and consultant reserve the right to decide the name of each activities and format of schedule.

f) *Detailed delivery tracker*: Within 3 days of receipt of letter of intent, Contractor shall update the Client / Consultants the key delivery milestones. The delivery tracker shall be updated weekly. However, Clients / Consultants reserve the right to change the format and the frequency of updating based on project requirement. Contractor shall also provide un-priced Purchase order copies to their sub-vendors / suppliers / manufacturers as a proof of material ordering and delivery confirmation, if demanded.

g) Cash flow statement: Contractor shall project monthly billing amount details to help planning the client the cash flow.

h) Proofs of insurance claims: Photocopy of all insurance details shall be submitted before mobilization of site team. If demanded, contractor shall show the original documents to Clients / consultants.

i) Statutory approvals: Photocopy of Labour licenses and any other statutory approvals as per Indian laws, shall be submitted before mobilization of site team. If demanded, contractor shall show the original documents to Clients / consultants.

j) Environmental, Health and Safety plan: Contractor shall submit a detailed policy of safety practices during installation, testing & commissioning and operation & maintenance. If the document found to be lacking extensive details on materials, procedures and standard formats, Client / Consultant reserve the right to demand revision.

- **Project Execution Stage:**

a) Quality Check sheets: Contractor shall submit the filled quality check lists of construction of all equipment / materials. The extent of details to be available and the format of checklists shall be decided by Consultants. Consultants also reserve the right to issue quality check lists. Contractor shall check the installation the quality of installation by them first and offer for the installation for Client / Consultants' inspection. Client / Consultant will inspect the installation and verify checklist. If the installation is found to be unsatisfactory, Client / Consultants may reject or offer comments on installation. Contractor shall ensure that the comments are adhered and checklists are revised. If the same installation is rejected more than two times, contractor shall be charged of administrative expenses of inspection and the cost shall be decided by Clients / Consultants.

b) Weekly Execution program tracker: Clients / Consultants would issue a tracker format upon awarding of contract and the vendor shall weekly update the status. Clients / Consultants reserve the right to seek as much micro information about status of vendor's activity. This document has to be revised by contractor to the satisfaction of client, weekly.

c) Method statements: Contractor shall submit detail method statements for installation of all activities, especially in hazardous, working factory environments. Contract shall execute such activities only after approval on method statements by Client / Consultants.

d) Work permits: Contractor shall seek prior approval of any hazardous installation activities or activities which may disturb the operation of Clients.

e) Test reports: For all supplied equipment / materials, contractor shall submit suppliers factory test reports and Client / consultant shall review and approve, if found satisfactory. If the test reports are up to consultants' satisfaction, contractor shall arrange testing of the materials / equipment at suppliers' factory, at no extra cost.

f) Commercial Invoices & billing details: Client reserves the right to demand to submit the invoices, supporting annexure in any format. Contractor shall submit all supporting documents including delivery challans, unpriced invoices, test reports, measurement sheets, and drawings with measurement, quality check lists and commissioning reports. Contractor also shall submit statutory tax return documents, if demanded.

- **Testing and Commissioning Stage:**

a) Details of instruments: Contractor shall submit the list of instruments to be used for testing and commissioning, make, range and validation details of the instruments for approval of Consultant. The original copy of validation certificates shall be shown to Client / Consultant.

b) Testing & Commissioning Procedures: Contractor shall submit testing and commission procedures according to International standards and manufacturer recommendation, to the satisfaction of consultants. Consultants also reserve the right to issue Testing & Commissioning Procedures.

c) Testing & Commissioning Record sheets: Contractor shall submit testing and commission record sheets such as pre-commissioning check lists and commissioning record sheets as per approved procedures, to the satisfaction of consultants. Consultants also reserve the right to issue Testing & Commissioning Record sheets. These records sheets shall be filled and offered for Client / Consultants approval.

- **Handing over Stage:**

a) Issues Log: shall submit the snag-lists / pending work lists identified by Client / Consultant and same shall be reviewed as per project needs. Client / Consultant reserve the right to decide on frequency of reviewing / updating this document along with contractor.

b) As-built drawings: All as-built drawings shall be prepared in conformance with the shop drawing standards and requirements detailed in Section 1.00.c "Shop Drawings". Unless approved by the Client / consultant, all information contained on Shop Drawings must be reproduced on as-built Drawings. All as-built drawings prepared by the Contractor shall be based on the actual physical measurements of work installed and survey records. For consistency, all as-built drawing title blocks and borders shall follow a format agreed by the consultant / Client. At least one set of as-built drawings shall be printed in full colour on the highest quality plotter / printer setting available and shall be handed over laminated for protection and future workshop reference. The cost of color printing shall be deemed to be included within the Contractor's price.

- Photocopies of as-built drawings shall be sharp, clean, crisp copies without distortion and blur. Electronic copies of approved as-built drawings (both PDF and AutoCAD versions) shall also be provided by the Contractor on DVDR/USB flash drive

- Contractor shall submit TWO sets of as-built drawings during each revised submission. Upon approval of consultants / Clients, contractor shall submit FOUR copies of as-built drawings in which two copies shall be submitted to Client and one copy shall be retained by consultants.

- One set of approved all floor layouts and chilled water schematic drawings shall be laminated and installed on a laminated board, in Clients' premises. The cost of lamination shall be deemed to be included within the Contractor's price.

c) Operation and Maintenance Manuals: Contract shall submit a draft version of Operation & Manual during commissioning stage itself. Operation & Maintenance Manual shall be provided in "Letter" size four ring binders with stability press clips and clear insert pockets on the spine and front cover, in accordance with the relevant Specification.

- For consistency, Operation & Maintenance Manuals shall follow a format issued by the Client / Consultant and the content of the manual is discussed in this part.

- Upon approval of Client / Consultant, Contractor shall submit FOUR copies of O&M manuals in which one will be retained by consultants and two copies shall be submitted to Client. At least one Operation & Maintenance Manual shall be produced and printed in full colour on the highest quality printer setting available. The cost of colour printing and production shall be deemed to be included within the Contractor's price.

- All other Operation & Maintenance Manuals shall be printed copies, not photocopies. Electronic copies of the Operation & Maintenance Manuals shall also be provided by the Contractor on DVDR.

- Manuals shall be provided with clear plastic satchels within for containment of original warranties and documents. At least 25mm clear space shall be provided from the face of the documents to the top of the rings to allow easy flipping over of documents within.

- For consistency, Operation & Maintenance Manuals shall follow a format issued by the Client / Consultant and the content of the manual is discussed in this part. The basic required elements to be made available in a typical O&M manual are given below; however these are indicative only and not limited. The extent of details required shall be decided by consultants and contractor shall provide the demanded details.

- Project Details
- Index
- Contact details of project team including Client, Consultants, Contractor and main sub-contractors
- Brief overview of contents of the document and objectives
- Schedule of Plant and equipment
- Description of each major equipment installed
- as-built controls for shut-down, unoccupied operation, seasonal change over, manual operation, alarms
- Final Sequence of operation
- Pre-set values of controls and pre-set schedule for operating the equipment
- Approved as-built drawings printed to appropriate size, folded neatly and enclosed

- Approved as-built drawings printed to appropriate size, laminated properly
- Approved as-built drawings written on permanent memory drives (DVDs) and enclosed
- Supply of necessary single line diagrams & isometric drawings
- Description of operation of plant and equipment
- Operational Safety aspects
- Routine Periodic Inspection and Maintenance Schedule of various equipment
- Manufacturers O & M Manual of Major Equipment
- General trouble shooting procedures for various equipment
- Contact details of all suppliers & sub vendors
- List of spare parts & tools to be stocked
- Warranty certificates of each equipment and system
- Factory test reports of each equipment
- Statutory approvals obtained
- Approved Testing & Commissioning Procedures
- pre-functional check lists
- functional check lists
- pending issues / tests, related to commissioning
- Performance data of equipment observed during commissioning
- Project completion Photos

END OF SECTION