

**(TO BE ATTACHED WITH PRICE BID)**

**NAME OF WORK : CONSTRUCTION OF STATE GUEST HOUSE ANNEXY BUILDING AT SHAHIBAUG, AHMEDABAD**

**GENERAL SPECIFICATIONS for VRV HEATING, VENTILATION & AIR-CONDITIONING (HVAC) WORKS**

1. Works to be done by the contractor
2. Completeness of the tender, Submission of commissioning planning, approval of drawings and commencement of work
3. Dispatch of material to site and their safe custody
4. Co-ordination with other agencies
5. Quality of materials and works man ship
6. Payment Terms
7. **VARIABLE REFRIGERANT FLOW / VOLUME SYSTEM**
8. Refrigerant Plumbing
9. Microprocessor Controller
10. **DUCTING** / Variable Air Volume (VAV) Boxes
11. **INSULATION WORK**
12. Earthing
13. Remote Control Cum Indicating Panel
14. Initial Inspection at Manufacturer's Works and Final Inspection
15. Testing Requirements and Procedures
16. Digital Controllers / Field Devices

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These General Specifications shall be read in conjunction with the General conditions of contract. These General Specifications shall also be read in conjunction with the tender specifications, schedule of work, allocation sheets and other documents connected with the work.

- **Heat Load Calculations and Equipment Selection**

- The successful bidder/ contractor should give detailed heat load calculations, immediately after award of work separately for all the seasons in which, the specified conditions are to be maintained.
- The successful Bidder/Contractor should also give the above heat load calculations wherever required separately for the areas served by each AHU in a central air conditioning/ heating system.
- The equipment selection and duct design shall be made on the basis of the above heat load calculations wherever required.
- The Contractor can refer and utilize the design done by the department/ consultants for the department, however, there shall be no commitment to provide the same to the contractor, nor the contractor shall be absolved of the responsibility of correct design and performance of the air-conditioning system provided by him.
- All works shall conform to National Building code as well as relevant BIS codes. All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 2003 and Indian Electricity Rules, 1956 amended to date. All components shall conform to Energy Conservation Building Code 2007 of India as amended or revised up to date.
- The contractor shall provide necessary barriers, warning signals and other safety measures while laying pipelines, ducts cables etc. or wherever necessary so as to avoid accident.

**1) Scope of Contractor for HVAC Work:**

The following works shall be done by the contractor and therefore, their cost shall be deemed to be included in their tendered cost whether specifically indicated in the schedule of work or not: -

- Foundations for equipment's including foundation bolts and vibration isolation spring/pads, Suspenders, brackets and floor/ wall supports for suspending/supporting ducts and pipes,
- Power supply for erection, commissioning and commissioning in contractor's scope
- Sealing of all floor slab/ wall openings provided by the contractor for pipes and cables, from fire safety point of view, after laying of the same,
- Painting of all exposed metal surfaces of equipment and components with appropriate color
- Making openings in the walls/ floors/ slabs or modification in the existing openings wherever provided for carrying pipe line, ducts, cables etc.
- Providing wooden/ metallic frames for fixing grills/ diffusers.
- Making good all damages caused to the structure during installation and restoring the same to their original finish.
- A set of three copies of operations manual shall be provided to the Engineer-in-Charge or his representative containing following information at a minimum
  - a) HVAC equipment capacity
  - b) Equipment operation and maintenance manuals, HVAC system control maintenance and calibration information, including wiring diagrams, schedules, and control sequence descriptions, A complete written narrative of how each system is intended to operate.

## **2) COMPLETENESS OF THE TENDER, SUBMISSION OF PROGRAMME, APPROVAL OF DRAWINGS AND COMMENCEMENT OF WORK**

- Completeness of the tender All sundry equipment, fittings, assemblies, accessories, hardware items, gaskets, masonry platforms/ foundation for Chilling Units, pumps, Cooling Towers etc., supports for pipes foundation bolts, supports, termination lugs for electrical connections, cable glands, junction boxes and all other items which are useful and necessary for proper assembly and efficient working of
- the various equipment and components of the work shall be deemed to have been included in the tender, irrespective of the fact whether such items are specifically mentioned in the tender or not.
- Submission of Schedule for erection, commissioning and testing Within fifteen days from the date of completion of civil work or site ready for erection of HVAC, the successful tenderer shall submit his Programme for submission of drawings, supply of equipment, installation, testing, commissioning and handing over of the installation to the Engineer-in-Charge. This Programme shall be framed keeping in view the milestones stipulated in the contract, building progress.
- Items like ducting, piping etc. that directly affect the building progress shall be given priority.

### **Submission of Drawings**

The contractor shall submit the drawings to the Engineer-in-Charge i.e. not below the post of Executive Engineer, Electrical Division, R & B Department for approval before start of work.

### **Commencement of Work**

The contractor shall commence work as soon as the drawings submitted by him are approved.

## **3) DISPATCH OF MATERIALS TO SITE AND THEIR SAFE CUSTODY**

The contractor shall dispatch materials to site in consultation with the Engineer-in-Charge. Suitable lockable storage accommodation shall be made available free of charge temporarily. Watch & ward however, shall be the responsibility of contractor. Programme of dispatch of material shall be framed keeping in view the building progress. Safe custody of all machinery and equipment supplied by the contractor shall be the responsibility of the contractor till final taking over by the department.

#### **4) CO-ORDINATION WITH OTHER AGENCIES**

The contractor shall co-ordinate with all other agencies involved in the work so that the work of other agencies is not hampered due to delay in his work. Ducting, piping, cabling or any other work, which directly affect the progress of building work, shall be given priority.

#### **5) QUALITY OF MATERIALS AND WORKMANSHIP**

- The components of the installation shall be of such design so as to satisfactorily function under all conditions of operation. The entire work of manufacture/ fabrication, assembly and installation shall conform to sound engineering practice. The entire installation shall be such as to cause minimum transmission of noise and vibration to the building structure.
- All equipment and materials to be used in work shall be manufactured in factories of good repute having excellent track record of quality manufacturing, performance and proper after sales service.
- None of the equipment/ machines supplied shall be more than Six months old from date of supply at site, Copy of Excise Gate Pass/ Invoice/ Shipment /Custom Clearance certificate/ details (in case of
- Imported equipment) shall be submitted to prove the date of manufacture & genuineness of the equipment/ machines supplied.

- **AFTER SALES SERVICES (1 YEAR WARRANTY AND 3 YEARS DLP)**

- The contractor shall ensure adequate and prompt after sales service in the form of maintenance, spares and personnel as and when required and shall minimize the breakdown period. In case of equipment supplied by other manufacturers the firm shall furnish a guarantee from the manufacturer for the same before the plant is taken over.
- The contractor shall guarantee the complete system to maintain the specified conditions under all conditions of ambience and internal loads subject to the condition that designed outside conditions & designed internal loads are not exceeded.
- All equipment shall be guaranteed for a period of 12 months from the date of acceptance and taking over of the installation by the Department against unsatisfactory performance and/or breakdown due to defective design, material, manufacture, workmanship or installation.
- The equipment or component or any part thereof so found defective during the guarantee period shall be repaired or replaced free of cost to the satisfaction of the Engineer-in-Charge. In case it is felt by the department that undue delay is being caused by the contractor in doing this, the same will be got done by the department at the risk & cost of the contractor.
- The decision of Engineer-in-Charge in this regard shall be final. Any leakage of refrigerant and/or oil due to defective design, manufacture, workmanship or installation during the guarantee period shall be made good by the contractor free of charge.

## 6) **PAYMENT TERMS**

The following percentage of contract rates shall be payable against the stages of work shown herein. Material should be supplied at the stage after inspection and commissioning stage only, so material **warranty period** must be considered 1 year after handing over of site in utilization.

Sr. No.	Stage of work	Machinery & Equipment	All other items
1	After initial inspection (wherever specified) & delivery at site in good condition on pro-rata basis	80%	60%
2	On completion of pro-rata installation	10 %	30 %
3	On commissioning and completion of successful running in period	5 %	5 %
4	On completion of major seasonal test	5 %	5 %

## 7) **VARIABLE REFRIGERANT FLOW / VOLUME SYSTEM**

The system selected is a modular system, with number of indoors connected to centrally located outdoor units. The outdoor units for all the system shall be air cooled type.

### 7.1.1 General Description

All the VRF air conditioners shall be fully factory assembled, wired, internally piped & tested. The outdoor unit shall be pre-charged with first charge of refrigerant. Additional charge shall be added as per refrigerant piping at site. All the units shall be suitable for operation with 415 V +/- 10%, 50 Hz + 3%, 3 Phase supply for outdoor units; & 220 V +/- 10%, 50 Hz +/- 3%, 1 Phase supply for indoor units.

### 7.1.2 Specifications of Outdoor units:

- Outdoors units of the VRV system shall be compact air-cooled type.
- The outdoor unit should comprise of Inverter controlled Twin Rotary Compressor / Scroll Compressor
- Each module of outdoor unit must have at least 50 % of Variable compressor which can work on Part load Suitable to operate at heat load proportional to indoor requirement.

- The ODU must deliver COP of minimum 4.7 at 50 % load.
- The outdoor units must be suitable for up to 225 m refrigerant piping between outdoor unit & the farthest indoor units. Allowable level difference between outdoor unit & indoor units shall be 50 m in case of outdoor unit on top & 40 m in case of outdoor unit at bottom.
- Allowable level difference between various indoor units connected to one outdoor unit shall be up to 15 m.
- The outdoor units shall be suitable to operate within an ambient temperature range of 5 Deg C to 43 Deg C in cooling mode; & -20 Deg C to 15 Deg C in heating mode.
- The entire operation of outdoor units shall be through independent remotes of indoor units. No separate Start/ Stop function shall be required.
- Starter for the Outdoor Unit compressor shall be –Direct on Line type.
- Inverter compressor of the unit shall start first & at the minimum frequency, to reduce the inrush current during starting.
- Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested

#### **7.1.3 Specifications of Indoor units:**

The units include pre-filter, fan section and DX coil section. The housing of units shall be light weight powder coated galvanized steel. Units shall have external casing of ABS Plastic for supply and return air.

#### **4 Way Cassette type indoor units**

- These units shall be installed between the bottom of finished slab & top of false ceiling.
- Unit shall have provision of connecting fresh air without any special chamber & without increasing the total height of the unit (320 mm maximum). 51 (c) The unit must have in built drain pump, suitable for vertical lift of 750 mm.
- Unit must be insulated with sound absorbing thermal insulation material, Polyurethane foam. The sound pressure level of unit at the highest operating level shall not exceed 46 dB (A).



- The unit must have drain pump kit if. The drain pump must be suitable to lift drain up to 1000 mm from the bottom of the unit.

#### **4 Way Compact Cassette type indoor units**

- The compact cassette unit should perfectly fit into ceilings and match the standard architectural modules, without the need to cut ceiling tiles.
- The flaps fold tightly against the ceiling when operation stops so that the ceiling is affected only slightly even if air conditioning is installed.
- Designed for simple & easy installation and maintenance. It should be slim in design only 268 mm in height even when an electrical box is located inside the unit.
- The unit must have drain pump kit if. The drain pump must be suitable to lift drain up to 1000 mm from the bottom of the unit.

#### **Concealed duct type units**

- These units shall be ceiling suspended with suitable supports to take care of operating weight of the unit, without causing any excessive vibration & noise.
- The cold air supplied by these units will be supplied to the area to be air conditioned, through duct system specified in the tender.
- Each indoor unit must have electronic expansion valve operated by microprocessor thermostat-based temperature control to deliver cooling/ heating as per the heat load of the room.
- The Sound Pressure level of unit at the highest operating level shall not exceed 38 dB (A), at a vertical distance of 1.5 m below the units with duct connected to the unit.
- The unit must have provision of adding drain pump kit if required & specified. The drain pump must be suitable to lift drain up to 1000 mm from the bottom of the unit.

#### **Wall Mounted Split AC Units.**

- Wall mounted units must be compact & stylish design that does not detract from the décor of the room.
- Each indoor unit must have electronic expansion valve operated by microprocessor thermostat-based temperature control to deliver cooling/ heating as per the heat load of the room.
- The unit must have provision of adding drain pump kit if required & specified. The drain pump must be suitable to lift drain up to 1000 mm from the bottom of the unit.

- The sound pressure level of unit at the highest operating level shall not exceed 46 dB(A).
- Refrigerant control in the indoor unit shall be through Electronic Expansion Valve.

#### **7.1.4 Installation of Indoor and Outdoor Units:**

- The outdoor units shall be mounted on ribbed rubber pads for vibration isolation. The contractor shall supply the required charge of refrigerant, lubricant and other consumables, for commissioning and testing of the equipment.
- All the equipment shall be thoroughly tested and checked for leaks. All safety controls shall be suitably set and a record of all setting shall be furnished to the project Supervisor.
- Providing and fixing M.S. structural support for condensing unit with vibration isolator pad in-between support and structure and vibration isolation suspender and pads for evaporating units shall be in scope of contractor.

#### **7.1.5 Painting:**

Shop coats of paint that have become marred during transportation or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop- painted surfaces.

#### **7.1.6 Condensate Drain Piping:**

All pipes to be used for condensate drain shall be PVC pipe conforming to IS: 4985 - Class I & all joints should be Gluing or solvent cementing as per manufacturer recommendation.

#### **7.1.7 Refrigerant Piping:**

- All refrigerant pipes and fittings shall be type 'L' hard drawn copper tubes and wrought copper fitting suitable for connection with silver solder. The copper thickness of wall shall be 20G/ 22G (0.7 to 1 mm)
- All joints in copper piping shall be swaged joints using low temperature brazing and/ or silver solder. Before jointing any copper pipe or fittings, its interior 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 construction of the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

- Refrigerant lines shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg per Sq.cm.
- After the refrigerant piping installation has been completed the refrigerant piping system shall be pressure tested using, Freon mixed with nitrogen at a pressure of 20 Kg per Sq. cm. (High side) and 10 Kg per Sq. cm (Low side). Pressure shall be maintained on the system for 24 hours.
- The system shall then be evacuated to a minimum vacuum of 70 cm. of mercury and held for 24 hours, during which time; change in 53 vacuums shall not exceed 12 cm of mercury.
  - All refrigerant piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturers.

#### **7.1.8 Power Supply:**

Power supply near the indoor unit will be provided by the department with suitable 6A plug point socket & switch. However, where the power requirement is of central control from ODUs, as per the design of the system, the entire power supply then shall be done by the contractor. Earthing for each outdoor units must be provided for ELV PCB protection with copper wire only and under guidance of OEM VRV manufacturer only.

#### **➤ DESIGN PARAMETER**

##### **➤ AIR HANDLING UNIT**

1. Maximum face velocity across cooling coil: 155 m/min
2. Maximum outlet air velocity: 610 m/min
3. Maximum velocity across filters:
  - Ordinary filters 155 m/min
  - Micro-vee filters 155 m/min
  - HEPA filters 155 m/min
4. Minimum spray density for humidification: 10 lpm/square meter

##### **➤ DUCTING FOR AIRCONDITIONING (office Building)**

	Main Duct	Branch duct
i) Maximum flow velocity:	400 m/min	250 m/min
ii) Maximum velocity at supply air grilles/ diffusers:	150 m/min	
iii) Maximum friction in duct:	1cm WG/100 m run	

## **8) Refrigerant Plumbing**

### **Design aspects of Refrigerant Plumbing**

**Refrigerant piping** shall be designed and installed so as to

- a) ensure circulation of adequate refrigerant at all loads.
- b) ensure oil return to crank case of compressor positively and continuously.
- c) keep pressure losses within limits, especially in suction lines.
- d) prevent oil/liquid refrigerant from entering the compressor when the compressor is working as well as when it has stopped.
- e) prevent trapping of oil in evaporator or suction lines, which may return to the compressor in the form of slug.

### **Hot gas lines:**

- a) Oil shall be entrained and carried by hot gas under all load conditions likely to be encountered in normal operation.

### **Liquid Lines :**

- a) Liquid lines shall be designed to ensure that flashing of liquid refrigerant does not occur by minimising the pressure drop suitably, by avoiding long vertical risers, and appropriate sub cooling.
- b) Each liquid line shall be provided with a permanently installed refrigerant drier of throw away or rechargeable type. The drier shall be installed in a valved line.
- c) Flow indicator (moisture indicating type) shall be installed on all liquid lines.

### **Suction Lines :**

- a) Oil shall be entrained and carried by the suction gas under all conditions of load likely to be encountered in normal operation.
- b) Piping shall be designed for a suitable velocity of refrigerant (similar to hot gas line) to ensure that oil will not separate from the gas and drain to the compressor in slugs.
- c) The refrigeration system shall be equipped with controls for pump down system so that the evaporator and suction line are emptied before the compressor shuts off, thus preventing liquid refrigerant and oil from entering the compressor when restarted.
- d) Refrigerant lines shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg. per sq.cm. (3 psi).

- Isolating valve shall be provided to enable isolation of each compressor in case of multiple compressor units (as built in valves), strainer, drier and any other components as may be required for proper operation and maintenance.
- Thermostatic / Electronic type expansion valve/ float valve shall be provided in refrigerant circuit of DX system/ flooded system.

### **Material**

Refrigerant plumbing for reciprocating type refrigeration plant and packaged type AC plants shall be with copper tubes, with tube thickness conforming to L type to ATM standards. The tubes shall be bright annealed copper up to and including 15 mm size. The tube shall be suitable for the duty involved. Fittings like bends, tees, sockets etc. shall be of wrought copper or forged brass and shall be suitable for the duty involved. Flare type compression fittings of forged brass shall be allowed up to 15 mm piping size. Tubes up to and including 15 mm size may be bent to form 90-degree bends with inside radius not less than 3 tube diameters. For bigger sizes, bend fittings as mentioned above must be used.

- Where specified in the tender specification, mild steel may be provided for refrigeration piping, with seamless MS tubes and fittings of heavy class conforming to IS: 1239. All liquid lines and instruments lines shall however be of copper only.
  - Refrigerant plumbing for centrifugal/ screw type chilling machine shall be of mild steel or wrought iron / copper to manufacturer's standards. Valves shall be of the packed, back-seating type for both copper and MS refrigerant plumbing work, and these shall be of forged or cast brass construction.

#### **➤ Pressure Testing:**

i) After completion of the piping installation, the entire chilling unit shall be pressure tested with dry nitrogen or any other inert gas at the following pressures for the particular refrigerant to be used: -Refrigerant Test pressure (Kg./Sq.cm. (Gauge)

	High pressure side	Low pressure side
R-134a	20	8

This test shall be carried out as follows: -

- a) The system shall be charged with nitrogen or inert gas to 1.0 Kg./sq.cm. gauge and all joints shall be checked for leakage with a mixture of four-part water, one part liquid soap and a small amount of glycerin. Leaks shall be marked, pressure released and repairs done.

Brazed joints, which leak, shall be opened and redone. These shall not be repaired by addition of brazing alloy to the joints.

b) The system shall now be charged with nitrogen or the inert gas to the pressure specified in the above table and the process of locating leaks and repairs shall be repeated.

ii) Final pressure test:

After all the leaks have been repaired, the system shall be retested with the test pressure maintained for a period of not less than 8 hours. No measurable drop in pressure should be detected after the pressure readings are adjusted for temperature changes.

Pressure gauges, controls and compressors may be valved off during pressure testing.

### MICROPROCESSOR CONTROLLER

5.11.1 Each Outdoor unit shall be complete with a microprocessor based interactive control console in a locked enclosure factory mounted (directly on the unit), prewired with all operating and safety controls and tested. Central remote control and individual specified area Remote control should be commissioned in area like all Rooms, VVIP Dining Hall, Conference Room, Meeting Room and VVIP Lounge area with proper approach and operational. Error in Remote must be attended for 1 year defect liability period by OEM technician without any extra charge. Minor errors in any unit must be attended within 2 days in order to avoid major Fault otherwise compressor, condenser, PCB damaged will be replaced without any extra charge during 1 year of free maintenance and chargeable AMC cost after 15 years.

### PAINTING

The equipment shall be supplied as per manufacturer 's standard finish Painting.

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