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PRASAR BHARATI
(INDIA's PUBLIC SERVICE BROADCASTER)
OFFICE OF THE ADDL. DIRECTOR GENERAL (ENGG.-EAST ZONE)
ALL INDIA RADIO & DOORDARSHAN : KOLKATA

No. ADG(E)(EZ)/Budgetary Quote/2024/1 Date: 11.09.2024

Sub : Invitation for Budgetary Quote

It is requested to send a budgetary quote for DSITC of 3 x 50 HP Air- Cooled Variable Refrigerant Flow (VRF)/ Variable . Refrigerant Volume (VRV) split type Air Conditioning System at Akashvani Kolkata (Specification attached).

Budgetary quote may be send through mail (airddadgofficeproject@gmail.com) as per attached specification within the scheduled date on **18th September 2024**

Yours faithfully

Shyamal Kumar Das.
(Shyamal Kumar Das)
Assistant Engineer (CO)
Project Section
For Additional Director General (E)(EZ)

PRASAR BHARATI
(BROADCASTING CORPORATION OF INDIA)
DIRECTORATE GENERAL: ALL INDIA RADIO
(P&D UNIT)

Technical Specification for DSITC for 3x50 HP Air-cooled Variable Refrigerant Flow (VRF) / Variable Refrigerant Volume(VRV) Split Type Air Conditioning System at Akashvani Kolkata

SECTION- I

1.1 GENERAL REQUIREMENT

1.1.1 This section specifies the requirements for the vendor submittal for Design, Supply, Installation, Testing & Commissioning of VRF Air conditioning indoor and outdoor units as shown in the Section II.

1.1.2 VRF outdoor units shall also be suitable for use with direct expansion coils of air-handling units from other manufacturers also.

1.1.3 Units shall be air cooled, consisting one or multiple outdoor units and combination of indoor units, each having capability to cool independently for the requirements of the required area.

1.1.4 The units must be factory tested, evacuated, dehydrated and pressurized with refrigerant holding-charge, for field installation. Unit shall be suitable to operate using R407C / R410A / R507C or any other refrigerant having zero ODP.

1.1.5 The complete unit shall be adequately protected from damage, corrosion, weather etc., during transportation and storage, until ready for installation. Fins, casing and all sections shall be protected from damage during installation.

1.1.6 High in energy efficiency and latest, space-saving VRF indoor and outdoor units shall be offered.

1.1.7 The actual equipment positions, sizes and arrangement shall be determined by the nominated HVAC Contractor, within the area provided, to suit at site.

1.2 **MANUFACTURER'S CREDENTIALs**:

The VRF/VRV Air Conditioning System manufacturer shall show at least 5 years of continuous experience in the design, manufacturing, installation, testing & commissioning and servicing of similar type of units as specified in the BOQ, for single and modular type combined unit models.

1.2.1 The ODU must deliver the rated capacity (within acceptable tolerance as specified in ISHRAE guidelines for testing and rating of VRF/VRV systems at outdoor ambient as per ISHRAE.

ISEER (**Indian Seasonal Energy Efficiency Ratio**) for quoted Outdoor unit should be better that 3.5.

1.2.2 Design Parameters:

a) Outside Conditions for Cooling

Summer & Monsoon	***Maximum Temperature*** *43 deg C(Summer)(June)* *39 deg C(Monsoon)(July-Aug)* ***Humidity*** *76%(Summer)(June)* *82% (Monsoon)(July-Aug)*

b) Inside Conditions:

Summer & Monsoon	24± 1 deg C (Relative humidity not exceeding 60%)

1.2.3 Bidder shall select the no. of ODUs from their high efficiency models, to meet the above COP/ EER criteria.

1.2.4 Refrigerant piping between indoor units and outdoor units shall be extended up to 175 m, with maximum 90 m level difference without any oil trap. Installation must be as per manufacturer's recommendations

1.3 Testing

1.3.1 The unit shall be tested for capacity and ISEER as per ISHRAE conditions at manufactures premises or at an accredited laboratory.

1.3.2 The capacity of ODU and IDU's shall be as per the BOQ and rated 100% capacity of ODU's within the acceptable tolerance of ±5 % at design condition i.e. at minimum 43^0 C outside condition. The OEM shall also submit the unit'sactual capacities at ISHRAE condition for the same unit.

1.4 GENERAL CONDITIONS OF CONTRACT

Payment terms, insurance cover, DSITC schedule and time of completion, inspection, testing and commissioning of equipment and guarantee terms, penalty for delay etc. would be applicable as per Akashvani terms and conditions on the subject framed by the indenter, namely Addl. Director General (BO) (EZ) Akashvani & Doordarshan,Kolkata.

1.5 DESCRIPTIVE TECHNICAL LITERATURE AND DRAWINGS

1.5.1. Site visit

In case the tenderers desire to have idea regarding the electrical and refrigerant piping for preparation of schematic layout of equipment in plant room, they are **advised to inspect the site** before submitting their tender.

29.07.2024
K N Pandey
ADE(SD)

29/07/2024
K. Murugan
DDG(E-SD)

29.07.2024
Jitender Pruthi
DDG(NBH)

1.5.2 Tender Documents

The tenderers shall submit the following in duplicate along with their tender (**as a part of technical bid**). Commercial bid will be in a separate sealed cover.

a) Descriptive and technical leaflets giving complete mechanical and electrical data about the equipment offered including detailed dimensions of the equipment.
b) The statement of bill of quantities, technical particulars (see Annexure-1) and performance specifications of the equipment offered in the proforma as per Section-II and Section-III of the specifications.
c) Tentative details showing cable sizes and length, equipment capacities, switchgear rating and number, rating and number of control components.
d) A schedule giving time period from start to finish of the complete work.

1.5.3 Installation Drawings

In the event of an order being placed, the tenderer shall supply to the indentor 3 copies each of the following for approval within one month from the date of placement of the order.

a) Dimensional drawings (including sections) giving complete details for erection of plants including foundation in case existing foundation cannot be reused and new foundation is necessary.
b) Electrical wiring diagram and control circuits of all electrical equipment showing cable sizes and electrical rating of the related equipment.
c) Instruction manuals of various equipment of the A/C plants detailing all adjustment, operation & maintenance/servicing procedures.

NOTE

Before taking up the installation work at site, the tenderer shall ensure that the indentor approves the installation drawings. The plants are to be replaced one by one at a time in consultation with Addl. Director General (BO) (EZ) Akashvani & Doordarshan,Kolkata and DDG(E), Akashvani Kolkata so that there is no disruption in service due to replacement work and ventilating air is circulated all the time when studios are functioning.

1.5.4 Completion Drawings and other Information

Three sets of complete drawings comprising of the following shall be submitted by the tenderer while handing over the installation:

a) Electrical drawings for the entire electrical equipment showing cable sizes, equipment capacities, switchgear ratings, control components, control wiring.
b) Schematic control drawings giving detailed notes to explain the sequence of

operation of the control circuit.

c) Refrigerant Piping drawing showing layout for the entire piping with all diameters, lengths and sizes etc. shown clearly. Isometric drawings showing each of the equipment/ units shall also be supplied.

d) Detailed drawings and specifications in respect of wearing parts and parts likely to be damaged.

e) Lists of components like thermostats, humidistat's, other control components, relays, timers, contactors etc. giving their type, designation, function etc.

f) Schedule of items of which the tenderer is not the manufacturer/the manufacturer's authorized dealer. This should contain the specifications of each item and the agency from which these items are procured.

1.6 EXCLUSIONS

The following items of work shall be undertaken by the indentor and need not therefore be included in the tender.

a) All supply and return ducts from plenum Chamber onward, including the plenum chamber & the R.S. Joists for the plenum chamber .However, supply and return ducts from AHU to plenum shall be fabricated by tenderer as per location of new AHU's and site condition.

b) Main electrical earthing up to the tenderer's switch boards.

1.7 INSTALLATION

a) This specification provides for dismantling of the existing plants & the complete erection including all the associated civil works like equipment foundation for the air conditioning equipment at site by the tenderer. The tenderer may examine the site before quoting the rates.

b) The tenderer shall make his own arrangement for storage of all equipment and materials brought to site from time to time and their safe custody at site till the plants are taken over by the indentor /his representative.

c) The tenderer shall make his own arrangements for procuring necessary labour, skilled and unskilled. He should conform to all local/central government laws and regulations covering labour charges and their employment.

d) The tenderer shall indemnify and hold harmless the purchaser against all claims in respect of injury to any person howsoever arising out of the erection of the equipment in the course of such installation. The tenderer shall discharge all his obligations under the Indian workman's compensation act in as far as it affects workmen in his employ.

e) The tenderer and his employees shall comply with the regulations in force for controlled entry into the premises where the air-conditioning equipment is to be installed.

1.8 TENDERER's LIABILITY FOR DAMAGES CAUSED DURING INSTALLATION

WORK AND IMPERFECTIONS NOTICED WITHIN THE GUARANTEE PERIOD

If the tenderer or his/her workmen or servants shall break, deface, injure or destroy any part of the building in which they may be working or any building, road, road kerb, fence, enclosure, water pipe, cable, drains, electric or telephone posts or wires, trees, grass or grasslands in the premises on which the work or any part of it is being executed, or if any damage shall happen to the work while in progress from any cause whatsoever, or if any defect, shrinkage or other faults appear in the work within 12 months (after certificate final or otherwise of its completion given by the indentor) arising out of defective or improper materials or workmanship, the tenderer shall, upon receipt of a notice in writing on that behalf, make good at his/her own expense, or in default, the indentor may get the same rectified and deduct the expenses from any amount that may be then due or at any time thereafter may become due to the tenderer or from his security deposit.

1.9 INSPECTION AND TESTS

1.9.1 Inspection: The equipment will be inspected by the indentor or his authorised representative at manufacturer's/Tenderer's works before dispatch in accordance with various standards/procedures specified in **Annexure III** (which shall be given along with the award letter) or modifications thereof that may be carried out by the indentor in consultation with the tenderer before issuing A/T. The copy of procedures shall be given at the time of work allotment only. The tenderer should intimate the indentor in advance about readiness of the equipment for inspection at a date mutually agreed upon by the indentor and tenderer. The tenderer should furnish in advance photocopies of all the relevant test certificates as per IS as applicable before giving inspection call. The tenderer must satisfy **themselves** to the readiness of the plant as per AKASHVANI specifications before asking the indentor for carrying out inspection and tests. During the inspection the tenderer shall have to repair/ replace any defective component/parts etc. which is noticed during inspection.

1.9.2 Acceptance Tests: Soon after erection of the plants at site, inspection of the plants before carrying out Acceptance Tests shall be carried out jointly by the Inspecting Officer and the representative of Indentor/consignee in the presence of tenderer's representative. The acceptance tests are to be carried out as per **Annexure-III** which shall be given along with the award letter. Separate capacity tests shall be carried out during summer months (preferably during **April to mid July**) and monsoon (**mid July to end of August**). Before offering the plant for capacity test, the tenderer will conduct trial run of the plant for 20 days subject to minimum aggregate of 120 hours for each plant so as to be sure that the plants are running satisfactorily. In case of a major problem being noticed during initial test run, the period of 20 days/120 hours will start afresh.

29.07.2024
K N Pandey
ADE(SD)

29/07/2024
K. Murugan
DDG(E-SD)

Jitender Pruthi
29.07.2024
Jitender Pruthi
DDG(NBH)

1.10 GUARANTEE

The AHU, VRV/VRF Outdoor Units, Refrigerant Pipes and other items used for operation of Air conditioning Plants shall be provided with on site guarantee for satisfactory working for a period of five years. For this purpose the guarantee period shall be counted from the date of satisfactorily completion of first performance test. Various defects arising/reported within the guarantee period as stated above will be rectified by repairs/replacement at site by the tenderer free of charge. This shall also include free supply of the refrigerant etc., if required, by the tenderer for optimum running of the plant during the guarantee period of the compressor and for the remaining part of the plant as stated above. The guarantee shall come into force after continuous running of the plants for a period of 20 days as per para 1.3.

1.11 QUOTATIONS IN MKS/S.I. UNITS

Values for performance figure given in these specifications are in MKS/SI units. Full particulars of all figures of performance of the equipment offered shall be furnished in MKS/SI Unit. The technical data should be furnished in MKS/SI units only. The technical data should be typed or should in capital letters.

1.12 TRAINING

The tenderer shall undertake to extend free training (for a period of not less than three days) in operation & maintenance of air-conditioning plants offered by them to five technical personnel of Akashvani Kolkata. Details of the training offered with period (not less than three days), may be indicated.

1.13 AFTER SALE SERVICE

The tenderer shall ensure adequate and prompt after sales service in the form of maintenance/servicing personnel and spares as and when required with a view to minimize the break down period. The tenderer has also to give a written undertaking that spare parts required for air-conditioning plants shall be available off - the – shelf for a period of at least 5 years from the date of commissioning of the plants at site. Sufficient advance intimation shall be given to the indentor before phasing out any spare component/part so that indentor is able to stock the same for future use.

1.14 MISCELLANEOUS

1.14.1 Completeness of tender

In order to avoid correspondence and clarifications at a later date, tenderers are requested to indicate clearly all the technical details and information asked for in Section II & III of this specification.

SECTION-II

SCHEDULE OF REQUIREMENTS FOR DSITC OF 3x50 HP AIR-COOLED VRF/VRV TYPE SPLIT TYPE AIR CONDITIONING SYSTEM FOR STUDIO AT AKASHVANI KOLKATA					
SNo	**Description of the equipment**	**Capacity of each Unit**	**Quantity**	**Reference to para of section-III for Technical specification**	**Remarks**
1	**VRV/VRF OUTDOOR UNITS**				
1.1	Supply ,Installation in position with testing & commissioning of Variable refrigerant flow/volume outdoor unit with compressors, air-cooled condensers, Refrigerant Gas, Control Unit and accessories.	50 HP	3 Nos	Para 1 Through 1.1 to 1.12	The Outdoor unit shall be placed on MS structure/RCC Foundation with vibration isolator pad. The unit shall be complete in all respect and should match the specification , drawings and Schedule. The unit shall be complete pipe joining kits required to connect the outdoor unit. All interconnecting piping, joints and U bends within the condensing unit shall be painted with two coats of clear transparent polymer coating for protection against corrosion from ambient air pollution.

29.07.2024
K N Pandey
ADE(SD)

29/07/2024
K. Murugan
DDG(E-SD)

29.07.2024
Jitender Pruthi
DDG(NBH)

2.AIR HANDLING UNIT					
2.1	Supply, installation, testing and commissioning Indoor Unit(FLOOR STANDING DX Type AHU)	50 HP	3 Nos.	Para 2 Through 2.1 to 2.15	New AHU shall be installed in existing AHU Room in place of Old AHU.AHU should be designed so that all the Studios are properly ventilated and cooled.
3.	**REFRIGERANT PIPES**				
3.1	Supply, installation, testing and commissioning of Refrigerant Copper Liquid/Gas piping for connection between indoor and outdoor units of the capacities mentioned above.		1 Job	Para 3 Through 3.1 to 3.6	
4.	**Remote status indication Panel**		1 Job	Para 4	
5.	**All control cables between indoor and outdoor unit laid in PVC Piping and clamp.**				
5.1	2 Core 1.5 Sq.mm Copper shielded Cable		216 RMT		
6.	**All power cables with earthing between indoor and outdoor (ELCB's provided 5m from ODU)**				
6.1	4 Core 10 Sqmm Copper shielded armoured cable (ODU to MCB)		30 RMT		
6.2	4 Core 16 Sqmm Copper shielded armoured cable (AHU to AC PANEL)		30 RMT		
6.3	Nitrogen flushing , pressure testing , vaccumising and commisssioning the system		1 Job		
7.	Supply of Refrigerant Gas		120 KG		
8.	Modification in Existing Supply and Return Duct according to the New AHU Specification		1 Job		
9	Supply, fabrication, installation and at the proposed location of MS base frame / platform for installing VRV outdoor units duly epoxy coated as mentioned above complete with vibration isolation pads, supports, etc.		1 Job		

29.07.2024
K N Pandey
ADE(SD)

29/07/2024
K. Murugan
DDG(E-SD)

29.07.2024
Jitender Pruthi
DDG(NBH)

10	Supply and Installation of Canvas Connection between AHU & Supply Duct	1 Job		
11.	Lifting Shifting of ODU and AHU	1 Job		
12.	Dismantling of Existing AC Plant	1 Job		Dismantled AC Plant shall be handed over to Akashvani Kolkata Authorities.
13.	Training of Akashvani Staff	1 Job	As per details at Section I Para 1.12	

29.07.2024
K N Pandey
ADE(SD)

29/07/2024
K. Murugan
DDG(E-SD)

29.07.2024
Jitender Pruthi
DDG(NBH)

SECTION -III

TECHNICAL REQUIREMENTS			
SNO	**PARTICULARS**	**AKASHVANI'S REQUIREMENT**	**TENDERER'S OFFER**
1.	**OUTDOOR UNITS**		
1.1	**General Requirements**		
1.1.1	The outdoor unit shall be factory-assembled, housed in a sturdy weather-proof casing constructed from rust proof panels, with power-coated finish.		
1.1.2	In case of multiple compressors in an outdoor unit, in the event of one compressor failure, the other compressor/s should be capable of running under emergency operation, until the failed compressor is replaced		
1.1.3	The outdoor unit shall be provided with its own microprocessor control panel, with provision for integration with local control system of air conditioning.		
1.1.4	Back-up function: In a multiple system, if the master unit fails, then any other single unit should be settable as the new master unit, so that the remaining healthy units, can keep on operating. This setting up should be possible through the PCB, by a DIP Switch at site.		
1.1.5	The outdoor unit must have the feature of recording running parameters of last 3 minutes before any failure, to enable fault analysis and easier / faster trouble shooting.		
1.1.6	In case trouble occurs in one indoor unit, continuous operation of the remaining healthy system and other indoor units must be possible.		
1.1.7	The noise / sound pressure level shall be limited to 70 to 75 dB(A) at normal operation, measured horizontally 1 m away and 1.5 m above ground level for single and modular type of multiple outdoor units.		
1.1.8	The outdoor unit shall be modular in design and should permit side-by-side installation. The outdoor units shall be capable of working at an ambient of 50 deg C and 0 to95% RH		
1.1.9	The outdoor units must be suitable for operation on 415V,3-Phase, 50Hz. AC supply.		
1.1.10	The unit shall also have feature to automatically modulate		

29.07.2024
K N Pandey
ADE(SD)

29/07/2024
K. Murugan
DDG(E-SD)

29.07.2024
Jitender Pruthi
DDG(NBH)

	the evaporating temperature between 6deg C to 9 deg C with respect to load for better comfortand energy efficiency.	
1.2	**Casing Cabinet**	
1.2.1	Casing shall be made from Galvanised Steel Sheet (GSS), with minimum 1.0 mm thickness. The zinc coating on GSS shall be of minimum 120GSM thickness.	
1.2.2	Powder coating shall be applied on GSS, of minimum 80-100 microns.	
1.3	**Compressors**	
1.3.1	The outdoor units shall be of fully D.C inverter technology, with scroll compressors.	
1.3.2	The inverter compressor shall be capable of changing the speed, corresponding to variations in cooling load requirement	
1.3.3	Compressor shall be of hermetically-sealed type, of high efficiency.	
1.3.4	Thermal casing shall be provided on the compressors, to minimise the noise level. In addition to that, compressor shall be mounted on vibration isolators inside the unit housing to further minimise the noise level.	
1.3.5	The VRF/VRV system to be equipped with overload protection	
1.3.6	All parts of the compressor shall be sufficiently lubricated.	
1.4	**Condensor**	
1.4.1	Condenser coil shall be of seamless deoxidized copper tubes, mechanically expanded into aluminium fins and leak tested / pressure tested at 3,447 kPa (500 psig).	
1.4.2	The OEM shall provide factory manufactured ODU with Hydrophilic Bluefin Coating, to provide protection from environmental corrosion.	
1.4.3	Copper tubes shall be of inner grooved type, for better heat transfer.	
1.4.4	There shall be low and high side access valves, for pressure measurements.	
1.4.5	Terminal box for power input shall be splash protected, water-proof type.	
1.5	**Fan & Motor**	
1.5.1	Bearing shall be designed to ensure an average operating life in excess of 40,000 hours.	
1.5.2	Fans shall be of axial type, direct and protected by gauge rust or corrosion resistance wire guard. Fan blade shall be of ABS /Polypropylene.	

29.07.2024
K N Pandey
ADE(SD)

29/07/2024
K. Murugan
DDG(E-SD)

29.07.2024
Jitender Pruthi
DDG(NBH)

1.5.3	The fan shall be statically and dynamically balanced to ensure low noise and vibration free operation. Bearing shall be of maintenance free and self-lubricated sealed type for lifetime	
1.6	**Refrigerant Circuit and Safety Devices:**	
1.6.1	The refrigerant circuit shall include an accumulator, liquid and gas shut-off valvesand solenoid valve.	
1.6.2	The accessories for refrigerant circuit viz. electronic sensor / thermistors, checkvalves, strainers, etc. shall be completely factory-installed.	
1.6.3	All necessary safety devices shall be provided to ensure safe operation of the system.	
1.6.4	For electrical protection, fuses, overcurrent sensor, overcurrent relay and thermal protectors for compressor and fan motors are to be provided, to ensure safe operation of the system.	
1.6.5	Crankcase heater to be provided for maintaining viscosity of the compressor oil	
1.7	**Oil Recovery System:**	
1.7.1	Units shall be equipped with an oil recovery system to ensure stable operation.	
1.7.2	Precise oil control technology shall be deployed in every outdoor unit and compressors oil kept at a safe operating level, in order to avoid lubrication problem,arising out of compressor oil inadequacy. The system should not be stopped for oil recovery, which has to be a continuous process. The unit must be charged with sufficient level of oil, for safe operation	
1.8	**Refrigerant**:	
1.8.1	The outdoor unit shall be factory pre-charged with refrigerant using R407C / R410A / R507C or any other refrigerant having zero ODP (the first charge), as per OEM's recommended quantity	
1.10	**Control/Power Cable**:	
1.10.1	Necessary control cabling between the Indoor Unit (IDU) and the Outdoor Unit (ODU) shall be laid with GI conduits & accessories. The size of the cable shall be as per manufacturer's recommendation.	
1.11	**Central / Master Controller:**	
1.11.1	OEM of the VRF/VRV units must supply a Central Controller. It shall be provided forcontrol and monitoring of VRF/VRV units.	

29.07.2024
K N Pandey
ADE(SD)

29/07/2024
K. Murugan
DDG(E-SD)

29.07.2024
Jitender Pruthi
DDG(NBH)

1.11.2	Individual and Group Control Facility for all indoor units shall be feasible.	
1.11.3	It shall have Scheduler Function.	
1.11.4	External or inbuilt energy / power monitoring device shall provide by the OEMfor the following: (1) Power Consumption of each indoor unit (in kW-hr.) (2) Total power consumption of all indoor units(in kW-hr.)	
1.11.5	Central controller should allow emergency stop interlock, in case of fire or anyother hazardous condition.	
1.11.6	The central controller shall memorize the latest malfunction code, for ease oftroubleshooting and maintenance services.	
1.11.7	The address of the indoor unit shall be set automatically, in case of individualand Group Control.	
1.12	**Control System:**	
1.12.1	The system shall be microprocessor-based, to achieve precise temperature control and minimum energy consumption. The control system shall employ Proportional-Integral-Differential (PID) temperature control and shall have accuracy of $\pm$ 0.5 °C.	
1.12.2	Control wiring is to be done by using 3-Core cables, with non-polarity multiplex transmission system. (Outdoor-to-Outdoor, Outdoor-to-Indoor and Indoor-to Indoor).	
1.12.3	Unit shall be equipped with automatic fan speed and its own 3-speed fan controller, LED indicators.	
1.12.4	It is also to be equipped with a self-diagnosis circuit, for easy and quick maintenance service. It shall also be able to indicate malfunction codes on displays/	
2.	**AIR HANDLING UNIT:**	
2.1	**Scope**	
2.1.1	The scope of this section comprises the supply, Installation, Testing and Commissioning of factory fabricated double skinned Air Handling Units.	
2.2	**Type**	
2.2.1	Floor Mounted Indoor Air Handling Unit with Heat Recovery Wheel(HRW) for 100 % Fresh AIR.	
2.3	**Capacity**	
2.3.1	The AHU should be able to provide 16000 CFM Air flow with **75 mm External Static Pressure .**	

29.07.2024
K N Pandey
ADE(SD)

29/07/2024
K. Murugan
DDG(E-SD)

29.07.2024
Jitender Pruthi
DDG(NBH)

2.4	**CASHING**	
2.4.1	Double skinned vertical type with thermal break profile at corners and at joints with 0.8 mm thick pre-coated galvanized sheet outside and 0.8 mm thick 275 GSM galvanized steel sheet inside Aerofoil Backward curved direct driven plug type in supply with IE3 rating & suitable for 415+10%, 3 Phase along with IP 20 VFD. The AHU shall be insulated with 40 mm thick injected fire retardent PUF of density 40+2 Kg/m³	
2.5	**FILTER SECTION**	
2.5.1	Each Unit shall be provided with factory assembled pre-filter (EU-4) section with non woven synthetic washable media of 10µ (micron) particle size with an efficiency of 90% before cooling coil, fine filter (EU-7 / F7) section with Synthetic fiber media with frame material made out by Aluminum anodized with flange rigid media with efficiency 99 % at 3µ (micron)	
2.6	**AHU CERTIFICATION**	
2.6.1	AHU should be EUROVENT Certified and verified in accordance to EN-1866-1998 Certifications as given below: Mechanical Strength -Class D1 Casing Air Leakage-Class L1 Filter Bypass Leakage- Class F9 Thermal Bridging -Class TB2 Thermal Transmittance -Class T2 Noise Level should not be exceed dB70 @ 1 Meter	
2.7	**DAMPER**	
2.7.1	Dampers shall be opposed blade type. Blades shall be made of double skinned aerofoil aluminum sections with integral gasket and assembled within a rigid extruded aluminum alloy frame. All linkages and supporting spindles shall be made of aluminum or nylon, turning in teflon bushes. Manual dampers shall be provided with a Bakelite knob for locking the damper blades in position. Linkages shall be extended wherever specified for motorized operation. Damper frames shall be sectionalized to minimize blade warping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure.	

29.07.2024
K N Pandey
ADE(SD)

29/07/2024
K. Murugan
DDG(E-SD)

29.07.2024
Jitender Pruthi
DDG(NBH)

2.8	**MOTOR AND DRIVE**	
2.8.1	The motor & fan assembly shall be mounted on aluminum extruded section	
2.8.2	Fan motors shall be energy efficient and shall be 415±10% volts, 50 cycles, three phases, totally enclosed fan-cooled class F, with IP-55 protection. Motors shall be especially designed for quiet operation. Drive to fan shall be provided through belt-drive/ direct drive arrangement. Belts shall be of the oil-resistant type to maintain class of cleanness. Frequency converter (VFD) for energy saving shall be supplied by the AHU manufacturer for all AHUs with direct driven fans.	
2.9	**COOLING COILS**	
2.9.1	6 RD / 8RD cooling coil shall be made of copper with hydrophilic coating with aluminum fins with spacing at 12-15 FPI. It should be suitable for DX-refrigeration circulation. Any additional items as may be required for using the AHUs along with the VRF type condensing units shall also be included in the costing of the AHU, whether specifically mentioned in the BOQ or not.	
2.10	**DRAIN PAN**	
2.10.1	The polished stainless steel SS 304 drain pan of 1.25 mm thick under cooling coil shall be provided to drain all condensate.	
2.11	**ACCESSORIES**	

29.07.2024
K N Pandey
ADE(SD)

29/07/2024
K. Murugan
DDG(E-SD)

29.07.2024
Jitender Pruthi
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2.11.1	Each air handling unit shall be provided with manual air vent at high point in the cooling coil and drain plug in the bottom of the coil. In addition, the following accessories may be required at air handling units, their detailed specifications are given in individual sections, & quantities separately identified in schedule of Quantities. a. Insulated butterfly valves, balancing valves, `Y' strainer, union & condensate drain piping with 'U' trap upto sump or floor drain in air handling unit room, as described in section "Piping". b. Thermometers in the thermometer wells & pressure gauge (with cocks) within gauge ports in chilled water supply and return lines as per the section "Instruments". c. Water resistance marine light with power cabling.	
2.12	**FRESH AIR INTAKE**	
2.12.1	Extruded aluminum construction duly anodized (20 microns and above) fresh air louvers with bird screen and dampers shall be provided in the clear openings in masonry walls of the air handling unit rooms having at least one external wall. Louvers, damper, pre-filters, ducts and fresh air fan with speed regulator shall be provided as shown on Drawings and in Schedule of Quantities. Fresh air dampers shall be of the interlocking, opposed-blade louver type. Blades shall be made of extruded aluminum construction and shall be rattle-free. Dampers shall be similar to those specified in "Air Distribution". Fresh air fans and fresh air intakes shall be as per the requirements of Schedule of Quantities.	
2.13	**PAINTING**	
2.13.1	Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.	
2.14	**PERFORMANCE DATA**	

2.14.1	Air handling unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data, with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation. **Computerized selection for air handling units shall be provided through 3rd party certified software for all the FMUs.**	
2.15	**TESTING**	
2.15.1	Cooling capacity of various air handling unit models be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.	
2.16	**Starter Panel**	
2.16.1	Each AHU shall be provided with separate starter panel in addition to remote indicator panel	
2.17	**AHU Kit**	
2.17.1	A suitable AHU Kit shall be provided with each AHU Unit	
3.	**REFRIGERANT PIPING**	
3.1	The scope of Refrigerant Piping work shall include Supply, installation, testing and commissioning all interconnecting pipe work of minimum thickness 1.25 mm (18 gauge) between the condensing unit and the AHUs.The piping shall be refrigerant quality seamless copper tube with brazed connections and with the appropriate Distribution joints and headers. The piping should be routed at site in such a manner, that brazed joints in the Ref Piping are kept to a minimum. During brazing, pass dry nitrogen through the pipework. The gas used for the brazing process must necessarily be dry nitrogen (oxygen, carbon dioxide and floron gases shall not be used).	

3.2	Refrigerant piping shall be conforming to ASTME-243 with nitrile rubber insulation of required thickness with thermal conductivity 0.037w/mK and suitable for minimum ADP of 27°C, including supports, necessary fittings, joints, brazing connections and necessary arrangement as per specification and to make system complete.	
3.3	Piping shall be with refrigerant grade hard copper pipes, as per required sizes. Pipejoints shall be done using special fittings. REFNET joints supplied by VRF manufacturer shall be provided wherever required. Pipe jointing shall be of brazed type. The wall thickness of copper pipes shall be 0.8 mm to 1.5 mm	
3.4	All joints in copper piping shall be swaged joints, using low temperature brazing and/ or silver solder. Before joining any copper pipe or its fittings, its interior shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. Piping shall be continuously kept clean of dirt and contaminants while construction of the joints. Subsequently, contaminants shall be thoroughly blown out using nitrogen.	
3.5	Refrigerant piping may runs up to 150m between the condensing unit and AHU with 50m level difference without any oil traps or double risers. The Oil Equalizing line should be inside the Condensing unit, to avoid 'inverted' oil traps at site.	

3.6	**Joint Orientation** :The Distribution refrigeration pipe joints and headers shall be located in an appropriate orientation to enable correct distribution of refrigerant. The Distribution Joints should be factory insulated with pre-formed sections of EPDM / Equivalent. **Cleanliness of piping:**All pipework must be kept clean and free from contamination to prevent breakdown of the system. Seal all pipe ends and keep sealed until immediately prior to making a joint. **Pressure Testing:** The piping shall be vacuum dehydrated immediately after installation of pipe work and prior to sealing of insulation joints and start up of equipment & pressure tested to 3,800kPa; held for a minimum of 48 hours & checked for leaks and repaired if necessary. Following this, the pipe work to be vacuum dehydrated to 500 micron vacuum and held for one to four hours depending on the pipe length (minimum one hour). Use of micron gauge (VP 61 or equivalent) is recommended and 500 micron vacuum should be held for one hour. **Refrigerant Circuit:** Complete refrigeration circuit of the condensing unit with refrigeration compressors, motors, fans, condenser coils, electronic expansion valve, solenoid valves, 4 way valve, distribution headers, capillaries, filters, shut down valves, service ports, receivers and accumulators and all other components which are essential for safe and satisfactory operation. **Y Joints'**-Joints made of copper pipes of the highest quality, resistant to cracks and devoid of burs or residue shall be used in VRF/VRF refrigerant piping.	

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4.	Remote status indication Panel	i. A Panel with status indications of the working of packaged unit shall be wired & installed in control room. ii. The panel shall have indication lamps i.e. Green Lamp/LED for OFF & Red for ON conditions of the equipment. \ iii. The tenderer shall carry Out DSITC of Remote Indication panel including cabling from A/C plant room to Control Room.	
5.	**CIVIL WORKS**		
5.1	Foundation blocks & Vibration isolation	The tenderer shall provide the foundation blocks, suitable mounting arrangements with vibration isolation for the plants for effective control of transmission of vibrations & structure borne noise. **NOTE** The holes if any made by the tenderer in the walls for passage of pipes, conduits, trenches, cables etc. shall be repaired & original finish shall be given by the tenderer.	
5.2	Staging & R.S. Joists	If required as per site conditions, the tenderer shall provide suitable staging/ R.S.Joists for Condenser. The design of the staging /R.S.Joists should be liberal & of adequate size. The R. S. Joists should be given coats of primer & anti-rust paint.	
5.3	Conduits & Cable tray.	The tenderer shall provide the conduits & cable tray necessary for various electrical wiring circuit and Refrigerant piping	
5.4	Plenum Chamber Modification	Necessary modifications in Plenum Chamber for connecting new AHU with Plenum Chamber shall be made.	

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5.5	Miscellaneous	Any other work not specifically mentioned above but necessary for satisfactory completion of entire job shall be the responsibility of the contractor.	
5.6	Surface Painting & Finish	All equipment & plumbing shall be painted after installation with an approved colour as given below.	
5.7	Refrigerant discharge line	Red	
5.8	Refrigerant liquid line	Dark Blue	
5.7	Refrigerant Suction Line	Yellow	
5.8	Steel Supports	Battle ship grey	
5.9	Electrical switch board and cable trays.	Battle ship grey	

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ANNEXEURE - 1

STATEMENT OF PARTICULARS FOR 3x50 HP AIR-COOLED VRF/VRV SPLIT TYPE AIR CONDITIONING SYSTEM

1. VRF/VRV OUTDOOR UNIT

a) Manufacturer's Name :
b) Model :
c) No. and Type of Compressor per ODU :
d) Nominal Capacity of each Compressor in HP:
e) Saturated Suction Temperature Deg.C :
f) Saturated Discharge Temperature Deg.C :
i) Refrigerant used :
j) Qty. of Refrigerant used :
k) Power consumption in KW/HP at Full load and part load at 75%, 50% and 25% W as per compressor design) :
m) Range of capacity variation :
n) Safety devices & controls :
o) Monitoring Devices :

2. ELECTRICAL ACCESSORIE

Please indicate the make, type, Rating/grade and other details of following:

a) Panels/ :
b) ACB/MCCB/FSU :
c) HRC Fuses :
d) Rotary/selector Switches :
e) Starters :
f) Contactors :
g) Indicating Lights :
h) Push Buttons :
i) Control Cables :
j) Power Cables :
k) Ammeters :
l) Voltmeters :
m) Single Phase Preventors :
n) Current Transformer :
o) Bus-bar/Grade :
p) Overall dimensions of the panel :

3. AIR HANDLING UNITS

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General:

a) Make and Model :
b) Type of AHU :
b) Range of Capacity (CFM/CMH) :
c) Capacity of A.H.U at rated coil Face velocity (CFM/CMH) :
d) Material/gauge of casing, Drain Pan :
e) Overall size LxBxH(mtrs.)
f) Overall weight in Kg. :
g) Service/side clearance required :

Cooling coil

a) Material of tube/fins and type of Expansion :
c) No. of fins/cm. :
d) No. of rows deep
e) Dia of tubes (MM) :
f) Face area (sq. metre) :
g) Cooling Capacity (K. cal/hr.) :
h) Entering/leaving temperature DB(Deg. C.)
i) Entering/leaving temperature WB(Deg.C.) :
j) Apparatus Dew Point (Deg.C) :
k) Face Velocity (meters per second) :
l) Test Pressure (Kg/cm sq.) :
n) Number of tubes :
o) Length of tubes :

Filter Section

a) Make :
b) Type of filters :
c) Size of filters :
d) Number of filters :
e) Air Velocity through filters (Meters/minutes) :
f) Efficiency in % for particulate size :

Fan and Fan Motor

a) Make :
b) Type of Fan :

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c) Number of Fans :
d) Width and dia of fans(mm) :
e) Type of blade :
f) Air quantity CFM/CMH :
g) Fan Speed :
h) Provision and range of speed reduction. :
i) Static Pressure in mm of water gauge:
j) Type of balancing :
k) Make and type of motor :
l) Class of insulation :
m) Voltage/frequency fluctuation permissible
n) Brake Horse Power in HP :
o) Motor RPM :
p) Type of Starter :
q) Make of Starter :
r) Protections available :
s) Sound level generated at outlet of AHU:

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ANNEXURE-II

INSPECTION PROCEDURE FOR INITIAL INSPECTION OF CENTRAL AC PLANTS AT MANUFACTURER/TENDERER WORKS.

I. AIR CONDITIONING PLANT COMPRISING of VRF/VRV ODU

a. Physical verification of the unit for its make, model, type, capacity etc. shall be carried out of the equipment offered at Manufacturer's/tenderer works with reference to A/T.

b. Manufacturer's test certificate shall be scrutinized to check compliance with the requirement as specified in the order.

II. A.H.U. AND COOLING COIL

A. Air Handling Unit

1) Salient features such as model, size, physical dimensions and other details of various sections, fan motor detail, fan dimension etc. shall be verified against the contract requirements.
2) Manufacturer's test certificate for the motor and air-handling unit shall be furnished and scrutinized as per contract requirements.
3) Test certificate for static and dynamic balancing of the fan/blower shall be furnished for verification.

B. Cooling Coil.

1) Manufacturers internal test certificate on salient features like type, material, no. and gauge of fins and tubes and no. of rows shall be furnished and verified with reference to contract requirements.
2) Hydraulic pressure to the extent (as per Manufacturer's recommendation) shall be applied and this pressure should be maintained for 15 minutes and no drop should be observed indicating any leaks. Alternatively pneumatic submerged pressure test shall be carried out for 15 minutes with compressed air or dry nitrogen to ensure that there is no leakage.

III. SWICH GEAR, CONTROL GEAR AND MEASURING INSTRUMENTS

a. It shall be verified that control panel is of CPRI approved make.
b. Manufacturer's test certificate for air circuit breaker shall be verified as per contract requirement.
c. Availability of measuring instruments of required accuracy for conducting different tests shall be verified.

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ANNEXURE-III

INITIAL TEST AT SITE AFTER INSTALLATION WITH TEST READINGS

Tenderer's representative shall witness all type of routine tests. Performance tests of equipment/control installed shall be carried out at site.

On completion of installation, the tenderer shall conduct initial test. Any defects found shall be rectified immediately. The test readings during initial test run shall be recorded in the Test Readings Proforma enclosed with this Annexure.

The initial test which has to be carried out by the tenderer shall be(but not limited to) as follows:-

a) Pressure tests for all condenser water and rerfrigerant circuit as given in this specification/ as recommended by the manufacturer before charging the system.

b) To check satisfactory functioning of all electrical motors, switch-gear, pumps, control, pressure testing of all condensor water and refrigerant system, air handler's etc.

c) To check alignment of motors.

d) To operate, check and run compressor, cooling towers, pump sets, air handlers and adjust water flows in all lines,

NOTES:

All necessary test instruments such as thermometers, pyrometer, pressure gauges, anemometer, dust-count meter, water flow-meter, Sound level (decibel) meter, personnel, and required quantity of gas, oil and lubricants etc. shall be arranged by the tenderer at his own expense. However, water and power for testing and commissioning of the system shall be provided free of cost by the indentor.

In addition to the initial test as explained in Section I and above, the tenderer shall also give two continuous running tests of the system during peak summer and monsoon each of 24 hour duration or for 3 days each of 10 hour duration when the ambient conditions are close to the design conditions. The capacity test shall be conducted in presence of representative of the indentor and inside and outside conditions shall be recorded on hourly basis.

CAPACITY OF PLANT

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Before capacity tests are conducted, the following aspects shall be checked:

a) The tests shall be conducted during the peak season only. In case the outside design conditions are not available, then tests shall be conducted at design conditions closest to outside design conditions.

b) All internal loads such as light load, occupancy or equipment load shall be close to design loads. Otherwise, artificial load shall be generated to satisfy internal design loads.

c) Hourly readings of temperature, relative humidity, electric current, power consumption etc. shall be recorded. The capacity of the system components shall be computed as given in the TEST READING-PROFORMA given below.

d) Test readings shall be furnished in duplicate prior to handing over the plants.

1. OUTSIDE DESIGN CONDITIONS

a) Season :
b) Dry bulb temp. Deg.C. :
c) Wet bulb temp. Deg.C. :

2. INSIDE DESIGN CONDITIONS

a) Dry bulb temp. Deg. c. :
b) Wet bulb temp. Deg.C. :
c) Relative Humidity % :

3. COMPRESSOR

a) Suction Temep. Deg.C. :
b) Suction Pressure Kg./Sq.cm. :
c) Discharge temp. Deg.C. :
d) Discharge pressure Kg/Sq.cm.
e) Oil Pressure Kg./Sq.cm. :
f) Capacity of compressor motor(HP):
g) Starting current(Amps)
h) Readings of voltmeter, Ammeter and power factor meter.

Power computation at various loads of 100% 75%, 50%, 25%

Motor current - Amps :
Voltage - Volts :
Starting current -Amps. :

4. AIR HANDLING UNIT

a) Coil face area Sq.mt. :
b) Maximum air quantity CFM/CMH :
c) Actual air quantity CFM/CMH :
d) Air velocity m3/hour :

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e) Entering air temp. DB/WB Deg.C :
f) Leaving air temp. DB/WB Deg.C :
g) Motor drive for air handlers
i) Rated horse power (HP) :
ii) Rated voltage/current/volt/ampere :
iii) Actual voltage/current/volt/ampere :
iv) Starting current amperes

The above data should also be recorded for each individual AHU.

5. FILTEERS

a) Area of filters m2 :
b) Effective area m2 :
c) Velocity of air m/hr. :
d) Quantity of air m3/hr. :

Notes:

1. TESTING VARIOUS LOADING CONDITIONS

The performance tests shall be conducted at various loads of 100%, 75%, 50% and 25% of the capacity of each plant.

2. COMPUTATION OF CAPACITY OF VARIOUS EQUIPMENT.

a) Compressor

$$\text{B.H.P./Ton} = \frac{\text{Power input in kW}}{0.746 \times \text{Compressor Cap. in ton.}}$$

The capacity of compressor shall be taken from manufacturer's rating chart to be supplied by the tenderer.

b) Condenser

Refrigerating Capacity Hc = [(T2 - T1)W-860P)] Kcal/hr.

$$= \frac{[(T2-T1)\ W-860P)]}{3024} \text{ TR}$$

Hc = Net cooling effect produced in Kcal/hr.
T2 = Outlet water temp.
T1 = Inlet water temp.
W = Quantity of water passed/hr in kg.
p = Power input in kW.

c) Cooling Tower

$$\text{Cooling Tower Efficiency} = \frac{\text{Range} \times 100}{}$$

$$\text{Range + Approch} = \frac{(Th - Tc) \times 100}{(Th - Tc) + (Tc - Twb)}$$

$$= \frac{(Th - Tc) \times 100}{(Th - Twb)}$$

Where-

Th - Hot water temp.(Water inlet)

Tc - Cold water temp.(Water Outlet)

Twb- Ambient wet bulb temp.

d) Cooling coils of Air Handlers

$$\text{Capacity of cooling coil} = \frac{\text{Cfm} \times 60 \, (he - hl)}{\text{Avg. sp. volume V} \times 12000}$$

Whereas he = Enthalpy of entering air in btu/lb*
hl = Enthalpy of leavidng air in btu/lb.*
V = (Ve + V1)/2
Ve = Specific volume of air entering in Cft/lb of air
V1 = Specific volume of leaving air Cft/lb of air.

* Wet bulb temperature of air before and after the cooling coil of the AHU should be measured to know he and hl values.

3. All functional tests of motors, other electrical equipment, and electrical cables shall be conducted as per Indian Electrical Rules and ISI specifications.

4. The interlocking of compressor motor with condenser and cooling tower fan shall be checked.

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5. HP/LP cut-out, oil failure switch, flow switch, etc. Shall be thoroughly checked and tested at various settings.

6. The inbuilt capacity control arrangement of each compressor shall be checked at various steps of loading.

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