INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH-THIRUVANANTHAPURAM [IISER-TVM]

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IISER/PUR/PT/22/10 Date: 24th December 2010

INVITATION TO TENDER

Dear Sirs,

SUB: SUPPLY, INSTALLATION, TESTING AND COMMISSIONING OF AIR-COOLED AIR-CONDITIONING SYSTEM

We invite Sealed Tenders for the above as per 'Schedule' attached.

Please quote your lowest rate and shortest delivery period. "Instructions to Tenderers" [Imports & Indigenous] attached are to be followed strictly.

YOUR OFFER IN SEALED COVER SUPERSCRIBING TENDER NUMBER AND DUE DATE SHALL REACH US ON OR BEFORE 18TH JANUARY 2011 (3 PM). LATE AND DELAYED OFFERS WILL NOT BE CONSIDERED UNDER ANY CIRCUMSTANCES.

Thanking You,

Yours Faithfully

CONSULTANT
(PURCHASE & STORES)

IISER-TVM
PUBLIC TENDER NO. IISER/PUR/PT/22/10
SCHEDULE

I. TENDER NO. IISER/PUR/1000/10

TECHNICAL SPECIFICATION

1.0 General

Design, supply, installation, testing and commissioning of any one of the following Air-Conditioning system to achive the inside condition as specified in room no. 117 of Computer Science and Engg Building at CET Campus, Thiruvananthapuram for IISER-TVM.

a) Variable Refrigerent Flow System,
b) Precision Air-Conditioning System, and
c) Ductable Split Air-Conditioning System.

Note: All the above three Air-Conditioning System shall be quoated with separate rates.Each system's Design data may be submitted along with the offer. The inside design condition is stringent and is to be maintained troughout the year.

1.1 Outside Temperature (^{o}C): (AS PER ISHRAE)

Seasons	DB	WB
Summer	33.3	26.7
Monsoon	29.4	26.7
Winter	22.2	18.3

1.2 Inside Conditions:

Area, Temperature & relative humidity:

Area Description			Inside condition	
Length	**Width**	**Hight**		
11 Mtrs	9 Mtrs	3.6 mtrs	DB	22 ± 1^{o}C
			RH	55 ± 5%

1.3 Design Parameters

1.3.1 Cooling Capacity :- 22 -24 TR

1.3.2 Total Airflow :- 22450-24490 CMH.

1.3.3 Occupancy:- Max 6-7 persons at atime.

1.3.4 Lighting Load:- 1000 watts (Maximum)

1.3.5 Equipment Load :- 45 kW (Maximum)

1.3.6 False ceiling :- Nil

1.3.7 False Flooring :- Nil

1.3.8 Floor :- Ground

1.3.9 Ducting :- Exposed type

1.4 Scope of Work

1.5.1 VARIABLE REFRIGERANT FLOW (VRF) SYSTEM

1.5.1.a Design, supply, erecting, testing and commissioning of variable refrigerant flow (VRF) system, suitable to operate at minimum 48^0C ambient temperature comprising of the following and complete as per specifications:

Combination of digital and fixed hermetic scroll compressors suitable for operation on R-410A, complete with high/low pressure cut-outs, oil pressure failure switch, fan motor, safety thermostat, over current relay, fusible plugs, fuses etc. and suitable for operation on 380-440V, 3 phase, 50 Hz A.C. supply.

Matching air cooled condenser with copper tubes and aluminium fins duly covered by anti-corrosion and hydrophillic resin film.

Oil separator suitable for the refrigerant piping.

Lot - Accumulator, liquid and gas shut-off valves and solenoid valves/modulation valve with fittings to interconnect compressor, condenser and evaporator coils.

Lot, frame work for mounting the above condensing unit.

Lot, initial charge of R-410A Gas and Oil

Lot, Anti-vibration/noise mountings as required

Indoor unit shall be factory built, cabinet type, floor mounted air handling unit in double skin construction of suitable capacity at high static pressure complete with factory fabricated independent sections, housing the various components e.g. blower, TEFC blower motor suitable for operation on 415 ± 10% volts, 3 phase, 50 Hz AC supply, copper tube aluminium finned direct expansion cooling coil, pre-filters, electronic expansion valve, humidifier, electric strip heater with thermostat, humidistat, corded remote and power and control wiring, drain connections with anti-vibration mountings etc. as required and as per specifications. The physical dimension of Indoor & Outdoor units shall be furnished.

OR

1.5.1.b PRECISION AIR-CONDITIONING SYSTEM (AIR-COOLED)

Design, supply, installation, testing & commissioning of self contained precision air cooled packaged type air-conditioners comprising hermetic scroll compressor, air cooled condenser, evaporated cooling coil with aluminium fins, blower and motor, thermostat, starters for motors of compressors, condenser and blower with over load relay and single phase preventer, filter, return air slots and associated refrigerant piping all (exept condenser unit) housed in a double skinned fire retardant insulated sheet metal cabinet and

dualy painted. The indoor units shall be installed in the packaged unit room adjacent to the AC area.

The condenser unit shall be of large face area with minimum 4 rows of copper coil with aluminium fins and hydrophilic coating, integral sub cooling circuit, refrigerant receiver, suitable fan and motor, refrigerant pipe connection, metallic frame work etc. prewired in a single cabinet, duly painted, covered with aluminium weather cowl which shall be suitably designed to prevent west direction solar rays from directly falling on condenser and suitable for outdoor duty and operation throughout the year.

The unit shall be designed to operate 415V, 50Hz, Ac supply. Unit should include controls like HP cut out, LP cutout, over load relays, oil safty switchs etc. Suitable Nitrile rubber or equivelant thermal insulation wherever required shall be provided. Condensing units shall be connected to the evaporated / compressor package and the refrigerant piping should include necessary service valves for isolation of refrigerant lines. The unit shall have an inbuilt steam generator as well as heaters to control humidity and temperature.

Package units shall be provided with Micro processor based control system and shall be fully Auto-matic in operation. Auto restart after resumption of power supply in case of power supply failure shall be an inbuilt feature of units. Display of parameters like room temp., RH, status of package unit, fault/trip indications, alarms etc. shall be provided as per the specifications.

OR

1.5.1.c DUCTABLE SPLIT AIR-CONDITIONING SYSTEM (AIR-COOLED)

Design, supply, installation, testing & commissioning of Floor mounted air cooled Package split Air-conditioners with scroll compressor, air cooled condensor, GSS casing, filters, cooling coils fan motors, copper refrigerant piping,(insulated) refrigerant controls and accessories complete, including MICRO-PROCESSOR CONTROL with indication lamps for the operation of the system with thermostat fixed in the respective rooms to adiust the temperature according to the equipments requirements with Micro-processor control panel for each machine. Strip heaters with controls shall be provided for controlling the temperature and humidity.

1.5.2 PIPING

1.5.2.a Supply and installation of suitable size interconnecting **refrigerant piping** (liquid & gas) with hard drawn copper including 'Y' joints and all other necessry fittings duly insulated with 19/13mm thick chemically cross linked closed cell polyethylene foam, FR-XPE fire retardant grade, duly clamped and supported on GI tray as per site conditions for connection between outdoor and indoor units. **- (Lump sum)**

1.5.2.b Supply and installation of suitable size condensate **drain** UPVC **piping** as per BIS 4985 with necessary clamps, supports, hangers and fitting such as bend, tees, reducers etc. duly insulated with 6 mm thick chemically cross-linked closed cell polyethylene foam FR-XPE fire retardant grade as required. **- (Lump sum)**

1.5.3 DUCTING

1.5.3.a Design, supply, installation, testing and balancing of exposed type rectangular GSS **ducting** factory fabricated of suitable thickness including necessary supports, hangers, nut bolts, gaskets, splitter dampers, vanes, canvas connections etc. complete as per IS-655 (latest), and **acoustic lining** with 10 mm thick engineered Nitrile Rubber open cell foam on the inner side of ducting including providing, fixing and finishing the same and covered with 0.63 mm perforated aluminium sheet as per specifications for ducts as required, and **duct lining** with 15mm thick chemically cross linked, closed cell polyethylene FR-XPE retardant grade insulation on duct tail end with prelaminated reinforced aluminium foil for supply air duct and sealed with self adhesive PVC tapes reinforced with 12mm wide PVC strap 500mm C/C as per required. **- (Lump sum)**

1.5.3.b Supply, installation, testing and commissioning of square/rectangular powder coated extruded aluminium **supply air diffusers / grills** of various sizes with volume control dampers, **return air diffusers / grills** of various sizes complete with / without volume control dampers, **fresh air louvers** with aluminium **bird screen** and MS volume control damper, and complete as per specifications. **- (Lump sum)**

1.5.4 ELECTRICAL

Supply, installation, testing and commissioning of Power cum control wiring with suitable panels including necessary switches, contactors and protection devices and cabling with suitable size XLPE, PVC insulated Aluminium core, steel armoured cable for power and FRLS, PVC insulated, stranded Copper cables for control wiring in suitable conduits between indoor and out door units and its remote controllers.

1.5.5 AIR CURTAIN

Supply, installation, testing and commissioning of 1000mm length, Compact **Air Curtain** with CRCA sheet enclosure duly powder coated, aluminium blowers, PVC coated steel grills, 1/10 HP.1440rpm motor, the Compact Air Curtain consisting Maximum Air Velocity At Nozzle 1350 FPM, Average Airflow At Nozzle 1050 CFM, and Maximum Mounting Height 8 Feet including all necessory components and suitable for operation on 230V, 1 phase, 50 Hz A.C. supply complete as required. **Qty = 1No**

1.5 Items to be provided by Department.

The following related items of work shall be provided by Department and need not to be included in the scope of work of air conditioning Supplier / agency.

1.5.1 Provision of main 3 phase, 50 Hz, 415 volts AC supply will be made available at AC plant room proposed.

1.5.2 Provision of concreate pedestal for installing Outdoor units.

1.6 Drawings

Proposed Room and location layout will be supplied by the Department. The fabrication and working drawings shall be prepared by the Supplier / agency and got approved from the Department before erection.

1.7 Test Data

The plant shall be tested as per the specifications given elsewhere and complete `Test Performa' shall be furnished on prescribed sheet.

1.8 Technical Data

The Supplier / agency shall furnish complete technical data on the equipment offered by him as required under the heading `Technical Data'.

1.9 Performance Data

The Supplier / agency shall guarantee that the air-conditioning system performance and shall maintain the designed inside temperature and the relative humidity as specified. The Supplier / agency shall also guarantee that the capacity of various components as well as the whole system shall not be less than specified.

2.0 VARIABLE REFRIGERANT FLOW UNITS (VRF)

2.1 General

It shall be air cooled, modular type variable refrigerant volume air conditioning unit consisting of outdoor unit and multiple indoor units, each suitable for cooling in summer and heating during winters as per the requirements. The supplier / agency should be OEM of VRF system.

The refrigerant piping shall be extendable up to 200m with 50m level difference without any oil traps.

2.2 Outdoor Unit

The outdoor unit shall be a factory assembled unit housed in a sturdy weather proof casing constructed form rust-proof mild steel panels coated with a baked enamel finish.

The outdoor unit shall have a combination of digital and fixed scroll compressors and be able to operate even in case of breakdown of one of compressors.

The noise level shall not be more than 62 dB(A)at normal operation measured horizontally 1m away and 1.5m above ground.

The outdoor unit shall be modular in design which can be installed side by side.

2.3 Compressor

The compressor shall be of highly efficient hermetic Digital Scroll capable of capacity modulation by time averaging method and fixed scroll compressors.

2.4 Heat Exchanger

The heat exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fin coil. The aluminium fins shall be covered by anti-corrosion resin film and hydrophilic coating.

2.5 Refrigerant Circuit

The refrigerant circuit shall include an accumulator, liquid and gas shut off valves and a solenoid valves or pulse width modulation valve.

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

2.6 Safety Devices

The following safety devices shall be part of the outdoor unit;

High Pressure Switch, Low Pressure Switch, Fan Motor Safety Thermostat, Over Current Relay, Fusible Plugs, Fuses, etc.

2.7 Oil Recovery System

Each unit shall be equipped, with an oil separator to ensure oil recovery with long refrigerant piping for the long life of unit.

2.8 Indoor Unit

The Indoor unit shall be air handling unit, exposed ductable type. It shall have electronic expansion valve to control refrigerant flow rate in response to load variations of the room. The fan shall be of the dual suction multi blade type and statically and dynamically balanced to ensure low noise and vibration free operation.

The identification number of the indoor unit shall be set automatically in case of individual and group control. In case of centralized control, liquid crystal remote controller shall set the same.

The indoor unit can be floor mounted type, AHU, concealed or ductable complete with the following components:

The unit shall be with pre-filter; fan section & DX coil section. The housing of unit shall be light weight powder coated galvanized steel. The unit shall be perfectly concealed in overhead boxing. Noise level should not be more than 35 db at low speed.

The cooling coil shall be of seamless copper tubes, and shall have continuous aluminium fins. The tubes shall be staggered in the direction of airflow. The fins shall

be uniformly bonded to the tubes by mechanical expansion of the tubes. The coils shall be tested against leaks.

Unit shall have cleanable type filter of resin net (with mold resistant) fixed to an integrally molded plastic frame. The filter should be slide away type but neatly inserted.

The filter shall be preferable with ionizer to inhibit the spread of bacteria or virus.

The computerized PID control shall be used to maintain a correct room temperature. Each unit to be provided with microprocessor thermostat for cooling & heating.

Each unit shall be with wired remote controller LCD type. The LCD remote controller shall memorize the latest malfunction code for easy maintenance.

2.9 Centralized System Remote Controller

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

The System Controller shall act as an advanced air conditioning management system to give complete control of VRV air conditioning equipment. The system shall be user friendly.

It shall be able to control up to 32 groups of indoor units with the following functions :-

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

Temperature setting for each indoor unit or zone.

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

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

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

2.10 Refrigerant Piping

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

All pipes shall be degreased, clean inner surface, free from any lubricant, carbon residue and suitable for refrigerant R-410A.

Each tube shall be capped, plugged at both ends so as to maintain the internal cleanliness of the tube under normal conditions of handling and storage. Straight tube shall be marked at repeated distances along the length, the number of standard, cross sectional dimensions, manufacturers identification mark, date of manufacture and batch/lot number etc. All joints in copper piping shall be through Copper-Phos-Silver brazing filter metals. Before joining copper pipes all burrs shall be removed from inside and outside of pipes. Brazing joint shall be oxygen free nitrogen, piping shall be pressure tested using nitrogen at 32 kg/cm^2 to be maintained for 24 hours.

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

The OD & wall thickness of copper refrigerant piping shall be as follows:

	Outside Dia (mm)	**Wall Thickness(mm)**
a)	41.3, 34.0	1.3
b)	31.8, 28.6, 25.4, 22.2	1.2
c)	19.1, 15.9	1.0
d)	12.7, 9.5, 6.4	0.8

2.11 Condensate Drain Piping

The indoor units shall be connected to drain pipe made of hard PVC.

The pipes shall be laid in proper slope for efficient drainage of condensate water.

2.12 Pipe Insulation

Refrigerant Pipe Insulation

The whole of the liquid and suction refrigerant lines including all fittings, valves and strainer bodies, etc. shall be insulated with 19/13 mm thick chemically cross linked closed cell polyethylene foam FR-XPE fire retardant insulation.

The joints shall be properly sealed with synthetic glue to ensure proper bonding of the ends.

Drain Pipe Insulation

Drain pipes carrying condensate water shall be insulated with 6 mm thick chemically cross-linked closed cell polyethylene foam FR-XPE fire retardant having a 'K' value of 0.033 W/mk at a mean temperature of 23°C and a minimum density of 30+3 Kg/cum.

The joints shall be properly sealed with synthetic glue to ensure proper bonding of the ends.

3.0 AIR HANDLING UNITS

3.1 General

The work under this part shall consist of furnishing all labour, material equipment and appliances as specified and required to install Air Handling Units and other allied work to make air conditioning system ready for operation.

Except or otherwise specified air handling unit and related item shall be in accordance with these specifications.

3.2 Housing/Casing

The Air handling unit shall be of sectionalized, draw through type double skin construction, consisting of fan section, Dx coil section, humidifier section, filter section, insulated drain pan, etc. as specified.

Double skinned air handling unit shall be in modular construction. Frame work shall be fabricated out of extruded aluminium sections. Panel shall be removable and made out of GSS sheets in sandwitched construction. Outside sheet of panel shall be minimum 0.8 mm thick pre-plastified GSS sheet while inside GSS sheet thickness shall be 1.0 mm minimum in natural finish. Polyurethene foam insulation of minimum 38 kg/m^3 density shall be injected/sandwitched between these panels. Panel thickness shall be 25mm. Suitable doors with die cast aluminium handles and hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on Aluminium channel frame work.

3.3 Cooling/Heating Coils

Coils shall be of the fin and tube type having aluminium fins mechanically bonded to copper tubes. All tubes shall be in staggered pattern. The fins shall be minimum 0.14 mm thick aluminium at a pitch of 5 fins/cm. All the tube connections to headers and return bends shall be brazed with silver brazing alloy. Capacity of the coil shall be as required under the scope of work. All coils shall be duly pressure tested for required pressure.

3.4 Fan

Fan shall be backward / forward curved, DIDW type. The fan housing, impeller shall be fabricated from 1.2/1.6 mm GI sheet. Fan impeller shall be mounted on a solid steel shaft statically and dynamically balanced. Shaft shall be supported to the housing with angle iron frame and pillow block heavy duty ball bearing. Fan housing shall be made of die-formed side sheets with streamlined inlets and guide vanes to ensure smooth air-flow into the fans. Fan housing and TEFC Fan motor in IP-55 Construction shall be mounted within the fan section on a common extruded aluminium base mounted inside the air handling unit on anti-vibration mounts. Fire retarding double canvas flexible connection shall be provided between fan outlet and AHU casing. The operation of the fan shall be quiet.

3.5 Motor and Drive

Fan motor shall be totally enclosed fan cooled type in IP-55 construction suitable for AC supply of 415 ± 10% V, 3 phase, 50 Hz. Motor shall be selected for quiet operation and a maximum motor speed of 1440 RPM. Drive to fan shall be provided through belt-drive arrangement. Belts shall be oil-resistant type.

3.6 Mixing Plenum

Wherever return air is ducted, double skin mixing plenum shall be provided having construction similar to air handling unit with provisions of flanged connections for return air and fresh air and factory fitted, manually operated, gear driven extruded aluminium volume control dampers. Filter plenum, wherever required shall be of the same construction and shall be factory fabricated by the AHU manufacturer only.

3.7 Humidification

Unit shall have an inbuilt steam generator. Steam shall be evenly distributed in the bypass air stream. Humidifier shall have an efficiency of not less than 1.3 kg/KW. Humidifier shall have replaceable electrodes. It should be capable of auto modulation of steam generation.

3.8 De-Humidification

Specific dehumidification cycle shall operate by reducing the air flow thereby reducing the surface temperature in the refrigeration coil.

3.9 Safety features

The fan access door shall be equipped with micro-switch interlock with fan motor enabling switching OFF the fan motor automatically in the event of door opening. Wire guard for fan section access door shall be provided.

3.10 Accessories

Each air handling unit shall be complete with:

a) Flexible connection between fan outlet and unit casing. Stainless steel chicken wire mesh screen shall be provided at the duct connection.

b) Vibration isolator of high efficiency.

c) Suitable concrete/steel foundation.

d) Motor and drive package.

e) Test pocket with thermometer for checking the air inlet and outlet temperature.

3.11 Filters at Air Handling Unit and Fresh air intakes

The filter shall be constructed out of 50mm deep non-woven polypropelene media stitched between 40 sieve HDPE mesh and aluminium mesh on the other side. All three stitched together and housed in 14 gauge anodised aluminium frame.

All the edges of the filter element shall be protected from polyester beading and perfectly sealed within the frame with ductile epoxy resin to avoid bypassing of unfiltered air. Filter element shall have minimum 38 folds per meter of filter face area. Filter shall be in foamless construction with rubber gasket fixed on the flange. All hardware used shall either be chrome plated or brass. The maximum pressure drop shall not exceed 2.5m to 3.5mm WG when clean. Filter shall be complete with mounting arrangement, nut bolts etc. and whatever is required to complete the installation. The efficiency of filter shall be 90% down to 20 micron.

3.12 Testing

The air handling unit shall be tested to measure air quantity and coil performance by measuring temperature difference, water flow rate and pressure drop through the coil and then calculating the capacity by using the above measurements.

Limitations

The air velocity across the filter media shall not exceed 2.5 M/S (500 FPM).
The air velocity across the coil shall not exceed 2.5 M/S (500 FPM).
The air velocity at the fan outlet shall not exceed 9.14 M/S (1800 FPM).

4.0 AIR FILTERS

4.1 General

The filters shall be supplied as a part of air handling unit or as specified and shown elsewhere.

The filters may be used for testing and commissioning purpose but on handover the element shall reasonably clean.

All filters shall be rated and tested to ASHRAE 52.2 – 2007 or Eurovent-4/5.

4.2 **Filters** at Air Handling Unit and Fresh air intakes

A set of filter shall be supplied with each air handling unit.

The filter shall be washable constructed out of preformed pleated extended surface type deep non-woven synthetic/blend of cotton and polyester fibres supported with aluminum mesh at downstream side and finished with HDPE mesh at upstream side. Media should be placed within 50mm deep Anodized Extruded aluminum frame. All the sides of the media shall be perfectly sealed with Polyurethane based epoxy resin to avoid bypassing of unfiltered air. Filter media area used shall not have less than 1.75 times of the total filter face area. Rubber gasket shall be fixed as required. The maximum pressure drop shall not exceed 5-6mm of WG at 500 fpm velocity when clean. Filter shall be complete with mounting arrangement, nut bolts etc. and whatever is required to complete the installation. The average efficiency of filter shall be 35-40% based on ASHRAE 52-76 (MERV 6 or above as per 52.2 and Arrestance more than 90% as per 52.1), filter shall be capable of operating to maximum of 500 fpm without impairing efficiency. Dust Holding Capacity: should not be less than 375 grms/ sqmtr. All filters to be of flange type construction with 30mm thick wide flange.

4.3 Fine Filters

4.3.1 Bag Air Filters

It should be non-supported, deep pleated, extended surface type with average efficiencies based on ASHRAE 52-76, and capable of operating to maximum of 625 fpm without impairing efficiency;

i) Maximum Initial Pressure Drop at 500 fpm:

a. Filters with 40 - 50 percent efficiency : 0.33 inch wg.

b. Filters with 60 - 65 percent efficiency : 0.45 inch wg.

c. Filters with 80 - 85 percent efficiency : 0.51 inch wg.

d. Filters with 90 - 95 percent efficiency: 0.70 inch wg.

ii) Media – non-woven synthetic to meet the above efficiencies. All filters to be made in flange type construction.

4.3.2 Rigid Air Filters:

Filters should be extended surface, deep pleated type with average efficiencies based on ASHRAE 52-76;

i) Maximum Initial Pressure Drop:

Average Percent Filter Efficiency	Initial Pressure Drop For 6 Inch Thick Filters (inch wg at 500 fpm)	Initial Pressure Drop For 12 Inch Thick Filters (inch wg at 250 fpm)
40-45	0.28	0.15
55-60	0.32	0.20
80-85	0.42	0.28
90-95	0.57	0.35

ii) Filter pack shall be constructed of high density microfine glass fibers laminated to synthetic backing material, and bonded to corrosion resistant welded wire support grid. Pleat configuration shall be maintained by pleat spacers installed on both air entering and air exiting sides. Filter pack enclosed and continuously sealed to aluminum/ galvanized steel enclosing frame, and supported by diagonal members bonded to both air entering and air exiting sides.

4.3.3 Fine Filter Mounting Frame

The rigid type Fine Filters shall be housed in a separate housing of 14 guage CRCA sheet duly reinforced and compartmentalized to install the required number of filters. The housing shall have angle iron flanges at both ends for 100% airtight

connection. The housing and frame work after derusting shall be provided with two coats of epoxy paint. Housing depth shall be 50 mm more than filter depth. 100% air tight inspection window shall be provided for the inspection of filters.

5.0 PRECISION PACKAGED AIR-CONDITIONING UNITS

5.1 General

The self-contained air cooled packaged air-conditioning unit shall be complete in all respect and comply with the specifications given below. Each unit shall be guaranteed by the manufacturer to produce the capacity not less than the specified value. The units with dx, refrigeration system are described hereunder.

5.2 Basic Unit

The unit shall be floor/room discharge type designed for high sensible heat ratio > 0.92.

The unit shall be modular construction suitable for operation on environment friendly refrigerant R-410A consistency of high efficiency, scroll compressor, fire filler, electronically commuted brushless motors with backward curved plug fans, direct expansion cooling coil, thermostatic expansion valve all contained in a heavy gauge cold rolled cold annealed corrosion resistant, powder coated, sheet steel cabinet panels with all four sides double skinned sandwich panels with AO class fire insulation, including door, with minimum thickness of 23mm and density 30 kg/cum.

5.3 Compress Motor Assembly

The compressor shall be high efficiency scroll operating with environment friendly refrigerant having in-built overload relays and mounted on anti-vibration mountings. Compressor shall have an EER of not less than 11.1 Btu-hr/watt (COP not less than 3.25).

5.4 Evaporator Coil

The unit shall have large area cooling coil. The coil shall be constructed of copper tubes and aluminium fins with hydrophilic coating, with GI frame and heavy gauge aluminium / stainless steel drip tray. The evaporator coil shall be minimum 2.0 row deep. The fins shall be minimum 0.18 mm thick at a pitch of 5 fins/cm. The face velocity across the coil shall be less than 2.7 m/sec. Coil should be designed for high SHF > 0.92.

5.5 Fans

The fans shall be equipped with direct driven backward curved plug fan with electronically commuted brushless motors. This technology allows the control of air flow and static by means of electronic controller. Fan motor assembly should be min IP 54 protection. The fan section shall have adequate fire retardant thermal insulation.

5.6 Refrigeration Circuit

The refrigeration circuit shall be direct expansion type. The system shall comprise filter drier, charging port, electronic thermal expansion valve, sight glass, liquid line receiver, liquid line solenoid valve, scroll compressor with crank case heater, high pressure and low pressure manual reset type cutouts for the safe operation of units.

The unit shall be complete with dehumidification system, to allow efficient moisture removal by reducing the air flow and eliminating the need of re-heating resulting in lower running cost. Hence by reduction of fan speed there shall be additional power saving.

5.7 Electrical Heating

The unit shall have low watt density elements in finned tubular construction. The electric heating elements shall operate at a heat density level not exceeding 60 kw/Sq.mt. The unit shall have proper safety protection for high temperature and loss of air flow.

5.8 Air filter

The unit shall have dry media, disposable filters capable of filtering air to 95% efficiency down to 5 micron dust particle size. The air filters shall be replaceable externally.

5.9 Condensers

The air cooled condensing unit shall be comprising of 4 row deep copper tube – aluminium fins coils direct driven, condenser fans, refrigerant piping etc. all contained in a heavy duty, weather proof sheet steel frame. The condenser fans should have stepless fan speed variation for winter operation.

5.10 De-Humidification

Specific dehumidification cycle shall operate by reducing the air flow thereby reducing the surface temperature in the refrigeration coil.

5.11 Humidifier

Unit shall have an inbuilt steam generator. Steam shall be evenly distributed in the bypass air stream. Humidifier shall have an efficiency of not less than 1.3 kg/KW. Humidifier shall have replaceable electrodes. It should be capable of auto modulation of steam generation.

5.12 Controls

Unit shall have a microprocessor based programmable PID logic controller, having LCD display screen visible from front of the unit without removing any cover/panels. The controller shall have separate indications for following:

a) Operating modes (Cooling, Heating, Humidifying, Dehumidifying),

b) Alarm for high-low temperature and humidity, compressor HP/LP, wet floor, loss of air etc.
c) Graphical display of temperature and humidity (set and achieved),
d) Date, time and unit identification display,
e) Visual System Alarm (along with mutable audio alarm),
f) Self diagnostic alarm for services.

The controller shall be password protected and fitted with RS-232 port, 2 spare alarm ports. The unit shall have following protections.

i) Single phase preventer
ii) Reverse phasing
iii) Phase imbalance
iv) Phase failure
v) MPCB with overload relay.

Unit shall have oil failure safety switch alongwith other safety controls. Unit shall have provision for fire tripping.

Microprocessor should have inbuilt features for sequencing of units in N+1 configuration. It should be able to operate the unit in team mode / cascade mode.

Note:

Vendor shall furnish computer generated selection sheet for the selected precision A.C. units.

5.0 DUCT WORK AND OUTLET (EXPOSED TYPE)

5.1 General

The duct has to be hung exposed in the AC room. The work under this part shall consist of providing all labour, materials,equipment and appliances as specified and required to install all sheet metal and other allied work to make the air conditioning system ready for operation.

Except or otherwise specified all duct work and related items shall be in accordance with these specifications.

Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

The factory fabricated ducts shall be manufactured and supplied in 'L' shape. The duct accessories and supports shall be as per SMACNA and approved by the Department.

5.2 Duct Materials

The ducts shall be fabricated from galvanized steel coils conforming to IS:277 (latest edition) with grade of coating not less than 120 g/m^2 of Zinc or aluminum sheets conforming to IS:737 latest edition(wherever aluminum ducts are specified). The

material for the factory fabricated duct works shall be of lock forming quality with mill test certificate.

All duct work, sheet metal thickness and fabrication unless otherwise directed shall strictly meet requirements, as described in IS:655 -latest edition.

The thickness of all four sides shall be determined by the thickness required for the longest side of the duct.

The ducts are to be fastened through clinching, rivets, bolts or sheet metal screw. The sealant shall be non hardening, water and fire resistant. Duct hanger rods shall be minimum 8mm galvanized having threading on one end/both ends/full length as per the requirement.

5.3 Duct Construction

5.3.1 Coil lines shall be used to ensure location of longitudinal seams at corners/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams shall be permitted along any face side of the duct.

5.3.2 All ducts, transformation pieces and fittings to be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.

5.3.3 All edges shall be machine treated using lockformers, flangers and roller for turning up edges.

5.3.4 Sealant dispensing equipment shall be used for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.

5.3.5 Duct construction shall be the rolamate in compliance with 1" (250 Pa) w.g. static norms as per SMACNA.

5.3.6 All transverse connectors shall be the Rolamate 4 bolt slip – on flanges system.

5.3.7 The specific class of transverse connector and duct gauge for a given duct dimensions shall be as per Table-1 below for the 1" (250 Pa) pressure class.

Table-1

FOR SELECTION OF ROLAMATE FLANGE CLASS AND DUCT GAUGES **AT 1200MM SPACING**						
Duct Dimension	**1"(250)*[5]**	**2"(500)**	**3"(750)**	**4"(1000)**	**6"(1500)*[4]**	**10"(2500)**
(in mm)			**Reinforcement Class – Duct Gauge**			
150 – 250	*[3]E-26	E-26	E-26	E-26	E-26	E-24
251 – 300	E-26	E-26	E-26	E-26	E-24	E-24
301 – 350	E-26	E-26	E-26	E-26	E-24	E-22
351 – 400	E-26	E-26	E-26	E-26	E-24	E-22

FOR SELECTION OF ROLAMATE FLANGE CLASS AND DUCT GAUGES **AT 1200MM SPACING**						
Duct Dimension	**1"(250)*[5]**	**2"(500)**	**3"(750)**	**4"(1000)**	**6"(1500)*[4]**	**10"(2500)**
(in mm)			**Reinforcement Class – Duct Gauge**			
401 – 450	E-26	E-26	E-26	E-26	E-24	H-20
451 – 500	E-26	E-26	E-24	E-24	E-24	H-20
501 – 550	E-26	E-26	E-24	E-24	H-24	H-20
551 – 600	E-26	E-26	E-24	E-24	H-22	H-20
601 – 650	E-26	E-26	E-24	E-24	H-22	H-20
651 – 700[*2]	E-26	E-26	E-24	H-24	H-22	H-18
701 – 750	E-26	E-26	E-24	H-24	H-22	J-18
751 – 900	E-26	E-24	H-22	H-22	H-20	J-18
901 – 1000	E-26	H-24	H-22	H-20	J-18	J-16
1001–1200	E-24	H-22	H-20	H-18	J-18	
1201-1300	[*3]H-24	H-20	J-18	J-18	J-16	
1301-1500	H-24	H-18	J-18	J-16		
1501-1800	H-22	J-18	J-16			
1801-2100	J-20	J-18				
2101-2400	J-18	J-18				
2401-2700	J-18					

5.3.8 Non-toxic, AC-applications grade P.E. or PVC gasket is to be provided between all mating Rolamate flanged joints. Gasket sizes should conform to flange manufacturer's specification.

5.3.9 The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.

5.3.10 Dimensional Tolerances : All fabricated dimensions will be within ± 1.0mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be ± 1.0mm per metre.

5.3.11 Each and every duct pieces should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge.

5.3.12 Ducts shall be straight and smooth on the inside. Longitudinal seams shall be airtight and at corners only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness.

5.3.13 Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

5.3.14 Plenums shall be shop/factory fabricated panel type and assembled at site.

5.3.15 The deflection of transverse joints should be within specified limit for rectangular duct deflection as given in SMACNA.

5.3.16 Reinforcement of ducts shall be achieved by either cross breaking or straight beading depending on length of ducts.

Duct sizes 19" (483mm) wide and larger which have more than 10 sq.ft. of unbraced panel shall be beaded or cross broken unless ducts will have insulation covering or acoustical liner. This requirement is applicable to 20 g (1.00mm) or less and 3" W.G. (750Pa) pressure or less. Ducts for 4" W.G. (1000 Pa) or more do not require beads or cross-breaks.

5.4 Support System

5.4.1 A completely galvanized system consisting of fully threaded rods, slotted angles or double-L bottom brackets (made out of 3.0mm M.S. sheet) nuts, washers and anchor bolts conforming to SMACNA standards should be used.

Support for Horizontal Rectangular Duct

Sr. No.	Maximum Duct Size (mm)	Hanger Rod Diameter	Interval (mm)
1	Up to – 700	6mm	2400
2	701 – 1200	8mm	2400
3	1201 – 2000	10mm	2400
4	Above – 2000	12mm	2400

5.4.2 As an alternative, slotted galvanized brackets attached to the top two bolts of the Rolamate system may also be used as appropriate for the site condition.

5.4.3 To provide the required thermal brake effect, Neoprene or equivalent material of suitable thickness shall be used between duct supports and duct profiles in all supply air ducts not enclosed by return air plenums.

5.5 Installation

5.5.1 Tools and tackles for site work

The duct installation shall conform to SMACNA norms. For duct assembly and installation suitable tools and tackles should be used to give the required duct quality and speed of installation including (but not restricted to)

a) Electric Pittsburgh Seamer – used for closing Pittsburgh joints

b) Electric Slitting shear – to make cut-outs

c) Drilling machine with drill bits – for drilling holes in sheet metal work

d) Hammer drill machine with drill bits – for drilling holes in building structures for anchors

e) Hoisting system – for lifting the duct assembly upto mounting heights

5.5.2 Installation Practice

All ducts shall be installed as per specifications and in strict accordance with approved shop drawings to be prepared by the Supplier / agency.

The Supplier / agency shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these specifications and drawings. The work shall be in accordance to the approval of Department in all its parts and details.

All necessary allowances and provisions shall be made by the Supplier / agency for beams, pipes, or other obstructions in the building whether or not the same are shown on the drawings. Where there is interference/fouling with other beams, structural work, plumbing and conduits, the ducts shall be suitably modified as per actual site conditions.

Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick appropriate insulation around the duct and totally covered with fire barrier mortar for complete sealing.

All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge.

5.6 Testing

After duct installation, a part to duct section (approximately 5% of total ductwork) may be selected at random and tested for leakage. The procedure for leak testing should be followed as per SMACNA – “HVAC Air Duct Leakage Test Manual” (First Edition).

5.7 Dampers

5.7.1 Volume Control Damper

Volume dampers must be provided at the junction of each branch duct with main duct and split of main duct. Dampers shall be two gauge heavier than gauge of the large duct, and shall be rigid in construction to the passage of air.

Volume dampers shall be of an approved type, lever operated and complete with locking devices which will permit the dampers to be adjusted and locked in any positions.

The dampers shall be of spliter, butterfly type. Damper blade shall not be less than 1.25 mm (18 gauge) reinforced with 25mm angles 3mm thick along any unsupported side longer than 250mm. Angles shall neither interfere with the operation of dampers, nor cause any turbulence. The damper shall be so fabricated as to avoid any leakage of air through the bearing space around damper leave rod.

Automatic and manual opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Dampers and frames shall be constructed of 1.8mm steel and blades shall not be over 225mm wide. Dampers for fresh air inlet shall additionally have extruded aluminum rain protection louvers with wire mesh screen fixed on the air inlet side of louver.

Wherever required for system balancing, provide a volume balancing opposed blade damper with quadrant and fly-nut lock.

After completion of the duct work, dampers are to be adjusted and set to deliver the required amounts of air as specified on the drawings.

5.7.2 Fire Damper

The fire dampers shall be provided wherever required. The damper blades and outer frame shall be constructed out of 1.8 mm galvanised sheet steel. Damper blades shall be pivoted using chrome plated spindles with bronze bushes. Damper housing shall be provided with seals all around to avoid smoke leakage. Damper shall normally be held open by a stainless steel spring loaded fusible link, duly stamped by preferably UL (Underwriter Lab) or any approved testing authority. In case of moterised damper it shall be operated by motorised damper actuator on getting a signal from fire alarm panel or any other smoke/ heat sensing device. Remote control panel shall be provided with the fire damper and shall provide the facility to operate and test the damper operation at regular interval.

The fire dampers shall have at least 100 minutes fire resistance rating.

5.8 Access Panel

A hinged and gasketed access panel shall be provided on duct work before each reheat coil and at each control device that may be located inside the duct work.

5.9 Miscellaneous

a) All ducts above 450mm to be cross broken to provide rigidity to the ducts.

b) All duct work joints to be square or approaching square with all sharp edges removed.

c) Sponge rubber gaskets also to be provided behind the flange of all grilles.

d) Each shoot from the duct, leading to a grille, shall be provided with an air defector to divert the air into the grille through the shoot.

e) Inspection doors measuring at least 450mm x 450mm are to be provided in each system at an appropriate location as directed by The Department.

f) Diverting vanes must be provided at the bends exceeding 500mm and at branches connected into the main duct without a neck.

g) Proper hangers and supports should be provided to hold the duct rigidly to keep them straight to avoid vibrations. Additional supports to be provided where required for rigidity or as directed by The Department.

h) The duct should be routed directly with a minimum of directional change.

i) The ductwork shall be provided with additional supports/ hangers, wherever required or as directed by the Department, at no extra cost.

j) All duct supports, flanges, hangers and damper boxes etc. shall be given 2 coats of red oxide paint before installation and one coat of aluminum paint after the erection, at no extra cost.

k) All angle iron flanges are to be welded by electric arc welding and holes to be drilled.

l) All the angles iron flanges are to be connected to the GSS duct by rivets at 100mm centers.

m) All the flanged joints to have 4mm thick felt packing stick to the flanges with shellac varnish. The holes in the felt packing are to be burnt through.

n) The GSS duct should be lapped 8mm across the flanges.

o) The duct should be supported by approved type supports at a distance not exceeding 2.4m.

p) Sheet metal connection pieces, partitions and plenums required shall be constructed of 1.25mm (18 gauge), sheet thoroughly stiffened with 25mm x 25mm angle iron braces and fitted with access door.

q) Duct sections in general shall be provided with 18 gauge galvanised weld mesh with about 8mm center for rat protection in the supply air ducts at AHU/fan outlets, return air openings in AHU room and above return air slits in conditioned spaces or as directed by the The Department at no extra cost.

5.10 Grilles

The supply and return air grilles shall be fabricated from extruded aluminum sections. The supply and return air grilles shall have double adjustable louvers. The supply air grille shall additionally have an opposed blade extruded aluminum damper. The grilles shall be with outer frames.

The opposed blade dampers in black anodised finish shall be suitable for operation from the grille face.

Grilles longer than 450mm shall have intermediate supports for the horizontal louvers. The grilles shall generally be the design of Tuttle and Balley grilles and registers. Grilles shall be powder coated as per the shade approved by Department.

Linear grilles shall be fabricated from extruded aluminum section have horizontal fixed sections of minimum 3 mm uniformly thick at angle of 15 Deg.

Return air grilles in MS construction shall be provided with vertical and horizontal adjustable bars and volume control dampers operational from front of grille.

The frame shall be of minimum 20G and louvers out of 24g sheet steel. The damper blade shall be of 20G sheet steel.

5.11 Diffusers

The ceiling type rectangular or square diffusers shall be fabricated from extruded aluminum section in removable core construction and provided with anti-smudge ring.

All supply diffusers shall be provided with extruded aluminum, opposed blade dampers, adjustable and lockable from bottom. Dampers shall be in black anodised finish.

Linear diffuser shall be multislot type fabricated from extruded aluminum sections. Each slot shall have air direction controllers with sliding damper for supply air portion only.

5.12 Fresh air intake and Extract Louvers

All the louvers shall be rain protection type and shall be fabricated from extruded aluminum section. The minimum depth of louver assembly shall be 76mm in case of air volumes larger than 8000 CMH. The louvers shall additionally be provided with heavy duty expanded metal (aluminum-alloy) bird screen. In case of smaller air volumes the depth of louver assembly can be 38mm.

5.13 Painting

All grilles, diffusers shall be powder coated in the shade approved by the Department.

All ducts immediately behind the grilles/diffusers etc. are to be given two coats of black paint in matte finish.

5.14 Testing

After completion, all duct system shall be tested for air leakage.

The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the record of balanced air quantity through each outlets shall be submitted to the Department for approval.

5.15 Design parameter

a)	Maximum Velocity in main duct	-	450 mpm
b)	Maximum Velocity in supply outlet	-	150 mpm
c)	Maximum friction in duct	-	1.0 cm WG / 100 m run.

6.0 INSULATION

6.1 General

The insulation of, air handling units, ducting, etc. and acoustic treatment of AHU enclosures, as applicable, shall be carried out as per specifications given under:

6.1.1 Materials

The materials to be used for insulation shall be as follows, unless some other material is specifically mentioned elsewhere.

S. No.	Application	Material	Density (Kg/M^3)	`K' Value (W/MK)	I.S./ B.S. Code (Latest)
1	Duct thermal insulation	Chemically Cross Linked Closed Cell Polyethylene FR-XPE Fire Retardant grade	30±3	Not to exceed 0.033 at 23 ^{o}C mean temp.	IS:3348/ 11080

6.1.2 Mineral Wool

Mineral wool used for insulation and acoustic treatment shall be made from specifically formulated fibres and binder in a suitable ratio to produce fine, fibrous insulation material. The mineral wool shall conform to all properties as mentioned in IS-8183. It shall not settle down due to vibration and jolting. It shall be suited for the maximum design temperature. The material shall be supplied in factory made rolls/slabs of uniform thickness and density and laminated with aluminium foil as specified. Mineral wool shall be non combustible grade and tested to BS-476 (Part 4, 5, 6, 7).

6.1.3 Polyurethane Foam

Rigid polyurethane foam used for thermal insulation shall be made from Polyol and isocyanate chemicals specially formulated to give CFC free fire retardant properties, good compressive strength and minimum water vapour permeability. The material shall be suitably packed to avoid damage during transit. Rigid polyurethane foam shall be supplied in slabs and pipe sections, suitably laminated with aluminium foil and shall be machine cut from buns and provided with shiplap joint finish conforming to IS-12436.

6.1.4 Polyisocyanurate Foam

Rigid polyisocyanate foam made from a specially formulated mixure of polyol and isocyanate chemicals, modified suitably to make it fire safe, CFC free, closed cell, rigid and minimum vapour permeability. The material shall be laminated suitably with aluminium foil or Kraft paper as specified. The material shall be available in slabs and pipe sections provided with shiplap joints finished at the edges. The product shall be machine cut from buns and shall conform to IS-12436.

6.1.5 Polyethylene Foam

Polyethylene insulation shall be made by addition Polymerization of Ethene molecules and specifically formulated to give Fire Retardant properties, good

compressive strength and minimum water vapour permeability. The material shall be suitably packed to avoid damage during transit.

6.1.6 Cross linked Closed Cell Polyethylene

The chemically cross linked closed cell polyethylene insulation material shall be made by polyethylene resin and foaming done through nitrogen gas. It should be chemically cross linked to give strength to air cell and shall be added by the chemicals to give fine retardant properties. It should have tiny, non-inter communicating air cells forming close-cells to provide resistance to flow of heat. It shall have low thermal conductivity, weather resistant, self extinguishing non dripping, non toxic, resistive to fungus/bacteria, vermin proof resilient, and shall not detoriate during handling.

6.1.7 Acoustic Insulation:

i) Material shall be engineered Nitrile Rubber open cell foam.

ii) The Random Incidence Sound Absorption Coefficient (RISAC); tested as per ISO 354, should be minimum as per the chart below:

Freq (Hz)	125	250	500	1000	2000	4000	NRC
10 mm	0.03	0.04	0.14	0.04	0.88	1.00	0.35
15 mm	0.01	0.09	0.29	0.74	1.08	0.83	0.55
20 mm	0.04	0.13	0.4	0.9	1.04	0.90	0.60
25 mm	0.02	0.25	0.86	1.14	0.88	0.99	0.80
30 mm	0.07	0.32	0.99	1.16	0.93	1.08	0.85
50 mm	0.23	0.73	1.29	0.99	1.09	1.11	1.05

iii) The material should be fibre free.

iv) The density of the same shall be within 140-180 Kg/m3

v) It should have Microban®*; antimicrobial product protection,andshould pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180.

vi) The material should have a thermal conductivity not exceeding 0.047 W/m.K @ 20 Deg. C

vii) The material should withstand maximum surface temperature of +850C and minimum surface temperature of -200C

viii) The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & UL 94 (HBF, HF 1 & HF 2) in accordance to UL 94, 1996.

ix) The insulation should pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 (section 12.7).

Thickness of the material shall be 15mm for duct work and 30mm for mechanical rooms.

6.2 Air Handling Units

Each section of the double skin air-handling unit shall be provided with adequate thermal insulation.

6.2.1 Insulation

25mm thick insulation shall be sandwiched between the two sheets of double skin AHU by applying cold sticking compound both to the surface and the insulation. All joints shall be sealed completely to avoid any thermal loss. Alternatively, polyurethane foam can be injected between the panels.

6.3 Condensate/Refrigerant Pipes

Condensate piping and refrigerant piping shall be insulated as applicable in the manner specified above. All valves, fittings, strainer etc. in refrigerant piping shall be insulated to the same thickness as specified for the main run of piping and applied generally in the manner specified above. Valve bonnets, yokes and spindles shall be insulated in such a manner to allow the dismantling of pumps without damaging the insulation.

6.4 Ducting

a) Insulation Material Thickness

Supply and return air duct (when both are exposed to atmosphere).

Supply duct - 20 mm thick.
Return Duct - 15 mm thick.

6.5 Installation

Exposed Ducts: (Insulation laminated with ultra violet).

i) Clean the duct surface to be insulated and apply a thin film of adhesive (Pidilite SR 998/MAS-83) and leave it for drying. Once the adhesive is tacky to touch, place the insulation sheet laminated with UV barrier film in position.

ii) Press the sheets in position and butt the joints well.

iii) Apply 75mm wide self adhesive tape laminated with UV barrier film on both longitudinal and transverse joints.

6.6 Acoustic Lining (Ducts)

The first 5 meters length of duct or upto the first supply grille, starting from each fan outlet, shall be provided with 15 mm thick Open Cell Nitrile Rubber insulation for acoustic purposes.

The inside surface for the ducts shall be covered with adhesive recommended by the manufacturer. Cut Foamed sheets into required sizes apply adhesive on the foam and stick it to the duct surface.

6.7 Acoustic Treatment of Walls and Ceiling of Equipment Room

Two walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with acoustic lining with open cell Nitrile Rubber insulation sheets. The recommended insulation thickness is 30 mm.

6.8 Installation Procedure

The wall surface shall be cleaned and required surface preparation shall be done for applying adhesive. Rubber based contact adhesive recommended by the manufacturer (Pidelite make - SR 998) shall be used. The foam sheets shall be cut to required size and a thin layer of adhesive shall be applied to both the surfaces; wall and acoustic sheet. When it is tack dry, it is should applied / stuck with enough pressure to the walls/ceiling. Minimum 5 fasteners with washer (of G.I Sheet 2.5 inch x 2.5 inch) / square meter, 4 at corners & 1 at centre shall be put immediately after sticking with the help of adhesive. The length of the fastener should be minimum 75 mm.

7.0 TESTS AT SITE

7.1 General

The Supplier / agency must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the Department, in accordance with the provisions of the applicable 'ASHRAE' standards or approved equal and as per site requirements. All tests shall be recorded in the format approved by The Department.

7.2 Piping System

In general pressure tests shall be applied to piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subjected to pressures exceeding their test ratings.

Tests shall be completed and approved before any insulation is applied.

After tests have been completed, the system shall be drained and cleaned of all dust and foreign material. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.

All water piping shall be tested and proven tight under hydrostatic pressure of 10 Kg/sq.cm. unless stated otherwise in the specifications. The prescribed pressure shall be maintained for 24 hours.

7.3 Duct Work

All branches and outlets shall be tested for air quantity, and the total of the air quantities shall be within plus ten percent (+10%) of fan capacity.

Fire dampers, volume dampers and splitter dampers shall be tested for proper operation.

7.4 Balancing and Adjustment

All air handling ventilation equipment, duct work and outlets shall be adjusted and balanced to deliver the specified air quantities indicated, at each inlet and outlet, as required. If these air quantities cannot be delivered without exceeding the speed range of the sheaves or the available horse power, the Department shall be notified before proceeding with the necessary rectification and balancing of air distribution system.

7.5 Electrical Equipment

All electrical equipment shall be cleaned and adjusted on site before application of power.

The following minimum tests shall be carried out by Supplier / agency as per relevant IS/IE rules.

i) Wire and Cable continuity tests.

ii) Insulation resistance tests, phase to phase and phase to earth, and phase to neutral on all circuits and equipment, using a 500 Volt meggar.

iii) The earth resistance between conduit system and earth must not exceed half (0.5) OHM.

iv) The phase rotation tests.

v) Operating tests on all protective relays to prove their correct operation before energising the main equipment including secondary injection test at site.

vi) Operating tests on all starters, circuit breakers, etc.

7.6 Performance Tests

The installation as a whole shall be balanced and tested upon completion, and all relevant information as per 'Test Proforma' Section - 2 including the following shall be submitted to the The Department.

i) Air volume passing through each unit, duct, grilles, etc.

ii) Differential pressure readings across each filter, fan and coil and through each pump chiller and condenser.

iii) Electrical current readings, in ampers of full and average load running, and starting, together with name plate current of each electrical motor.

Daily records should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream 'ON-COIL' of each cooling coil, also suction temperatures and pressures for each refrigerating unit, the current and voltage drawn by each machine.

Any other reading shall be taken which may subsequently be specified by the Department.

7.7 Miscellaneous

The above tests are mentioned herein amplification but not by way of limitation to the provisions specification. Duration of the test shall be continuous 120 working hours. Supplier / agency shall carry out three seasonal tests each of 48 hours duration during defect liability period of the approved dates.

The date of commencement of all tests listed above shall be subject to the approval of the Department and in accordance with the requirements of this specification.

The Supplier / agency shall supply the skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system if the The Department requests such a test for determining specified or guaranteed data, as given in the specifications or on the drawings.

Any damage resulting from the tests shall be repaired and/or damaged material replaced, all to the satisfaction of the Department.

In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed.

The Supplier / agency must inform the The Department when such tests are to be carried ot giving sufficient notice, in order that the nominated representative of the Department can may be present.

Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the The Department.

The Supplier / agency may be required to repeat the test as required, should the ambient conditions at the time not given, in the opinion of the The Department sufficient and suitable indication of the effect and performance of the installation as a whole or of any part, as required.

Payment terms:- The work being urgent and to be competed in short period, 90% of the total cost will be released on supply and erection of whole work and balance 10% will be released on successful load testing, commissioning of system and produsing of Bank gaurentee as per norms.

TEST PROFORMA

S.No.	Item	Unit	Test Result
1	**CONDITIONS**		
1.1.	Ambient Conditions		
	- Date		
	- Day		
	- Time	AM/PM	
	- Temp. D.B.	°.C	
	- Temp. W.B.	°.C	
	- R H	%	
2	**COMPRESSOR**		
2.1	Compressor	Make/Model	
2.2	Capacity specified at full load	Kcal/hour	
2.3	Current at full load	Amp	
3	**CONDENSER**		
3.1	No. of Fans	Nos.	
3.2	Speed	rpm	
4.	**AIR HANDLING UNIT**		
4.1	AHU	Make/Model	
4.2	Air handling capacity	CMH	
4.3	Coil face area	Sq.m.	
4.4	Air Temp. - entering		
	- Dry bulb	°C	

- Wet bulb °C

4.5 Air Temperature leaving
- Dry bulb °C
- Wet bulb °C

6. FANS

6.1	Fan	Make/Model
6.2	Air Qty.	CMH
6.3	Static pressure	WG
6.4	Fan speed	RPM
6.5	Motor rating	KW/Amps
6.6	Fan motor current (actual)	Amps
6.7	Fan motor voltage (actual)	Amps

7. ROOM CONDITIONS AT DESIGNED PARAMETERS

7.1 Date
7.2 Day
7.3 Time AM/PM
7.4 Temperature °C
- Dry bulb
- Wet bulb

(A no. of reading shall be taken and computed)
7.5 Controls Report on test and functioning of all controls

8. NOTES :

8.1 Test Instructions

1. All instruments for testing shall be provided by the Airconditioning Supplier / agency.

2. Thermometers used for measurement of temperature shall have graduations of 0.1°C and shall be got calibrated from NPL or any recognised test house before hand.

3. Thermometers used in the Psychrometers shall have graduations of 0.2°C and shall be calibrated as at (2) above.

TECHNICAL DATA (To be filled in by Supplier / agency)

Sl.No.	Description	Unit
1.0	**VARIABLE REFRIGERANT FLOW UNITS**	
1.1	Actual Capacity at design conditions	HP (TR)
1.2	Weight of Unit	Kg
1.3	Physical Dimensions	mm x mm x mm
1.2	**COMPRESSORS**	
1.2.1	Manufacturer	Name

1.2.2	Model	No.
1.2.3	Compressor type	-
1.2.4	Number of Circuits	No.
1.2.5	Number of fixed compressors	No.
1.2.6	Number of digital compressors	No.
1.2.7	Speed (Maximum)	RPM
1.2.8	Input power at 100% capacity	KW
1.2.9	Refrigerant used	R
1.3	**CONDENSERS**	
1.3.1	Type	
1.3.2	Fans	Nos.
1.3.3	Speed	RPM
1.4	**REFRIGERANT PIPING**	
1.4.1	Name of Manufacturer	Name
1.4.2	Material for pipes	Name
1.4.3	Thickness of pipe	mm
1.4.4	Material of fittings	Name
1.4.5	Material of valves	Name
1.4.6	Make of expansion valve if provided	Name
1.5	**STARTER FOR COMPRESSOR MOTOR**	
1.5.1	Manufacturer	Name
1.5.2	Type of starter	-
2.0	**AIR HANDLING UNITS**	
2.1	Manufacturer	Name
2.2	Type	-
2.3	Operating weight	Kg
2.4	Overall dimensions	mm
2.5	Noise level	db
2.6	Material and thickness of casing	Name/ mm
2.7	Material and thickness of drain pan	Name/mm
2.8	Manufacturer of coil	Name
2.9	Dimension of coil	mm
2.10	No. of rows	No.

2.11	Fins per CM	No.
2.12	Type of fins	Plain/crimped
2.13	Tube material	Name
2.14	Thickness of tube	mm
2.15	Tube dia	mm
2.16	Fin material	Name
2.17	Method of bonding of tubes and fins	-
2.18	Fan section manufacturer	Name
2.19	Type of fan	-
2.20	No. of fans	No.
2.21	Fan speed	RPM
2.22	Fan wheel diameter	mm
2.23	Drive arrangement	
2.24	Fan outlet area	Sqm
2.25	Fan outlet velocity	m/s
2.26	Air quantity	CMH
2.27	Total static pressure	mm WG
2.28	Motor rating	Kw
2.29	Type of air filters	-
2.30	Size of air filter and quantity	mm/No.
2.31	Thickness of air filters	mm
2.32	Air velocity at filter face	m/s
2.33	Pressure drop across filter	mm WG
2.34	Humidification Arrangement & Type	Yes/No
2.35	Electric strip heaters provided & power rating (k w)	Yes/No

3.0 INSULATION

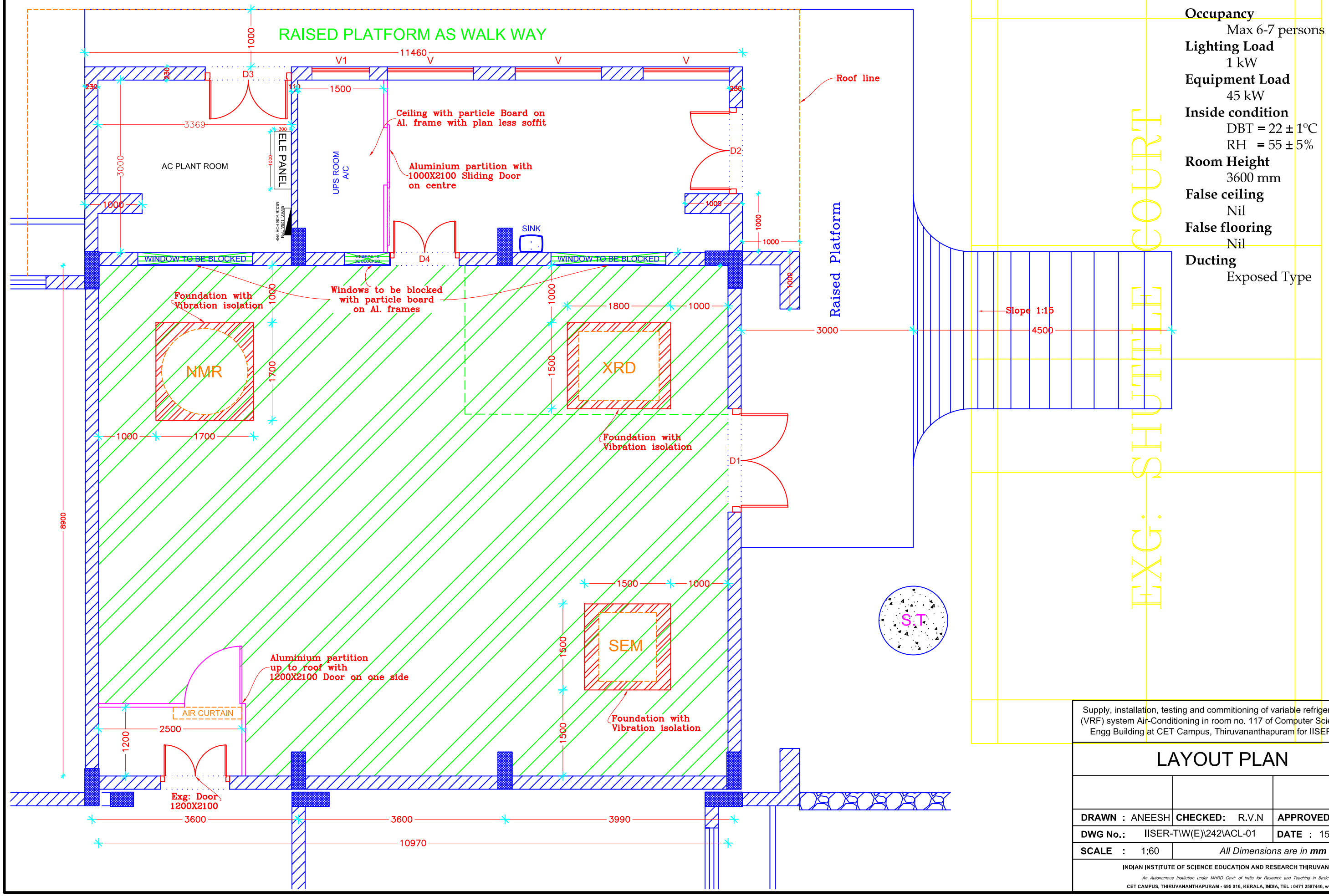
			Duct Work	Acoustic Lining	Pipe Work
3.1	Manufacturer	Name			
3.2	Materials	Name			
3.3	Density	Kg/m^3			
3.4	Mean `K' value				

4.0 THERMOSTATS

			Antifreeze Cooling (for cooler)	Cooling (Unitary Type)
4.1	Manufacturer/Model	Name		
4.2	Type (Snap acting, etc.)	-		
4.3	Electrical Characteristics	V/ / Hz		
4.4	Range	-		
4.5	Differential/throttling range	-		
5.0	**FANS**			
5.1	Manufacturer	Name		
5.2	Type	-		
5.3	Size	mm		
5.4	Air Quantity	CMH		
5.5	Static pressure	mm WG		
5.6	Speed	RPM		
5.7	Motor rating	Watts		
5.8	Speed regulator	Yes/No		
5.9	Gravity Louvers	Yes/No		
5.10	Bird screen	Yes/No		
5.11	Static weight	Kg		
5.12	Dynamic weight	Kg		
5.13	Make/Model of VFD	-		
6.0	**DAMPERS**			
		Make	**Material**	**gauge)**
6.1	Fire Dampers			
6.2	Volume control dampers			
7.0	**GRILLES/DIFFUSERS**			
		Make	**Material**	**gauge)**
7.1	Louvers			
7.2	Grilles			
7.3	Diffusers			

NOTE:

1. **LEAFLET/CATALOGUE OF THE ITEMS QUOTED SHALL ACCOMPANY THE QUOTATION WITHOUT FAIL.**
2. **ALONG WITH THE TECHNICAL DETAILS PROVIDE A TABULAR COLUMN INDICATING WHETHER THE MODEL OF THE EQUIPMENT OFFERED BY YOU MEETS THE SPECIFICATIONS BY INDICATING 'YES' OR 'NO'. IF 'YES' SUPPORT THE CLAIM WITH PROOF.**



Design Parameters

Occupancy
Max 6-7 persons
Lighting Load
1 kW
Equipment Load
45 kW
Inside condition
DBT = 22 ± 1ºC
RH = 55 ± 5%
Room Height
3600 mm
False ceiling
Nil
False flooring
Nil
Ducting
Exposed Type

Supply, installation, testing and commitioning of variable refrigerant flow (VRF) system Air-Conditioning in room no. 117 of Computer Science and Engg Building at CET Campus, Thiruvananthapuram for IISER-TVM

LAYOUT PLAN

DRAWN : ANEESH	**CHECKED:** R.V.N	**APPROVED:** P.A.P
DWG No.: IISER-T\W(E)\242\ACL-01		**DATE** : 15.12.2010
SCALE : 1:60	*All Dimensions are in* ***mm***	

INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH THIRUVANANTHAPURAM
An Autonomous Institution under MHRD Govt. of India for Research and Teaching in Basic Sciences
CET CAMPUS, THIRUVANANTHAPURAM - 695 016, KERALA, INDIA, TEL : 0471 2597446, www.iisertvm.ac.in

IISER – TVM
INSTRUCTIONS TO TENDERERS [INDIGENOUS].

1. Tenders should be sent in sealed envelopes superscribing the relevant tender no. and the due date of opening. Only one tender should be sent in each envelope.
2. Late tender and Delayed Tenders will not be considered under any circumstances.
3. Sales Tax and /or other duties/levies where legally levies and intended to be claimed should be distinctly shown separately in the tender.
4. (a). Your quotation should be valid for a minimum period of 60 days from the date of opening of the Tender. Quotation with firm prices will be preferred.
   (b). Prices are required to be quoted according to the units indicated in the Invitation to Tender. When quotations are given in terms of units other than those specified in the tender form, relationship between the two sets of units must be furnished.
5. (a) Preference will be given to those tenders offering supplies from ready stocks and on the basis of delivery at IISER site.
   (b) Preference will also be given to those who agree our payment terms of within 30 days of receipt and acceptance of the item at our site.
6. (a) All available technical literature, catalogues and other data in support of the specifications and details of the items should be furnished along with the offer.
   (b) Samples, if called for, should be submitted free of all charges by the tenderer and the IISER shall not be responsible for any loss or damage thereof due to any reason whatsoever. In the event of non-acceptance of tender, the tenderer will have to take back the samples at his own expense.
   (c) Approximate net and gross weight of the items offered shall be indicated in your offer. If dimensional details are available the same should also be indicated in your offer.
   (d) **Specifications:** Stores offered should strictly conform to our specifications. Deviations, if any should be clearly indicated by the tenderer in their quotation. The tenderer should also indicate the Make/Type number of the stores offered and provide catalogues, technical literature and samples, wherever necessary along with the quotations. Test Certificates wherever necessary should be forwarded along with supplies. Whenever specifically mentioned by us the tenderer could suggest changes to specifications with appropriate reasons for the same.
7. IISER shall be under no obligation to accept the lowest or any tender and reserves the right of acceptance of the whole or any part of the tender or portion of the quantity offered and the tenderers shall supply the same at the rates quoted.
8. Corrections, if any, in the Quotation must be attested. All amounts shall be indicated both in words as well as in figures. Where there is difference between amounts quoted in words and figures, amount quote d in words shall prevail.
9. The tenderer should mention the name of his bankers, Sales Tax Registration, PAN number etc in the tender.
10. The authority of the person signing the tender, if called for, should be produced.
11. The purchaser reserve the right to accept or reject the lowest or any other offer in whole or in part without assigning any reason.
12. IISER being a Govt of India Educational and Research Institute, is exempted from payment of Excise Duty and Customs Duty under Notification No. 51/96- Customs dated 23rd July 2009. Also, we can issue Form16 as per VAT Rules.
13. There is no EMD or Tender Cost.

CONSULTANT
(PURCHASE & STORES)

IISER-TVM

INSTRUCTION TO TENDERERS [IMPORTS]:

1. **PRICE:** The price quoted shall be firm. The terms of FOB/EXW/FCA/CIF/CIP etc shall be clearly mentioned.
2. **AGENT & AGENCY COMMISSION:** In case Tenderer is represented by any agent in India, their name and address shall be furnished. The amount of commission included in the price shall be clearly shown in the offer; which will be paid directly to the Indian Agents by purchaser in equivalent Indian Rupees. Incase Indian agents existing and their agency commission is not shown in the Tender, reasons for the same shall be clearly mentioned in Tender. Details of Indian agent's statutory registration shall be stated. If Agency Commission is paid by Principals in foreign currency, the reasons for the same and exemption from Enforcement Directorate in India shall also be provided.
3. **LEAFLET/CATALOGUE:** Tenderer should furnish all necessary leaflet/catalogue etc., of the stores offered by him to enable the Purchaser to evaluate his offer correctly.
4. **MODE OF DESPATCH:** Tenderer shall indicate the mode of dispatch (*i.e.,* Sea/Air-freight/Parcel Post, etc.) depending upon the normal mode of dispatch adopted by him for the type of stores offered for consideration of the Purchaser.
5. **COUNTRY OF ORGIN:** Tenderer shall indicate in his offer the country of origin of goods offered and the name and address of the manufacture.
6. **INSURANCE:** If insurance of the goods is felt necessary, the same shall be advised by the Tenderer in the offer.
7. **DELIVERY/SHIPMENT:** The time for and date of delivery quoted shall be reasonable/realistic and shall strictly be adhered to incase of placing order on the Tenderer.
8. **MODE AND TERMS OF PAYMENT:** Payment in full (excluding the amount of Agency Commission included in the price payable directly by the Purchaser to the Indian Agents in Indian Rupees) will be made immediately on presentation of the prescribed documents against SIGHT DRAFT or LETTER OF CREDIT.
9. **WARRANTY:** Period of warranty and conditions shall be clearly mentioned in the Tender.
10. **GENERAL:** The Tenderer shall also be complied with the following:
    a. Mention your Banker's name and address.
    b. Show approximate net and gross weight and dimensions of packages/ cases.
    c. Furnish list of recommended spares for satisfactory operation for a minimum period of one year if the quote is for Plant & Machinery, Equipments etc.
    d. Details of any technical service, if required for erection assembly, commissioning and demonstration.
    e. Conform that the prices quoted are inclusive of all taxes, levies, duties arising in the tenderer's country.
    f. The offer is valid for a minimum period of 90 days from the due date of opening of the tender.
    g. Samples, if called for, will be sent free of all charges.
    h. Late tenders and Delayed will not be considered.
    i. Offers made by Indian Agents on behalf of their Principals, should be supported by the Proforma Invoice of their Principals.
    j. The authority of person signing the tender, if called for, shall be produced.
    k. The purchaser reserves the right to accept or reject the lowest or any other offer in whole or in part without assigning any reason.

CONSULTANT
(PURCHASE & STORES)