

SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF HVAC WORK AT LECTURE HALL BUILDING OF IISER, MOHALI (PB)

GENERAL SPECIFICATION FOR HVAC WORK

- Name of work** **SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF HVAC WORK AT LECTURE HALL BUILDING OF IISER, MOHALI (PB)**
- 1(a) The definition of terms used in these specifications shall be in accordance with IS:3615.
- 1(b) Site Information
- The tenderer should, in his own interest, visit the site and familiarize himself with the site conditions before tendering. For any clarification, tenderer may discuss with the Engineer-in-Charge.
- 1(c) Heat Load Calculations and Equipment Selection
- i) The tenderer should also give the above heat load calculations wherever required separately for the areas served by each Unit in a air conditioning / heating system.
- ii) The equipment selection shall be made on the basis of the above heat load calculations wherever required.
- 1(d) CONFORMITY WITH STATUTORY ACTS, RULES, STANDARDS AND CODES
- i) All components shall conform to relevant Indian Standard Specifications, wherever existing, amended to date. A list of such standards is appended in Appendix 'B'.
- ii) All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 2003 and Indian Electricity Rules, 1956 amended to date.
- 1(e) SAFETY CODES AND LABOUR REGULATIONS
- i) All the safety procedures outlined in the safety codes listed in Appendix-C shall be complied with.
- ii) In respect of all labour employed directly or indirectly on the work for the performance of the air conditioning contractor's part of work, the contractor at his own expense, will arrange for the safety provisions as per the statutory provisions, B.I.S. recommendations, factory act, workman's compensation act, and instructions issued from time to time. Failure to provide such safety requirements would make the tenderer liable for penalty for each violation. In addition the Engineer-in-charge, shall be at liberty to make arrangements and provide facilities as aforesaid and recover the cost from the contractor.
- iii) The contractor shall provide necessary barriers, warning signals and other safety measures while laying pipelines, ducts cables etc. or wherever necessary so as to avoid accident. He shall also indemnify IISER against claims for compensation arising out of negligence in this respect. Contractor shall be liable, in accordance with the Indian Law and Regulations for any accident occurring due to any cause. The department shall not be responsible for any accident occurred or damage incurred or claims arising there from during the execution of work. The contractor shall also provide all insurance including

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third party insurance as may be necessary to cover the risk. No extra payment would be made to the contractor due to the above provisions thereof.

1(f) WORKS TO BE ARRANGED BY THE DEPARTMENT

Unless otherwise specified in the tender documents, the following works shall be arranged by the Department:

- i) Space for accommodating all the equipment and components involved in the work,
- ii) False ceiling and/or return air enclosure excluding return air duct wherever provided as required.
- iii) Power supply, Water supply and Drain points.
- iv) Masonry ducts within and outside the building for carrying pipe lines and cables wherever specified.
- v) Air-tight fire doors with minimum one hour fire rating for Air Handling unit rooms, fan rooms and other equipment rooms.
- vi) Water proofing of floors of packaged unit rooms.
- vii) Providing 15 amps power outlet within 2 meter reach of each single phase equipment at locations called for on air conditioning contractor's shop drawings.
- viii) Providing wiring and earthing for sump pumps with pumps in plant room.
- ix) Making openings in the walls/ floors/ slabs or modification in the existing openings wherever provided for carrying pipe line, ducts, cables etc
- x) Providing sump pumps and necessary piping for drainage of packaged unit room at each level and other machine rooms located below ground level.
- xi) Disposal of condensate drain from fan coil units beyond the condensate drain riser.

1(g) WORKS TO BE DONE BY THE CONTRACTOR

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

- i) Foundations for equipments including foundation bolts and vibration isolation spring/pads,
- ii) Support columns and beams for cooling towers,
- iii) Suspenders, brackets and floor/ wall supports for suspending / supporting ducts and pipes,
- iv) Suspenders and/or cable trays for laying the cables,
- v) Excavation and refilling of trenches in soil wherever the pipes are to be laid directly in ground, including necessary base treatment and supports.

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- vi) Sealing of all floor slab / wall openings provided by the Department or contractor for pipes and cables, from fire safety point of view, after laying of the same.
- vii) Painting of all exposed metal surfaces of equipments and components with appropriate colour as per para 1(q).
- ix) Providing wooden/ metallic frames for fixing grills/ diffusers.
- x) Making good all damages caused to the structure during installation and restoring the same to their original finish.

1(h) POWER SUPPLY, WATER SUPPLY AND DRAINAGE

- i) Unless otherwise specified, 3 phase, 415 volts, 50 Hz power supply shall be provided by the department free of charge to the contractor at one point for installation at site. Termination switchgear however, shall be provided by the contractor. Further extension if required shall be done by the contractor.
- ii)
 - a) The power supply for testing and commissioning of the complete installation shall be made available by the Department free of charge to the contractor. For this purpose, the power supply shall be given at the main incomer unit of the main electrical panel (provided by the contractor) through U.G. cable, or bus trunking arrangement as specified in the contract. The termination of this feeder in the main incomer unit shall be the responsibility of the contractor and nothing extra shall be paid on this account.
 - b) Unless otherwise specified in the contract, further power distribution to the various equipments shall be done by the contractor.
- iii) Where the power supply has to be arranged by the Department at more than one point as per the terms of the contract, the termination of all such power feeders in the incomer of respective control panels (provided by the contractor) shall be the responsibility of the contractor.
- iv) The contractor shall not use the power supply for any other purpose than that for which it is intended for. No major fabrication work shall be done at site. Power shall be used only for welding / cutting works. The power supply shall be disconnected in case of such default and the contractor shall then have to arrange the required power supply at his cost.
- v) Wherever there is a possibility of lower supply voltage, which does not allow motors to be operated, necessary voltage correction devices like HT voltage regulator/ ON- Load tap changer/ Servo Stabilizer etc may be provided to ensure proper voltage.
- c) Power supply shall also be backed by suitable standby DG set. It is necessary to provide stand by supply to fan motors, to ensure air circulation in air conditioning areas when the AC plant is not working due to non availability of normal electrical supply. Additionally where the air conditioning is a functional/ critical requirement such as hospitals, computer centers, labs etc, provision shall be made by the department for operation on standby power supply.

1(i) WATER SUPPLY

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- i) Water supply shall be made available to the contractor by the Department free of charge at only one point for installation. Further extension if required shall be done by the contractor.
- ii) Water shall be made available by the Department free of charge in make up water tank near the cooling tower, AC plant room, AHU room, expansion tank, hot water generator, air washer, etc. as required for testing and commissioning. Further connection from make up water tank to cooling tower shall be carried out by the contractor and shall be separately measured & paid for as per contract.
- iii) Water analysis should be obtained of the water available at site and if required water softening plant may be provided.

1(j) DRAINAGE

- i) Drain traps in A.C. plant room, AHU room, Air washer room, hot water generator and near cooling tower shall be arranged by the department.
- ii) All drainage arrangements from the drain traps in the A.C. plant room, AHU room, air washer room, hot water generator room etc to the drain line shall be arranged by the Department as required.
- iii) Piping Connections from the equipment to the drain trap including providing valves at the drain points shall be done by the contractor. These items of work shall be separately measured and paid as per contract.

1(k) MACHINERY FOR ERECTION

All tools and tackles required for unloading / handling of equipments and materials at site , their assembly, erection, testing and commissioning shall be the responsibility of the contractor.

1(l) COMPLETENESS OF THE TENDER, SUBMISSION OF PROGRAMME, APPROVAL OF DRAWINGS AND COMMENCEMENT OF WORK

i) Completeness of the tender

All sundry equipments, fittings, assemblies, accessories, hardware items, foundation bolts, supports, termination lugs for electrical connections, cable glands, junction boxes and all other items which are useful and necessary for proper assembly and efficient working of the various equipments and components of the work shall be deemed to have been included in the tender, irrespective of the fact whether such items are specifically mentioned in the tender or not.

ii) Submission of program

Within fifteen days from the date of receipt of the letter of acceptance, the successful tenderer shall submit his program for submission of drawings, supply of equipment, installation, testing, commissioning and handing over of the installation to the Engineer-in-Charge. This program shall be framed keeping in view the building progress. Items like ducting, piping etc. that directly affect the building progress shall be given priority.

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iii) Submission of Drawings

The contractor shall submit the drawings to the Engineer-in-Charge as per para 1.18.2 for approval before start of work.

iv) Commencement of Work

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

1(m) DISPATCH OF MATERIALS TO SITE AND THEIR SAFE CUSTODY

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

1(n) CO-ORDINATION WITH OTHER AGENCIES

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

1(o) QUALITY OF MATERIALS AND WORKMANSHIP

- i) The components of the installation shall be of such design so as to satisfactorily function under all conditions of operation.
- ii) The entire work of manufacture/fabrication, assembly and installation shall conform to sound engineering practice. The entire installation shall be such as to cause minimum transmission of noise and vibration to the building structure.
- iii) All equipments and materials to be used in work shall be manufactured in factories of good repute having excellent track record of quality manufacturing, performance and proper after sales service.

1(p) CARE OF THE BUILDING

Care shall be taken by the contractor during execution of the work to avoid damage to the building. He shall be responsible for repairing all such damages and restoring the same to the original finish at his cost. He shall also remove all unwanted and waste materials arising out of the installation from the site of work from time to time.

1(q) COLOUR SCHEME FOR THE EQUIPMENTS AND COMPONENTS

- i) Colour scheme for equipment like chilling unit, pumps, AHUs, cooling tower etc shall be as per manufacturer's standard colour scheme.
- ii) The scheme of colour code painting of pipe work services for air conditioning installation shall be as per National building code and is indicated below:

Description	Ground colour	Lettering colour	First colour band
Condenser water piping	Sea Green	Black	French Blue
Chilled water piping	Sea Green	Black	Black
Central heating piping	Sea Green	Black	Canary Yellow

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Below 60 deg C			
Central heating piping 60 deg C to 100 deg C	Sea Green	Black	Dark Violet
Drain pipe	Black	White	
Vents	White	Black	
Valves and pipe line fittings	White with black handles	Black	
Belt guard	Black & Yellow diagonal strips		
Machine Bases, Inertia Bases and Plinth	Charcoal Grey		

- iii) Colour bands shall be 150mm wide, superimposed on ground colour to distinguish type and condition of fluids. The spacing of band shall not exceed 4.0m.
- iv) In addition to the colour bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow identified as follows:-

High temperature Hot water	:	HTHW
Medium temperature Hot water:	:	MTHW
Low temperature Hot water	:	LTHW
Chilled water	:	CHW
Condenser water	:	CDW
Steam	:	ST
Condensate	:	C

1(r) INSPECTION AND TESTING

- i) Initial inspection of materials & equipments at manufacturer's works as per details will be done by the engineer-in-charge or his representative. For item/equipment requiring initial inspection at manufacturer's works, the contractor will intimate the date of testing of equipments at the manufacturer's works before dispatch. The contractor shall give sufficient advance notice regarding the dates proposed for such tests to the department's representative(s) to facilitate his presence during testing. The Engineer-in-charge at his discretion may witness such testing. Equipments will be inspected at the manufacturer/ authorised dealer's premises, before dispatch to the site by the contractor.
- ii) The department also reserves the right to inspect the fabrication job at factory and the successful tenderer has to make arrangements for the same.
- iii) The materials duly inspected by engineer-in-charge or his authorised representative shall be dispatched to site by the contractor.

1(r1) Final Inspection & Testing

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Final Inspection & testing will be done by the Engineer-in-Charge or his representative as per details indicated in Specifications for HVAC works.

1(r2) Safety measures

All equipments shall incorporate suitable safety provisions to ensure safety of the operating personnel at all times. The initial and final inspection reports shall bring out explicitly the safety provisions incorporated in each equipment.

1(r3) RUNNING IN PERIOD & DATE OF ACCEPTANCE

- i) After the installation work has been completed by the contractor, he will conduct tests and make adjustments as may be necessary to satisfy himself that the plant including low side equipments is capable of continuous running. There after he will offer to the department a running-in period of 7 days subject to a minimum aggregate of 120 hrs at his cost. The duty cycle of the plant during this running in period shall be same as that specified in the tender documents. In case of multiple compressor installations, all the compressors should be run by rotation. The plant will be operated and a log of all parameters will be maintained during this period. The contractor will be free to carry out necessary adjustments etc. during this period without stopping the plant. Record of inside conditions will be made during this period to check the same are as per NIT requirements. The plant will be said to have successfully completed the running-in-period, if no break down or abnormal/ unsatisfactory operation of any machinery occurs during this period. After this the plant will be made available for beneficial use. After the plant has operated without any major break down/ trouble and inside conditions are maintained as per NIT requirements for the above specified running in period, it shall be taken over by the department subject to guarantee clause mentioned below. This date of taking over of plant after trouble free operation during the running in period shall be the date of acceptance.
 - ii) Any loss of refrigerant or oil during the running in period shall be made good by the contractor free of charge.
 - iii) Capacity test of the chilling unit & other major equipments shall be carried out as and when conditions become stabilized as per instructions of engineer in charge.
 - iv) Seasonal testing may be carried out as & when outside conditions become suitable.
- 1(s1) When the major seasonal test cannot be carried out on commissioning of the installation due to any reason not attributable to the contractor, the installation will be handed over to the Department for beneficial use after completion of successful running in test of 7 days subject to a minimum aggregate of 120 hours as per para 1(r3) above. The balance payment shall be released to the contractor on his furnishing a bank guarantee in the specified format from a scheduled bank for an equivalent amount. The bank guarantee shall be valid for a period of 6 months. However it will be extended till the successful completion of the major seasonal test. This bank guarantee shall be independent of the one furnished for performance guarantee.
- 1(s2) The following shall be considered major seasonal test for the purpose of the above payment terms: -
- a) Air-conditioning system : Summer or monsoon
 - b) Central heating system : Winter

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c) ETAC : Summer

1(t) TENDER DRAWINGS, DRAWINGS FOR APPROVAL & COMPLETION DRAWINGS

The drawings appended with the tender documents are intended to show the areas to be conditioned, space allotted for various equipments, tentative duct, cable and pipe routes. The equipments offered shall be suitable for installation in the spaces shown in these drawings.

1(t1) Drawings for approval on award of the work

The contractor shall prepare & submit three sets of following drawings and get them approved from the Engineer-in-charge before the start of the work. The approval of drawings however does not absolve the contractor not to supply the equipments/materials as per agreement, if there is any contradiction between the approved drawings and agreement.

- a) Lay out drawings of the equipments to be installed in various rooms such as plant room, AHU rooms, hot water generator room, cooling tower and other equipments.
- b) Drawings including section, showing the details of erection of entire equipments including their foundations, water basin for the cooling towers / air washers, etc.
- c) Plumbing drawings showing the layout of entire piping, dia & length of pipes, valves and isometric drawings showing connections to various equipment.
- d) Ducting drawings showing sizes, locations of dampers, grilles & diffusers.
- e) Electrical wiring diagrams for all electrical equipments and controls including the sizes and capacities of the various cables and equipments,
- f) Dimensioned drawings of all electrical and control panels,
- g) Drawings showing the details of all insulations and vapour barrier works,
- h) Drawings showing details of supports for pipes, cable trays, ducts etc.
- i) Any other drawings relevant to the work.

1(u) Completion Drawings

Three sets of the following laminated drawings shall be submitted by the contractor while handing over the installation to the Department. Out of this one of the sets shall be laminated on a hard base for display in the A.C. plant room. In addition one set will be given on compact disc.

- a) Plant installation drawings giving complete details of all the equipments, including their foundations,
- b) AHU room installation drawings.
- c) Plumbing layout drawings including insulation giving sizes and lengths of all the pipes and the sizes and locations of all types of valves, and including isometric drawings for the entire piping including the pipe connections to the various equipments and insulation details wherever required.

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- d) Duct layout drawings with their sizes and locations, and sizes and locations of all dampers, grills & diffusers.
- e) Line diagram and layout of all electrical control panels giving switchgear ratings and their disposition, cable feeder sizes and their layout,
- f) Control wiring drawings with all control components and sequence of operations to explain the operation of control circuits,

1(v) AFTER SALES SERVICES

The contractor shall ensure adequate and prompt after sales service in the form of maintenance, spares and personnel as and when required and shall minimise the breakdown period. In case of equipment supplied by other manufacturers the firm shall furnish a guarantee from the manufacturer for the same before the plant is taken over.

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1(w) DOCUMENTS TO BE FURNISHED ON COMPLETION OF INSTALLATION

Three sets of the following documents shall be furnished to the department by the contractor on completion of work:-

- a) Completion drawings as per Specifications for HVAC Works.
- b) 3 sets of manufacturer's technical catalogues of all equipments and accessories.
- c) Operation and maintenance manual of all major equipments, detailing all adjustments, operation and maintenance procedure.

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BASIS OF DESIGN AND SCHEME

1 AMBIENT CONDITIONS

Outdoor Design Conditions

The following design conditions have been considered.

Season		DBT (°C)	WBT (°C)
Summer	:	43.3 (110 °F)	23.8 (75 °F)
Monsoon	:	35 (95 °F)	28.3 (83 °F)
Winter	:	7.2 (45 °F)	5 (41 °F)

Indoor Design Conditions:

Summer / Monsoon DB : 24 ± 1 Deg C (75 ± 2 Deg F)

RH : Less than 60%

Winter provision for winter heating in few areas.

- 2 Design Data: Following design parameters are being considered for calculating the heat loads.

Occupancy		As per table 1 attached
Lighting		1.5 Watts / Sqft (Fluorescent)
Outdoor Fresh Air addition rate		1 ACPH
Equipment load		100 WATTS PER Computer
Area		As per table 1 attached

3. SYSTEM DESCRIPTION

The proposed air conditioning system shall consist of Aircooled Packaged / ductable units . These units shall suitable capacity indoor units The outdoor units shall be connected with Indoor units thru heavy grade Refrigerant piping adequately sized. All motors for air-conditioning system shall be energy efficient type, suitable for $415 \pm 10\%$ / $220 \pm 6\%$ volts incoming power supply.

Condensing units shall be placed on epoxy coated MS frames and provided with anti-vibratory supports. All foundations shall be protected from mechanical damage by providing epoxy coated angle nosing.

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All ducts shall be factory fabricated out of galvanized sheet steel (GSS) for long life and as per fire norms. The conditioned air shall be distributed thru air registers and diffusers as shown in the drawings. All ducts shall be insulated with closed cell nitrile rubber. AC units shall also be tripped in case of emergency thru fire panel.

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TABLE 1

SUMMARY OF HEAT LOAD					
		Area	Tonnage	CFM	Fresh air
		SqFt	TR	CFM	CFM
	Ground floor				
	Lecture Hall 1	1,495	11.15	4767	384
	Lecture Hall 2	1,495	11.15	4250	384
	Lecture Hall 3	1,495	11.15	4250	384
	Lecture Hall 4	1,495	10.99	4185	384
	Auditorium	5,380	46.97	17097	4353
	stage	2,195	11.04	4361	804
	First Floor				
	Lecture Hall 5	3,843	27.53	10404	1030
	Lecture Hall 6	3,843	27.42	10360	1030
	Total	21,243	157.41		

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DESIGN PARAMETERS

Given below are some design parameters which should be followed in addition to those given in various sections of technical specifications enclosed

DUCTABLES

- a) Maximum Face Velocity across cooling coil MPM : 152.43
- b) Maximum Face Velocity across Pre filters MPM : 152.43
- c) Maximum water pressure drop across coil in Mt : 4.6
- d) Maximum water velocity through coil in MPS : 2.5
- e) Fan outlet velocity (maximum) MPS : 9.5
- f) Maximum fan speed (forward curved) : 1000 RPM
- g) Maximum fan motor speed : 1450 RPM

DUCTING WORK

- a) Method of Duct Design : Equal friction method/ constant friction method
- b) Maximum Air Velocity in supply air duct : 450.00
- c) Maximum Air Velocity in return air duct : 305.00
- d) Friction loss in duct (max) MM wg in 100 Mt run : 10
- e) Maximum Velocity at supply air grill outlet MPM : 150.00

INSULATION

Maximum temperature rise in the supply air duct from Air Handlers outlet to farthest outlet
1.1Deg C

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APPLICABLE STANDARDS AND CODES

TERMS AND DEFINATIONS

The following terms have been used in the tender specifications and drawings etc.

ISI	Bureau of Indian standards
ASHRAE Engineers	American society of Heating Refrigeration and Air-Conditioning
ASME	American Society of Mechanical Engineers
BS	British Standard
CMH	Cubic Meter per hour
USGPM	US gallons per Minute
RPM	Rotations per minute
BTU/Hr.	British Thermal unit per hour
Kcal/ Hr	Kilo calories per hour
SAG	Supply air Grill
RAG	Return Air Grill
FD	Fire damper
FAD	Fresh air damper
DP	Drain Point
SAD	Supply air diffuser
RAD	Return air Diffuser.

LIST OF BUREAU OF INDIAN STANDARDS CODES

Following relevant IS codes shall apply read in concurrence with there latest amendments.

IS:226-1975	Specification for structural steel
IS:277-1992	Specification for galvanised sheet (plain and corrugated)
IS:325-1978	Specification for three phase induction motors
IS:655-1963	Specification for metal duct
IS 659-1964 (1991)	Safety code for air-conditioning (resived)
IS:660-1963 (1991)	Safety code for mechanical refrigeration
IS:800-1984	Code of practice for general construction in steel
IS:808-1964	Specification for rolled steel beam channel and angle section
IS:816-1969	Code of practice for metal arc welding for general purpose in mild steel
IS:823-1964	Code of procedure for manual metal arc welding of mild steel
IS:1554-(Part 1) –1976	Specs for PVC insulated (heavy duty electrical cables)
IS:2253-1974	Designation for types of construction and mounting arrangement of rotating electric machine.
IS:2312-1967	Specs for propeller type AC ventilating fans
IS:2379 - 1963	Colour code for the identification of pipelines
IS : 3103-1975	Code of practice for Industrial Ventilation
IS 4064 - (Part -II) 1978	Specific requirements for the direct switching of individual motors.
IS: 4736 - 1968	Hot-dip zinc coatings on steel tubes
IS: 4894-1987	Test Code for Centrifugal Fan.
IS : 7240-1981	Application & Finishing of thermal insulation material

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- IS:8544 (Part-I to IV)1979 Starters
- IS:9224 (Part II) - 1979HRC cartridge fuse links upto 650 volts.
- IS:3069-1965 Glossary of terms, symbols and unit relating to thermal insulation material
- IS:3346-1980 Method for the determination of thermal conductivity thermal I insulation material (two slab, guarded hot plate method)
- IS:3588-1966 Specification for electric axial flow fans
- IS:3724-1966 Specs for cartridge type heating elements (non embedded type)
- IS:4158-1967 Specs for solid embedded type electric heating elements
- IS:4691-1984 Degree of protection provided by enclosure for rotating electrical machine
- IS:4722-1968 Specs for rotating electrical machine
- IS:4729-1968 Measurement and evaluation of vibration of rotating electrical machine.
- IS:4831-1968: Recommendation on units and symbols for Refrigeration
- IS:4894-1987 Specs for centrifugal fans
- IS:5111 -1993 Testing of Refrigerating compressors.
- IS:6272-1971: Specs of industrial cooling fans
- IS:7616-1975 Method of testing panel type air filters for air conditioning and ventilation purposes
- IS:8623 1977 Specs of factory built switch / control section.
- IS:8623(Part3) 1993: Specs for low voltage switchgear and control gear assemblies
- IS: 8789- 1978 Values of performance characteristics for three phase induction motor
- IS-13947 (Part-1)1993Specs for low voltage switchgear and control gear.

In case of any revision in above BIS code the REVISED one shall only be applicable.

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GENERAL MECHANICAL REQUIREMENTS

1 This chapter deals with the general mechanical requirements specifically applicable to HVAC. The additional requirement given in any chapter is in addition to the bare minimum stated in this chapter and shall be complied with.

2 SUBMITTALS

Under provisions of the NIT sample approval for all major items like grills, diffusers, valves, insulation, sheet etc is necessary before the commencement of the project. The products mentioned in the Approved list of manufacturers shall only be acceptable. In case of any alternate make is required to be used the same will have to be approved by the customer/engineer in charge with proper quality and rate justification as per the mode of approval mentioned in the list. Shop drawings and product data grouped to include complete submittals of related Systems, products, and accessories in a single submittal. Shop Drawings shall be based on the actual duct routes after the site survey, details of concrete pads and foundations for the various equipments, Layout of the AHU including dimensions of the room / boxing with inspection window dimensions, the foundations and the sizes and all necessary construction details required on site, location of the allied equipments and the requirements from other agencies, trench locations if any, Sump location and size, sleeve location if any, fresh air / exhaust air locations, location of wall mounted equipment (If any) and any structural inputs.

3 BROCHURES

Submit manufacturer's product data and brochure including complete description of the item with illustrations, rating charts, accessories, dimensional data, capacities stated in the terms specified in the NIT and Performance curves, wherever applicable like fans and pumps.

4 REGULATORY REQUIREMENTS

Liaison / Approvals from the bodies mentioned below (or any other), if required shall be taken by the contractor on behalf of the client and at his own cost. BIS / Local Fire Authority / LOCAL CODES .

5 PROJECT / SITE CONDITIONS

- Mechanical layouts indicated on drawings are diagrammatical. Co-ordination (final) shall be required with other trades prior to installation. Install all works as shown on the drawings, unless prevented by project conditions.
- Prepare drawings showing proposed rearrangement of work to meet the project conditions. Obtain permission from of engineer in charge before proceeding.
- Place anchors, sleeves and supports prior to pouring concrete on installation of masonry works.

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- Keep roads and site clear of debris and scrap.

6 GENERAL INSTALLATION FEATURES

- Piping / ducting installation requirements are specified in other section. The Drawings indicate the general arrangement of piping, valves, fittings, ducts and specialties. The following are specific connection requirements:
 - Arrange piping installations adjacent to units to allow unit servicing and maintenance.
 - Connect piping to all equipment with flanges enabling easy removal of the coil.
 - Connect condensate drain pans using drain pipe and extend to nearest floor drain. Construct deep trap connection to drain pan and install cleanouts at changes in direction.
- Make final duct connections with flexible connections.
 - Connect unit components to ground in accordance with the National Electrical Code

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AIR COOLED PACKAGE AIRCONDITIONERS SYSTEM

1. SCOPE

The scope of this section comprises of the supply, erection, testing and commissioning of Air cooled Package machines conforming to specifications given hereunder and in accordance with the requirements of drawings and schedule of quantities.

2 TYPE

The Package Units shall be complete with multiple SCROLL compressors, blower & motor assembly, condensers, cooling coils, interconnecting refrigerant piping, control panel, controls and internal wiring and shall be enclosed in an attractive cabinet.

3 CAPACITY

Actual refrigeration capacity of Package Units shall be as given in schedule of quantities.

4 COMPRESSOR

The compressor shall be for heavy duty specifically designed for high head pressures. Compressors shall be of SCROLL, Hermetically sealed with gas cooled motor. The motor and compressors shall be enclosed in a single Hermetic casing. The compressor shall be suitable for R-22 refrigerant and shall be mounted in the indoor units.

5 CONDENSORS

Condensor shall be of air cooled, fitted with integral finned copper tubes of 12 mm O.D. Condensor shall be manufactured to ASME code for unfired pressure vessels. Working pressure for refrigerant side shall be for refrigerant used. Condensers shall be complete with the following accessories:

- Hot gas inlet connection, liquid outlet connection, relief valve, purge valve, fusible plug, air vents etc. Shall be salt sprayed.
- Any other standard accessories necessary for equipment supplied.

6 COOLING COIL

The cooling coil shall have copper tubes of not less than 1/2 " O.D continuous Aluminium plate fins. The tubes shall be staggered in the direction of the Airflow. Suitable cleanable air filters shall be provided before the coil.

7. FAN SECTION

The fan Section shall consist of Forward curved fans, complete with scrolls, shaft and self-aligning bearings, fan motor mounted on flexible supports and adjustable speed drive. The units shall be complete with Cooling Thermostat, reset relay, Hi-Lo pressure cutout, Expansion valve and other necessary controls / safety devices. The various components shall be interconnected by copper refrigerant pipes, fittings and

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valves. The suction line shall be suitably insulated. The unit shall be complete with required charge of refrigerant gas and Lubricating oil. The Units should be complete with factory manufactured control panel housing the starters, safety control relays etc. the various electrical components shall be neatly prewired at the factory requiring only main power supply from external source. All components listed above shall be enclosed in Factory built Sheet Metal cabinet. The cabinet shall be divided in Compressor section, Cooling coil section and Fan section. The whole cabinet shall be insulated with 25 mm insulation. It shall have suitable openings for Fan outlets, return air grille etc.

8 TESTING

Equipment capacity in Tons of refrigeration shall be computed from the temperature readings. The computed results should tally with the specified capacities. All instruments, services needed for the tests required shall be furnished by the contractor.

9 PAINTING

All the equipment including mounting frame shall be painted with two coats of approved enamel paint.

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AIR COOLED SPLIT AIRCONDITIONER UNITS:

1 SCOPE

The section comprises the supply, installation, commissioning and testing of Air Cooled Ductable Air Conditioners conforming to the specifications and Bill of Quantities and equipment schedule.

2 CASING

The casing for outdoor unit of air conditioner shall be of heavy gauge mild steel sheet sufficient to withstand load of equipment installed therein and designed to provide convenient access to the machinery for routine maintenance and checking. The housing shall be epoxy painted. The fan coil and drain section of indoor unit shall be insulated with expanded polystyrene / polyethylene sheet.

3 COMPRESSOR

The compressor shall be preferably serviceable hermetic/ semi sealed **scroll** type suitable for 415-440V, 3 phase, 50 HZ electric supply. It shall be mounted on spring / ribbed type vibrations isolators to avoid transmission of vibration to the body of the unit. It shall be provided with necessary safety devices. All units except for 5 TR or below capacity shall have **minimum 2** compressors for capacity optimization.

4 AIR COOLED CONDENSER UNIT

The outdoor unit shall be factory assembled, weather proof casing, constructed from heavy gauge mild steel panels and coated with baked enamel finish. The unit should be completely factory wired tested with all necessary controls. The outdoor unit shall have minimum 2 scroll compressors and be able to operate even in case of breakdown of one of compressors. The Condenser coil shall be of copper tube and extended aluminium fins. Tubes shall be arranged in a staggered design for better efficiency. The condenser coil shall have weather protection coating to enhance the life of the coil. Adequately sized direct driven fans to operate quietly and to provide enough air quantity to keep condensing temperature low should be provided.

5 INDOOR UNIT

Indoor units shall be ceiling mounted ductable type. Each unit shall have preferably electronic expansion valve or normal thermostatic expansion valve.

The blower shall be forward curved dual suction multi blade type fabricated with aluminium / mild steel sheet of heavy gauge sufficient to deliver design quantity and static pressure. The blower shall be statically and dynamically balanced to ensure low noise and vibration free operation. The fan shall be direct driven type / belt driven as per the OEM design. The blower shall be driven by TEFC type motor.

The cooling coil shall be made out of seamless copper tubes and have continuous aluminum fins. The fins shall be spaced by collars forming an integral part. The tubes shall be staggered in the direction of airflow. The tubes shall be hydraulically/

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mechanically expanded for minimum thermal contact resistance with fins. Each coil shall be factory tested. There shall be minimum 4-5 fins/cm (11-13 FPI). The coil will be minimum 3/4 rows deep complete with refrigerant distributor, section headed and other accessories. The velocity across the coil should not exceed beyond 152 mpm (500 FPM).

The filter shall be easily serviceable. The air filters shall be 3 ply HDPE washable type fitted within aluminium frame. The efficiency of filters shall be 90% down to particle size of 15-20 microns.

7 CONTROL BOX

Electrical control box shall contain capacitor / contactors for fan, compressor, and blower motor with non-recycling control relay and high & low-pressure cutouts. A separate control box containing selector switch for convenient operation directly from within a room may be provided.

The electrical wiring between the evaporator / condensing units and control boxes to be carried out by the vendor.

8 REFRIGERANT:

The air cooled ductable units shall be suitable for R 407 or any other environmental friendly refrigerant. Units working on R 22 shall not be accepted.

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SPECIFICATIONS FOR PIPING

1 SCOPE

All piping work shall conform to quality standards and shall be carried out as per specifications and details given hereunder.

2. **Piping :**

2.1 **Drain Piping: PPRC Pipes**

2.1.1 The drain piping shall be PN16 grade PPRC and laid in continuous slope.

2.1.2 The fittings shall be of PN25 grade of equal forged connections.

2.1.3 Pipe crosses shall be provided at bends, to permit easy cleaning of drain line.

2.1.4 The drain line shall be provided upto the nearest drain trap and pitched towards the trap.

2.1.5 Drain lines shall be provided at all the lowest points in the system, as well as at equipment, where leakage of water is likely to occur, or to remove condensate and water from pump glands.

2.3 **Copper Piping :**

2.3.1 Seamless soft copper tubing, type L shall be used to make connections to equipment, wherever required or specified.

2.3.2 Flare fittings e.g. flare nuts, tees, elbows, reducers etc. shall all be of brass.

2.4 **Refrigerant Piping :**

Refrigerant piping shall be Copper tube for sizes upto and including 15 mm dia. For over 15 mm dia piping shall be with heavy class seamless steel pipe conforming to IS 1239 schedule 40. Fittings like bends, tees, shall be of copper or brass for copper piping. For bigger sizes bends, tees etc shall be steel butt-welded type and shall be suitable for working pressure as of refrigerant piping. Welded joints shall be used for steel pipes and brazed joints for copper pipes. For small lines such as gauge connections, equalizer lines of expansion valve etc flared fittings shall be used. The refrigerant piping arrangements shall be in accordance with good practice within the air conditioning industry, and are to include charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits. Piping shall be installed with adequate number of bends / loops to ensure flexibility for minimising vibrations. Necessary isolating materials like rubber and felt should be provided so as to reduce vibration.

While installing the piping adequate clearance between pipes should be provided for insulation wherever specified. Piping shall be pitched to 4mm for every metre in the

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direction of refrigerant flow. Necessary loops and bends shall be incorporated in the piping to ensure proper oil drainage to the compressor even under partial load conditions. Brazing of copper tubing shall be done with silver solder. Flanged joints wherever used shall be provided with gaskets suitable for use with halogenated hydrocarbon refrigerants.

All joints in copper piping shall be sweat joints using low temperature brazing and or silver solder. Before jointing any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using nitrogen. System shall hold the pressure for a period of 24 Hours without revealing any leaks . The system shall then be de-hydrated by drawing vacuum which shall be maintained for 24 Hrs.

After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using nitrogen at pressure of 20Kg per sq.cm and 10 Kg per sq.cm (lowside). The air-conditioning system supplier shall be design sizes and erect proper interconnections of the complete refrigerant circuit.

The thickness of copper piping shall not be less than mentioned below:

<u>Pipe Size in mm(OD)</u>	<u>Wall Thickness in mm</u>
54.1	1.5
41.3 – 34.9	1.3
28.6 – 25.4	1.2
22.2 – 15.9	1.0
12.7 - 6.4	0.8

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

3. Pipe Insulation :

a. Refrigerant Pipe Insulation

The whole of the liquid and suction refrigerant lines including all fittings, valves and strainer bodies, etc. shall be insulated with 19mm /13 mm thick elastomeric nitrile rubber Class I as specified in BOQ.

b. Drain Pipe Insulation

Drain pipes carrying condensate water shall be insulated with 6 mm thick elastomeric nitrile rubber insulation.

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For proper drainage of condensate, U Trap shall be provided in the drain piping (wherever required). All pipe supports shall be of pre fabricated & pre painted slotted angle supports, properly installed with clamps etc.

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SPECIFICATIONS FOR AUTOMATIC CONTROLS AND INSTRUMENTS

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of automatic controls and instruments conforming to these specifications and in accordance with requirement of drawings and 'Schedule of Quantities'

2. PRODUCTS

- 2.1 **Thermostats** shall be electrical mode, fixed differential type with sensing element located in the return air stream.

3. INSTRUMENTS

- 3.1 **Thermometer:** Thermometers shall be dial type 100 mm dia or V form industrial type. Body shall be aluminum alloy, anodized gold colored surface. The casing shall be adjustable sideways for reading from the front. The glass capillary shall be triangular in shape with blue mercury filled in glass for better visibility. Scale of reading shall be of the range 0 deg C TO 60 deg C & +32 deg F to 150 deg F. Graduation of scale shall be 1 deg in both readings. Ranges of scales shall be 30-90 degrees F (0-50 deg C) for all conditioning applications of cooling only.

Thermometer shall be suitable for 15mm connection. Thermometer for chilled water shall be with long stem so that thermometer is removable without damaging the insulation ms socket to be welded on pipes shall be provided with thermometer. Thermometer shall be installed of chilled water supply and return at each air handling unit, supply and return of each chiller, condenser.

- 3.2 **Pressure gauge:** shall be installed on suction header and at discharge side of each pump in the chilled water supply and return at each air handling unit, at inlet and outlet of each chiller. Suction side gauge at pump suction header shall be compound gauge with 150 MM dia, range 75 cm vacuum to 10 kg pressure. Discharge side gauge at pumps and at all other locations shall be 150mm range 0-10 kg per sq cm (0-150 PSI) Pressure

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SPECIFICATIONS FOR SHEET METAL WORKS

1. SCOPE

The scope of this section includes supply, fabrication, installation & testing of all sheet metal ducts as per specifications & drawings. Except as otherwise specified all ductwork and related items shall be in accordance with these specifications. Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners, hangers & all accessories.

2. DUCT MATERIALS

2.1 The ducts shall be fabricated from galvanized steel sheets class VIII - Light coating of Zinc conforming to ISS: 277-1962 (REVISED) with accompanying Mill test Certificates. Galvanizing shall be of 120gms/sq.m. (total coating on both sides). In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

Only new, fresh, clean (unsoiled) and bright GI / Aluminum sheets shall be used. The Owner / Consultants reserve the right to summarily reject the sheets not meeting these requirements. Fabrication of ducts shall be through Lock forming machines.

In case of factory fabricated duct the G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross-section dimensions

3 SPECIFICATIONS FOR SITE FABRICATED DUCING

All duct work, sheet metal fabrication unless otherwise directed, shall strictly meet requirements, as described in IS: 655-1963 with Amendment-I (1971 Edition)

Longer size of Duct	Sheet Thickness GI (MM)	Type of Joints	Bracing
Up to 750	0.63	GI Flange	-
751-1000	0.80	25x25x3 mm angle iron frame with 8 mm Dia nuts & bolts	25X25X3 MM @ 1M
1001-1500	0.80	40x40x5 mm angle iron frame with 8 mm Dia nuts & bolts	40x40x5 MM @1M
1501-2250	1.00	50x50x5 mm angle iron frame with 10 mm Dia nuts & bolts at 125 mm center	40x40x3mm@ 1.2m to be braced diagonally.
2251 & above	1.25	50x50x6 mm angle iron frame with 10 mm Dia nuts	40x40x3mm @ 1.6m diagonally braced

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		& bolts at 125 mm center	
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Ducts larger than 450 mm shall be cross broken, duct sections up to 1200 mm length may be used with bracing angles omitted.

Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 Deg. Angle from the axis of the main duct unless otherwise approved by the Engineer-in-Charge.

All ducts shall be supported from the ceiling/slab by means of M.S. rods of 10 MM Dia with M.S. angle at the bottom of size 40 mm x 40 mm x 6 mm for sizes up to 1500 mm at 3 m intervals. Above size 1500 mm upto 2250, support shall be provided with 10 mm dia. MS rod and MS angle size 50 mm x 50 mm at bottom at 2.5 m intervals. Above size 2250 mm support shall be provided with 12 mm dia MS rod and MS angle size 50 mm x 50 mm at bottom

3. INSTALLATION

All ducts shall be fabricated and installed in workman like manner, generally conforming to relevant BIS codes. Round exposed ducts shall be die formed for achieving perfect circle configuration

Ducts so identified on the drawing shall be acoustically lined and thermally insulated as described in the section 'Insulation' and as indicated in 'Schedule of Quantities'. Duct dimensions shown in drawings are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in 'Schedule of Quantities'.

Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made airtight.

All exposed ducts upto 60 cm width within conditioned spaces shall have slip joints. The

internal ends of the slip joints shall be in the direction of airflow. Ducts and accessories within ceiling spaces visible from air-conditioned areas shall be provided with two coats of matt black finish paint.

Change in dimensions and shape of ducts shall be gradual. Air turns shall be installed in all vanes arranged to permit the air to make the turn without appreciable turbulence.

Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees of ample size to keep the ducts true to shape and to prevent buckling, vibration or breaking.

All sheets metal connections, partitions and plenums required to confine the flow of air to/ through the filters and fans shall be constructed of 18 Gauge GSS thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary

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inspection doors as required to give access to all parts of the apparatus. Doors shall be not less than 45cm X 45cm in size.

Plenums shall be panel type and assembled at site. Fixing of MS angle iron flanges of duct pieces shall be with rivet heads inside i.e. Towards G.S. sheet and riveting shall be done from outside.

Rubber gasket 3 mm thick shall be used between duct flanges and between duct and duct supports instead of felt in all ducting installation for complete sealing.

During the construction, the Contractor shall temporarily close duct openings with sheet metal covers to prevent debris-entering ducts and to maintain opening straight and square, as per direction of Engineer-in-Charge.

Great care should be taken to ensure that the ductwork does not extend outside and beyond height limits as noted on the drawings.

All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be tight and shall be made in the direction of airflow.

The ducts shall be reinforced where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication procedures as given in I.S. specifications shall be adhered to and shall be considered as an integral part of these specifications.

The ductwork shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted duct design and subject to the approval of the engineer-in-charge. The Contractor shall verify all measurements at building and shall notify the Engineer-in-Charge of any difficulty in carrying out his work before fabrication.

Sponge rubber or approved equal gaskets shall be installed between all connections of sheet metal ducts to walls. Sheet metal connections shall be made to walls and floors by means of galvanized steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. Sheet metal connections shall be as shown in the drawings or as directed by Engineer-in-Charge.

All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angel/channel under ducts. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods and angles / channels shall be hung through these cleats. Wherever use of metal insert

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plates is not feasible, duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats.

Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick TF quality thermo Cole around the duct prior to sealing of the opening.

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. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 100 mm long but not more than 200 mm, securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

Flanges and supports are to be black, mild steel and are to be primer coated on all surfaces before erection and painted with aluminum thereafter. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

The ductwork should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling Contractors.

4. SPECIFICATIONS FOR FACTORY FABRICATED DUCTING

Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards-Metal and Flexible-Second Edition-1995" SMACNA)

4.1 Duct Connectors and Accessories

All transverse duct connectors (flanges / cleats) and accessories/related hardware are such as support system shall be zinc-coated (galvanized).

4.2 FABRICATION STANDARDS

- 4.2.1 All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces must be factory-fabricated. Equivalency will require fabrication by utilizing the following machines and processes to provide the requisite quality of ducts and speed of supply. Coil lines to ensure location of longitudinal seams at comes / folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct. All ducts, transformation pieces and fittings to be made on CNC profile cutlers for required accuracy of dimensions, location and dimensions of notches at the folding lines. All edges to be machine treated using lock formers, flanges and roller for fuming up edges. Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified will be used.

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5. SELECTION OF G.I. GAUGE AND TRANSVERSE CONNECTORS

Duct Construction shall be in compliance with 2” (500Pa) w.g. static norms as per SMACNA. All transverse connectors shall be similar to Rolamate 4-bolt slip-on flange system or equivalent of similar 4-bolt systems with built-in sealant if any to avoid any leakage additional sealant to be used. The specific class of transverse connector and duct gauge for a given duct dimensions will be 1”(250 Pa) pressure class. Non-toxic, AC -applications grade P.E. or PVC Casketing is required between all mating flanged joints. Gasket sizes should conform to flange manufacturer’s specification.

6. DUCT CONSTRUCTION

- 6.1. The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.
- 6.2. Dimensional Tolerances: All fabricated dimensions will be within ± 1.0 mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be ± 1.0 mm per meter.
- 6.3. 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.
- 6.4. Ducts shall be straight and smooth on the inside Longitudinal seams shall be airtight and at comers only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness.
- 6.5. 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 tum without appreciable turbulence.
- 6.6. Plenums shall be shop/factory fabricated panel type and assembled at site.
- 6.7. FACTORY FABRICATED RECTANGULAR GSS DUCTING.**

All ducts shall be fabricated from galvanized steel / aluminum of the following thickness, as indicated as below:

Rectangular Ducts G. S.	External Pressure 500 Pa		
	Duct Section Length 1.2 m (4 ft)		
Maximum Duct Size	Gauge	Joint Type	Bracing Spacing
1–600 mm	24	C & SS	Nil

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601-750 mm	24	4 Bolt Transverse Duct Connector-E (TDC) with built in sealant	Nil
751-1000 mm	22	4 Bolt TDC-E	Nil
1001-1200 mm	22	4 Bolt TDC-H	Nil
1201-1300 mm	20	4 Bolt TDC-J	Nil
1301-1500 mm	18	4 Bolt TDC-J	Nil
1501-1800 mm	18	4 Bolt TDC-J	Nil
1801-2100 mm	18	4 Bolt TDC-J	Nil
2101-2250 mm	18	4 Bolt TDC-J	Nil
2251-2400 mm	18	4 Bolt TDC-J	Nil
2401-2700 mm	18	4 Bolt TDC-J	600

'C'-cleat; 'S'-S cleat; 'SS'-Standing S cleat; 'AI' -Angle Iron in mm

*Distance of reinforcement/bracing from each joint. Bracing material to be same as of material used for joining of duct sections.

NOTE:

- a) DUCT USING LOCK FORMER MACHINE AT SITE SHALL NOT BE ACCEPTED.
- b) MS FLANGES SHALL BE USED FOR DUCTS FOR THE AHU HAVING HEPA FILTERS.

6.7.1 Fabrication Standard: All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the machines to provide the requisite quality of ducts. Coil lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct. All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines. All edges to be machine treated.

6.7.2 Duct Construction: All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes. Ducts so identified on the Drawings shall be insulated from outside as described in the section "Insulation" and as indicated in schedule of Quantities. Duct dimensions shown on drawings, are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of quantities. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps. Ducts shall be straight and smooth on the inside with longitudinal

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seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness. All ducts up to 75cms width within conditioned spaces shall have slip and drive (C & S/SS) joints. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that S/SS Cleats are mounted on the longer side of the duct and Cleats on the shorter side. Ducts and accessories within ceiling spaces, visible from air-conditioned areas shall be provided with two coats of mat black finish paint. Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence. Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing. All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size. Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside. Self adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

7. INSTALLATION

- 7.1 During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer-In-Charge.
- 7.2 Great care shall be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.
- 7.3 All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.
- 7.4 The ducts shall be re-in forced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.
- 7.5 All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.

The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge. The contractor shall verify all measurements at site and shall notify the Engineer-In-Charge of any difficulty in carrying out his work before fabrication.

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- 7.6 Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.
- 7.7 Flanges bracings and supports are to be sourced from the duct manufacturer. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.
- 7.8 Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.
- 7.9 Joints requiring bolting or riveting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.
- 7.10 Fire retarding flexible joints is to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-In-Charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.
- 7.11 The flexible joints are to be not less than 75 MM and not more than 250 MM between faces. The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.
- Duct passing through brick or masonry, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.
- 7.12 The work shall meet with the approval of Consultant/customer in charge in all its parts and details All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and conduits, the ducts shall be transformed, divided or curved to one side (the required cross sectional area being maintained) all as per the site requirement. If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available in accordance with other services and as per approval of consultant/customer in charge.
- 7.13 All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle / channel or a pair of brackets, connected by galvanized steel rod under ducts. The spacing between supports should be not greater than 2.0 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze

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hanger formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners. Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Consultant / customer in charge. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractor's work in the building. 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. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation. Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

8. DOCUMENTATION TO MEASUREMENTS

For each drawing, all supply of ductwork must be accompanied by computer-generated detailed bill of material indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable.

Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.

All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.

9. TESTING

After duct installation, a part of 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). 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. All angle iron flanges are to be welded electrically and holes to be drilled. All the angle iron flanges are to be connected to the GSS ducts by rivets at 100 mm centers.

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 final balance of air quantity through each outlet shall be submitted to the engineer-in-charge for approval. Measured air quantities at fan discharge and at various outlets shall be identical to or less than 5% in excess of those

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specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time.

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SPECIFICATIONS FOR AIR TERMINALS

1 SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of air terminals and dampers conforming to these specifications and in accordance with the requirement of drawings and 'Schedule of Quantities'.

2. TYPE

The terminals shall be of type as indicated in drawings and 'Schedule of Quantities'

3. DAMPERS

At the junction of each branch duct with main duct and split of main duct, volume control dampers must be provided. Dampers shall be rigid in construction to the passage of air.

The volume dampers shall be of an approved type, lever operated and complete with suitable level links & quadrants, locking devices, which will permit the dampers to be adjusted and locked in any position.

The dampers shall be of opposed blade or louver type. The damper blade shall not be less than 1.25 mm (18) gauge and shall not be over 225 mm wide. Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Damper frames shall be constructed of 16 gauge steel

After completion of the ductwork, dampers are to be adjusted and set to deliver the required amount of air as specified in the drawings.

4 ACCESS PANEL

A hinged and gasket access panel shall be provided on ductwork before each control device that may be located inside the ductwork. Doors shall be provided with neoprene rubber gaskets. Angle joints shall be provided with neoprene rubber gaskets for leak tightness of the joints. Access door/panels shall be provided: -

- Near each smoke sensor
- Any other place specifically mentioned in the drawing or if asked by Owner / Consultants during execution stage.

5. SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be made of extruded aluminum section as specified in BOQ. The diffusers shall be powder coated in finish. Supply air diffusers shall be provided with screw operated opposed blade volume control devices of GSS in black mat finish. The diffusers shall be suitable for concealed fixing arrangement and as approved by Architect/Consultant.

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The diffusers shall be provided with removable central core.

All diffusers shall be selected as per selection curves and in consultation with Architect / Consultant. All diffusers shall have soft continuous rubber/foam gasket between the periphery of the diffusers and the surface on which it has to be mounted.

6. LINEAR GRILLS:

Linear continuous supply or return air grills shall be extruded aluminum construction with fixed horizontal bars at 0 / 15 ° inclination with flanges on both sides. The thickness of fixed bar louvers shall be 3mm in front and the flange shall be 20mm wide with round edges. The grille shall be suitable for concealed fixing and horizontal bars of the grille shall be mechanically crimped from the back to hold them.

Volume control device of GSS construction in black mat finish shall be provided in S.A. duct collars.

7. ADJUSTABLE LOUVERED SUPPLY / RETURN AIR GRILLS WITH HORIZONTAL / VERTICAL OR VERTICAL / HORIZONTAL LOUVER ARRANGEMENT:

The grille shall be adjustable as each louver shall be pivoted to provide pattern with 00 to plus or minus 150 ARC upto 300 deflection down towards. The louvers shall hold deflection settings under all conditions of velocity and pressure. The rear louver of the register shall be in black shade.

Volume control device of GSS construction with black mat finish shall be provided in S.A. grills.

8. EXHAUST AIR REGISTER:

Exhaust air register shall be made of extruded aluminum with fixed horizontal louvers at 40 degree angle setting on a 20 mm louvers pitch. The register shall have 20 mm wide flange with round edges all around. The register shall be suitable for front screw fixing.

Volume control device of GSS construction with black mat finish shall be provided.

9. LINEAR CEILING MOUNTED DIFFUSERS:

Linear ceiling mounted air terminals shall be made of extruded aluminum surface mounted one way or two way pattern. The linear terminal shall have alignment strips to give straight look while installation. Volume control device of GSS construction in black matt finish shall be provided in S.A. diffuser.

10. FRESH AIR INTAKE LOUVERS:

Fresh air intake louvers 50 mm deep (minimum) wherever required as per shop drawing will be made of extruded aluminum construction duly anodized or powder coated. Bird/insect screen will be provided with the intake louvers. The blades are inclined at 45° on a 40 mm blade pitch to minimize water ingress. The lowest blade of

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the assembly shall extend out slightly to facilitate disposal of rainwater without falling in door/wall on which it is mounted.

Wherever specified, the intake louvers shall be provided with factory fitted all aluminum construction volume control dampers in black anodized finish.

11. MISCELLANEOUS

Sponge rubber gaskets also to be provided behind the flange of all grills. Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot. Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system at an appropriate location, as directed by Engineer-in-Charge.

Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck. Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Engineer-in-Charge. All duct work joints are to be true right angle and with all sharp edges removed.

12 PAINTING

All grilles, and diffusers shall be powder coated in color as approved by Architect / Consultant before installation.

All ducts immediately behind the grilles / diffusers etc are to be given two coats of black paint in Matt finish. The return air and dummy portion of all linear grilles shall be provided with a vision barrier made of 24 gauge galvanised sheets. The vision barrier shall be fixed to the false ceiling frame with self tapping screws and shall be given two coats of black paint in matt finish. Care shall be taken to ensure that the return air path is not obstructed.

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SPECIFICATIONS FOR INSULATION

1 SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of air terminals and dampers conforming to these specifications and in accordance with the requirement of drawings and 'Schedule of Quantities'.

2 MATERIAL

Insulation material for **Duct insulation** shall be Closed Cell Elastomeric Nitrile Rubber. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.038 W/m²K or 0.313 Kcal/M hr°C or 0.212 BTU/(Hr-ft²-°F/inch) at an average temperature of 30°C. The product shall have temperature range of -40°C to 105°C. Density of material shall not be less than 0.06 gm/cm³. The insulation shall have fire performance such that it passes minimum CLASS O as per BS476 part 7 for surface spread of flame. Water vapour permeability shall not exceed 0.024 per inch (3 x 10⁻¹⁴ Kgs/m.sec.Pa). The material shall have approval from the Chief Fire Officer.

Insulation material for **Duct Acoustic Lining** shall be resin bonded fibre glass. The thermal conductivity shall not exceed 0.034K Cal/(hr-sq.m-deg C/meter) or 0.23 BTU/(hr.sq.ft.-deg F)/inch) at 32 deg C (90 deg F) mean temperature and density shall be not less than 32 Kg/Cum. Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer test certificate for thermal conductivity values and density. Samples of insulation material from each lot delivered at site may be selected by Engineer in charge and gotten tested for thermal conductivity and density at Contractor's cost. All joints shall be sealed properly with adhesive, which shall provide similar vapour barrier as the original insulating material.

3 APPLICATION

- 3.1 Duct acoustic Lining: Thickness of the material shall be as specified for the individual application. Ducts so identified and marked on drawings and included in Schedule of Quantities shall be provided with acoustic lining of thermal insulation material for a distance of minimum 5 meters as follows:

The inside surface for the ducts shall be cleaned, and provided with 22 gauge GI Channels 25 x 25 mm screwed back to back and fixed on the inside of duct, spaced not more than 60 cm center to center to form a frame work of 60 x 60 cms square. Cut panels 60 x 60 cms of fiber 25 mm thick shall be fitted in the squares. The insulation panels shall be fixed to the sheet metal with cold setting adhesive compound and covered with fibre glass tissue paper.

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The inner most surfaces shall be covered with 28 gage perforated aluminium sheet having atleast 15 percent perforations. The aluminium sheet shall be screwed to GI channels using cup washer and neatly finished to give true inside surface.

3.2 Duct Insulation: External thermal insulation shall be provided as follows: The thickness of closed cell shall be as shown on drawing or identified in the schedule of quantity. Following procedure shall be adhered to:

- Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work. Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubber sheets to size with sufficient allowance in dimension.
- Material shall be fitted under compression and no stretching of material shall be permitted.
- A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface. When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond.
- All longitudinal and transverse joints shall be sealed with adhesive SR 998 or equivalent.
- 26 G GI Chicken wire mesh shall than be wrapped on the insulated duct to hold the insulation.

3.3. FIRE BREAKS INSULATION

Firebreaks shall be provided in all ducts for internal lining/external thermal insulation after a run of 10 m center to center. There shall be a discontinuity of the insulating material in the form of MS angle of a minimum of 50 mm x 50 mm x 3 mm size. At the interface of the MS angle and insulating material, proper care of tucking in of the insulating material shall be taken so as to prevent erosion.

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SPECIFICATIONS FOR ELECTRICAL WORK AND CABLING

1. General :

The motor and switchgears required for various items shall generally be as per specifications given below all electric motors shall be suitable for 3 phase, 50 cycles, 415 volts A.C. Supply +/- 10%.

2. Switch Panel Board :

- The main L.T. Panel board shall be extendible type on both sides, having in it all switches, starters and accessories and completely factory prewired. It shall be suitable for voltage systems upto 500 volts, 3 phase, 50 Hz, 4 wire supply capable of functioning satisfactorily in temperatures of 47°C and rupturing capacity not below 35 MVA.
- The boards shall be fabricated from 2.0 mm thick, cold rolled M.S. sheets. The front opening door panels shall be from 2 mm thick, cold rolled M.S. Sheets. Suitable stiffeners shall be used in fabricating the housing. A clear space of 450 mm shall be left at the bottom. All steel members shall first be degreased and then de-scaled using dilute sulphuric acid and a suitable phosphating process (7 Tank Process) then the boards shall be given 2 coats of red oxide primer and finished with stove enamel finish. The switch board shall be dust proof and vermin proof. The panel shall generally conform to IS 8623 (fully conformity not called for). It shall be flush in front and back. The panel shall have front and rear access.
- Cable compartment of adequate size shall be provided in the main distribution board for easy termination of all incoming and outgoing cables entering from bottom or top. Adequate support shall be provided in cable compartment to support cables. All incoming and outgoing switch terminals shall be brought out to terminal blocks in cable compartments.
- All switches below upto 32 Amps shall be MPCB of required rating and all switches 63 Amps and above shall be MCCB of adequate 50 KA fault rating.
- No MCCB/MCB, starter or accessories shall be provided in the bottom 450 mm of the panel.
- The bus bars shall be of aluminium strips of minimum specified ratings with PVC heat shrinkable sleeves of appropriate colour. There shall be adequate clearance between phase to phase and phase to neutral strips.
- Items such as ammeters, switches etc shall be located close to the corresponding switchgear, and otherwise all items shall be arranged in a neat symmetrical pattern.
- Every starter / contactor etc. shall be controlled by a MPCB / Moulded Case Circuit Breaker of adequate rating.
- A voltmeter and ammeter shall be provided to indicate incoming voltage alongwith a rotary phase selection switch.

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- Ammeters shall be provided for all motors of 7.5 HP and higher ratings. An ammeter to measure total current consumption should also be provided in such cases. Each switch, ammeter etc. Shall be provided with a name plate to indicate controlled items. All ammeters and voltmeters where specified shall be of 144 x 144 mm size.
- Panel fabrication drawings shall be got approved before fabrication.
- LED type indicating lamps in approved colours shall be provided for the 3 phases and for on status of all controlled devices.
- All the switches/breakers shall be interlocked with door so that the unit cannot be closed unless the unit door is closed. The interlock shall also prevent opening the unit door unless the switch/breaker is in off position.
- Default arrangement shall be provided for deliberate inspection of switch/breaker without having to switch off the unit.
- All the units pertaining to a motor shall be incorporated in one cabin i.e. switch, starter, etc ammeter single phasing preventor, indicating lamps, etc.
- All the switch gear shall be earthed to the earth bus. Earth shall be extended to each compartment to the door by means if a flexible, insulated copper conductor with crimped legs on either side.
- Etched plastic name plates shall be provided for all the incoming, outgoing switch gears etc.
- The doors of the switch compartments and cable access shall be hinged type and that of busbars shall be fixed type. The knobs of the hinged doors shall be provided with a locking arrangement to prevent them from falling down when they are unscrewed for opening the doors. All panel doors shall have rubber gasket of suitable type to make the compartment dust proof.
- All the control and auxiliary wiring shall be carried out with PVC insulated copper conductor of proper colour code and minimum 2.5 sq mm copper flexible wire shall be used.
- Ammeters for incoming current shall be operated with CTs and a selector switch.
- Each panel shall be provided with suitable size of earth bus at the rear of the panel and two earth terminals on either side.
- Suitable printed PVC ferrules shall be provided for all the conductors for easy identification.
- The power wiring from the switches/unit breakers to the starters shall be carried out using colour coded, PVC insulated copper conductors crimped with lugs.

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- The out going of starter shall also be PVC insulated colour coded copper conductor crimped with lugs and terminated on a terminal block of proper rating.
- A danger notice plate of 200 mm x 150 mm of mild steel at least 2 mm thick vitreous enameled white on both sides and with inscriptions in signal red colour on front side shall be provided on the panel board.

3. Wiring for Motors, Heaters etc :

- The wiring for above equipment shall be carried out in conduits or using PVC armoured cables.
- The PVC XLPE armored power cable for use on 415 volts system shall be 3 or 3.5 core with aluminium conductors and be of 1100 volts grade, as per IS 1554 part I-1964. The cross section of the cable shall be to suit the load or rating of the equipment. The cable shall be aluminium conductor XLPE insulated single wire / strip armored with overall PVC sheathing.
- The cables shall be laid as per IS-1255/1967, Indian Standard Code of Practice.
- The cables shall be laid, as per drawings or along a short and convenient route between switch board and the equipment, either in trenches, on wall or on hangers, supported from the slab. Cable routing shall be checked on the site to avoid interference with structure, equipment etc. Where more than one cable is running close to each other, proper spacing should be provided between them.
- The radius of bends of the cable should not be less than 12 times the radius of cable to prevent undue stress and damage at the bends, the cables should be supported with wooden cleats fixed on M.S. Supports, when running in trenches wall or ceiling suspended hangers. When laid underground the cables should be covered with fine soft earth and protected with cement concrete covering. Suitable G.I. Pipe shall be used wherever the cable comes out of the connected surface and clamped properly.
- Wooden bushes shall be provided at the ends of pipes through which cables are taken in walls and floors.
- All cables shall be terminated using suitable size cable glands and packing.
- The wiring in conduits shall be 1100 volts grade.
- The conduits used shall be of high quality, all joints shall be made with sockets. The bends and elbows shall have inspection covers fixed with grease free screws. The joints shall be water tight. Approved metal saddles shall be used to secure the exposed conduits at a space of 1 meter or less. The connection of the conduit to switches etc. shall be secured by a check nut and ebonite bushes provided at the ends of conduits.
- Flush inspection covers shall be provided in case of concealed, recessed conduits. The staples for the conduits shall not be spaced more than 0.60 meters apart. Before filling up the chase with concrete the conduits should be given a coat of rust proof paint.

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- The wires shall be drawn only after all the conduits have been properly fixed in position.

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4. Control Wiring :

- Control cables shall be 650 volts grade as per IS 1554 made from copper conductor of 1.5 / 2.5 sq. mm PVC insulated single multi core unarmoured with an overall PVC sheathing. All cables & wires to be FRLS grade.
- The cables and conduits wiring shall be carried out as per details given above.

5. Earthing :

All equipment connected with electric supply shall also be provided with double earthing continuity conductors. The size of copper earthing conductors shall be:-

Size of phase wire sq.mm Aluminium	size of copper conductor tape/wire (swg)
185	20 mm x 3 mm (strip)
150	20 mm x 3 mm (strip)
120	12 mm x 3 mm (strip)
70	4 Swg
50	6 Swg
35	8 Swg
25-6	8 Swg
4	10 Swg

Note: GSS earthing conductors of equivalent size may be used in lieu of copper earth mentioned above.

6. Miscellaneous :

- The final connections to the equipment shall be through flexible connections in case of conduit wiring and also where the equipment is likely to be moved back and forth, such as on slide rails.
- An isolator switch shall be provided at any motor which is separated from the main switch panel by a wall or partition or other barrier or is more than 15 meters away from the main panel.
- Two separate and distinct earthing conduits shall be connected from the equipment upto the main switch board panel.
- The branch lines from the main panel to each equipment shall be separated and should not crisscross other lines.
- The entire installation shall be tested as per electricity rules and I.S.S 732-1973 with amendments 1, 2 & 3 prior to the commissioning of the plant and a suitable test report furnished by a competent and authorised person. The test report will be obtained by contractor himself at his own expenses.

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- All exposed switch board panels, conduits; hangers etc. shall be given 2 coats of suitable paint of approved colour, when all work has been completed.
- 7 Painting: All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be baked in an oven. The finishing treatment shall be by application of powder coating of approved shade.
- 8 Rubber Mat: Rubber mat shall be provided in front to cover the full length of all panels. Where back space is provided for working from the rear of the panel, rubber mat shall also be provided to cover the full length of panel.

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PREAMBLE TO MODE OF MEASUREMENT

- 1 All equipment described hereafter shall be in accordance with the specifications. All equipment shall be selected and installed for the lowest Operating noise level.
- 2 Supply of various equipment shall include all expenses for correspondence with manufacturers, submission of shop drawings, documents and their approval by the Consulting Engineer, procurement of equipment, transportation, shipping, payment of all taxes and levies, storage, supply of equipment at the point of installation, furnishing all technical literature required, replacement of defective components, and warranty obligations for the individual equipment.
- 3 Installation of various equipment shall include all material and labour associated with hoisting and lowering of equipment in position, insulation of the components and vibration isolation as required, grouting and anchoring or suspension arrangements and all incidentals associated with the installation as per the specifications and manufacturer's recommendation.
- 4 Vibration isolators as specified or as recommended by the manufacturer shall be installed with each component. Performance ratings, power consumption and power data for each component shall be verified at the time of testing and commissioning of the installation, against the data submitted with the tenders.
5. Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirit, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.
6. Testing and commissioning shall include furnishing all labour, materials, equipments, instruments, and incidentals necessary for complete testing of each component as per the specifications and manufacturer's recommendations, submission of test results to the Consulting Engineer and obtaining their approval and submission of necessary documents and completion drawings.
- 7 All ducts shall be fabricated and installed conforming to the relevant Indian standards, approved shop drawings and the specifications.
8. Duct installation shall include fabricating and installing the ducts, splitter dampers, turning vanes, and distribution grids within the ducts in position, and providing, installing and making air tight all joints with slips, bonded felt insertions, nuts, bolts and screws as required. In addition multi-louvered manually adjustable dampers shall be provided in various branch ducts as required or shown on drawings for proper balancing of air flows.

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- 9 All registers and diffusers shall be provided with a soft continuous rubber gasket between their periphery and the surface on which these have to be mounted.
- 10 Registers and diffusers shall be given, at the factory, a rust resistant primer coat and enamel paint finish of approved colour.
- 11 After completion of the installation, the entire air distribution system shall be tested for air leaks and balanced in accordance with the specifications.

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MODE OF MEASUREMENT

- 1 Measurement of Equipment:
 - VRV/ VRF/ ductable unit – to include compressor, condenser, controls, motor etc on skid mounted platform complete factory assembled including chiller insulation and standard accessories as supplied by the OEM. – Unit nos.
 - Indoor units and cassette type FCU – to include blower with motor, casing, Unit nos.
 - Electrical Panel: Panels shall be counted as number of units. Quoted rates shall include as lumpsum for all internal wiring, earthing connections within panel box. The quoted rate of panel shall also include all accessories, switchgear, contactors, indicating meters and lights as per the Specifications and Schedule of Quantities.

- 2 Measurements for Ducting: All ducts fabricated and installed should be accompanied and supported by proper documentation. Bill of material / Packing list for every duct section supplied. Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise. Each and every duct piece to have a tag number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement and verification. Unless otherwise specified, measurements for ducting for the project shall be on the basis of centerline measurements described herewith. Ductwork shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface area shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the center of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in a similar manner. For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway between large and small diameter shall be adopted, the length of tapered duct section shall be the centerline distance between the flanges of the duct section. For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centerline. The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 5mm thick between duct and support, vibration isolator suspension where specified or required. The following accessories will be part of ducting and shall NOT be separately measured nor paid for
 - inspection chamber / access panel,
 - splitter damper with quadrant and lever for position indication,
 - turning vanes,
 - straightening vanes
 - all other accessories required to complete the duct installation as per the specifications.

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- 3 Air Distribution accessories shall be measured by the cross-section area perpendicular to air flow, as identified herewith:
- Grilles and registers - width multiplied by height, excluding flanges.
 - Volume control dampers - width multiplied by height, excluding flanges
 - Diffusers - cross section area for air flow at discharge area, excluding flanges.
 - Fire dampers - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, electrical actuators and panel. No special allowance shall be payable for extension of cross section outside the air stream.
 - Flexible connection - shall be measured by their cross sectional area perpendicular to the direction of air flow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.
 - Motorised Volume control damper - width multiplied by height, excluding flanges.
 - Exhaust air / Fresh air Louvers - shall be measured by their cross sectional area perpendicular to the direction of air flow.
- 4 Measurement of Duct Insulation: Unless otherwise specified measurement for duct insulation for the project shall be on the basis of centre line measurements described herewith Duct Insulation shall be measured on the basis of surface area along the centre line of insulation thickness. Thus the surface area of externally thermally insulated or acoustically lined be based on the perimeter comprising centre line (of thickness of insulation)width and depth of the cross section of insulated or lined duct, multiplied by the centre-line length including tapered pieces, bends, tees, branches, etc. as measured for bare ducting.
- 5 Measurement For Piping: Unless specified otherwise, measurement for piping for the project shall be on the basis of centre line measurements described herewith Piping shall be measured in units of length along the centre line of installed pipes including all pipe fittings, flanges (with gaskets, nuts, and bolts for jointing), unions, bends, elbows, tees, concentric and / or eccentric reducers, inspection pieces, expansion loops etc. The above accessories shall be measured as part of piping length along the centre line of installed pipes, and no special multiples of pipe lengths for accessories shall be permitted. The quoted rates for centre line linear measurements of piping shall include all wastage allowances, pipe supports including hangers, MS channel, PUF supports, nuts, check nuts, vibration isolator suspension where specified or required, and any other item required to complete the piping installation as per the Specifications. None of these items will be separately measured nor paid for. However, all valves (gate / globe / check / balancing / purge / butterfly / drain etc), strainers, thermometers, pressure gages shall be separately counted and paid as per their individual unit rates, which shall also include their insulation as per Specifications. Piping measurements shall be taken before application of the insulation. Contractor shall get pressure testing of pipes / measurements etc verified by the representative of Engineer in charge at site.

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- 6 Measurement of Pipe Insulation: Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers are separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.
- 7 Measurement of cabling: All power cabling, control cabling and earthing the same shall be measured for actual length and paid as per the unit rates available in the tender quotes.

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INSPECTION AND TESTING PROCEDURES

All major equipments such as packaged units, panels, fans shall be got inspected by the engineer in charge / customer at works by the AC contractor, if he so desires. All routine and Type tests shall be carried out and the test reports shall be submitted for approval before dispatch. The engineer in charge is free to witness any or all tests. In any case the OEM test certificates shall be submitted to the engineer in charge for verification of the same before the payments for the same can be processed. The AC contractor shall inform the engineer in charge well in time about the date of readiness of the equipment for inspection and testing. The inspection process shall be as under:

Equipment like packaged units, Ductable units, fans, Indoor units

- Salient features such as model and make shall be checked as per the contract requirement and shall be related with name plate/performance curves.
- The manufacturer's test certificate shall be furnished and verified.
- The test certificates shall be correlated with the equipment serial no.

Electric Motor

- The motor shall be of approved make. The OEM's test certificates shall be furnished and verified with the name plate and serial no. The requirement shall be as per technical data submitted.

Pipes

- Make, wall thickness for the pipe shall be checked at random for 5% of pipe lengths and shall be correlated with relevant IS codes.

Ducting

- The GI sheet to be used shall be physically checked for gauge as per IS 277. The bend test shall be performed at site. Randomly one sample of each gauge shall be checked chemically for composition and galvanizing by a reputed lab and report shall be submitted before starting work at site.

Insulation

- All type of insulation material shall be physically checked for quality, thickness as per tender specification.
- The samples shall be checked for density at site. The same shall be correlated with the OEM test certificates.
- The material shall be having required thermal conductivity which will be verified from TC.

Final Inspection

After completion of entire installation as per specifications in all respects, the AC contractor shall demonstrate trouble free operation of the entire installation simultaneously. The test readings shall be recorded in a mutually acceptable format. All tests shall be carried out by the AC contractor at his own expenses. However necessary utilities such as power and water

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shall be provided by the owner free of cost. The tests shall include but will not be limited to the following:

- To check satisfactory functioning of all equipment installed
- Clean all equipment to remove foreign material and construction dirt and dust with Vacuum cleaner.
- Verify that the equipment is secure on mounting and supporting devices and that connections for piping, ductwork and electrical are complete.
- Verify proper thermal overload protection is installed in motors, starters, and disconnects.
- Perform cleaning and adjusting specified as per OEM.
- Check proper motor rotation direction and verify fan wheel / pump free rotation and smooth bearing operations.
- Reconnect drive system and align belts.
- Lubricate bearings, pulleys, belts, and other moving parts with factory recommended lubricants.
- Set outside-air / supply air dampers to minimum outside-air setting.
- Install temporary throw away filters for initial run and finally install clean filters.
- Verify manual and automatic volume control, and fire dampers in connected ductwork system are in the full-open position.
- Replace fan and motor pulleys as required to achieve design conditions.
- Measure and record motor electrical values for voltage and amperage.
- Shut unit down and reconnect automatic temperature control operators.
- Cooling / heating capacity of various Indoor units shall 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 a calibrated rotating vane anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current, whereas, noise level at various locations within the conditioned spaces shall be measured by a sound pressure level meter.

NOTE:

- All measuring instruments such as thermometer, Psychrometer, Pressure gauges, anemometers, Flowmeter, dB Meter, Tong tester, etc or any other necessary instrument shall be arranged by the AC contractor at his own expense.
- The instruments shall be new and shall have a valid calibration certificate from a renowned test lab.
- The plant shall be run initially and all equipments shall be adjusted to give desired results as per contract. Thereafter the plant shall be test run for 96 hours as described above and the readings shall be demonstrated in the required format. The test shall be witnessed by the owners and engineer in charges representative. In case the conditions are not achieved during the initial run test the plant shall be readjusted and the new dates for tests shall be determined. The entire test shall be repeated and satisfactory results shall have to be obtained. Only after satisfactory test the installation shall be taken over by the customer and warranty period for one year shall commence.
- The test readings shall be suitably adjusted for the absence of Peak ambient conditions, fouling factor, and available load.

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- The snag list prepared jointly after initial test shall be attended to by the vendor during a maximum of 30 days from the start of warranty period. Failure to do so shall result in corresponding increase of warranty period.

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APPROVED MAKES OF EQUIPMENT & MATERIALS

S No	Equipment / Material	Approved Makes
1	Air Cooled Packaged units	Blue Star / Voltas / Carrier / Daikin.
2	Air Cooled ductable units	Blue Star / Voltas / Carrier / Hitachi / York / Daikin.
3	Split Air conditioners (cooling option only)	Daikin / Hitachi / York / O General.
4	Propeller fan	Alstom/ khaitan/ Crompton
5	In-Line fan	Systemair / Kanalflakt / Kruger / Ostberg
6	Grilles/ Diffusers	Caryaire / Ravistar / Airflow / coolwings
7	G.I. Sheet Metal Duct	SAIL/ Tata
8	Factory fabricated duct	Zeco / Ecoduct / Rolastar
9	Duct flange	Zeco / Ecoduct / Rolastar
10	Hessian (Fire treated)	Navair/ Pyroguard
11	VCD / Gravity louvers / Exhaust& fresh air louvers	Caryaire / Ravistar / airflow / coolwings
12	PPRC Pipe	Reliance.
13	Copper Pipe	Totaline / Rajco/ Mandev
14	Humidistat	Honeywell / Siemens / Anergy
15	Safety Thermostat for heater	Anergy Controls
16	Closed cell Nitrile rubber	Armacell / K flex / vido flex
17	Aluminium Tape	Johnson/ Birla 3M
18	Fibre glass	UP twiga / Owen corning
19	Anchor fastners	Hilti /fishner
20	Paints	ICI/ Asian/ Narolac/ Berger
21	Motor Control Centre	CPRI approved Panel manufacturer.

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22	Starter, Contactor, Push Button	Larsen & Toubro / GE Power Controls / Siemens
23	Moulded Case Circuit Breaker (MCCB) / Miniature Circuit Breaker (MCB) / Overload relays with built in SPP	Schneider Electric (MG) / Larsen & Toubro / Siemens
24	Current Transformer (Epoxy Cast Resin)	Automatic Electric / Indcoil / Pragati
25	Protection Relay (numeric type)	Alstom /Asea Brown Boveri / Siemens
26	Switch Fuse Unit, HRC Fuse /TDR /Rotary switch	Larsen & Toubro / GE Power Controls / Siemens
27	Timer	Schneider Electric (Telemecanique) / Larsen & Toubro / GE Power Control / Siemens
28	Selector Switch, Toggle switch	Larsen & Toubro / Kaycee
29	Change Over Switch	Larsen & Toubro / siemens
30	Ammeter and Voltmeter	Rishabh (L& T) / Automatic Electric
31	Indicating Lamps LED type , Push Button	Larsen & Toubro / GE Power Controls / Siemens / Vaishno Electricals

Note: For any other item required for successful completion, but not included in the above list the Contractor shall take prior written approval from the Consultant/ Owner.

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PREAMBLE TO SCHEDULE OF QUANTITIES

- 1 All items of work under this Contract shall be executed strictly to fulfill the requirement laid down under” Basis of Design” in the specifications. Type of equipment, material, specification, methods of installation and testing and type of control shall be In accordance with the specification, approved shop drawing and relevant Indian Standards, however capacity of each component and their quantities shall as fulfill the above mentioned requirement.
- 2 The unit rate for all equipment’s or materials cost in RUPEES for equipment and material including all taxes and duties and also including forwarding, freight, insurance and transport into Contractor’s store at site storage’ installation ‘testing balancing ‘ commissioning and other work required.
- 3 The rate for each item of work included in the Schedule of Quantities shall’ unless expressly stated otherwise, include cost of:
 - All materials. Fixing materials. Accessories, appliances tools, plants, equipment transport, labour and incidentals required in preparation for and in the full and entire execution as per Specification and Drawings.
 - Wastage on materials and labour.
 - Loading, transporting, unloading, handling/double, hoisting to all levels. Setting, fitting, and fixing in position, protecting, disposal of debris and other labour necessary in and for the full and entire execution and for the job in accordance with the contract documents, good practice and recognize principals.
 - Liabilities, obligations, and risks arising out of Conditions of Contract.
- 4 All requirements of Specification, whether such requirements are mentioned in the item or not. The Specification and Drawing where available, are to be read as complimentary to and part of the Schedule of Quantities and any work called for in one shall be taken as required for all.
- 5 In the event of conflict between Schedule of Quantities and other documents including the Specification, the most stringent shall apply. The interpretation of the Engineer in charge shall be final and binding.
- 6 All equipment, quantities, and technical data indicated in this Schedule are for Contractor’s guidance only; these are based on the documents prepared by the Consultant. This schedule must be read in conjunction with other documents. The Contractor shall be paid for the actual quantity of work executed by him in accordance with the approved Shop Drawing at the contract rates.
- 7 This Schedule shall be fully priced and the extensions and totals duly checked. The rates for all items shall be filled in INK including NIL items.

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- 8 No alteration whatsoever is to be made to the text or quantities of this schedule unless Consultant authorizes such alteration in writing. Any such alterations, cuts or additions shall unless authorized in writing, be disregarded when tender documents are considered.
- 9 In the event of an error occurring in the amount of the Schedule, as a result of wrong extension of the unit rate and quantity, the unit rate quoted by the tenderer shall be regarded as firm and the extensions shall be amended on the basis of rates.
- 10 Any error totaling the amount column and in carrying forward total shall be corrected, any error, in description or in quantity, omission of items from this Schedule shall not vitiate this corrected but shall corrected and deemed to be variation required by the engineer in charge.
- 11 The Contractor shall procure and bring Materials/ Equipment to the site only on the basis of drawing approved for construction and shop drawings and not on the Contractor's requisition for Engineer in charge supplied materials.

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BILL OF QUANTITIES

S.No.	Description	Unit	Qty	Rate	Amount
1	AIRCOOLED PACKAED UNITS Supplying, installing and commissioning of Air cooled type Packaged air-conditioning units complete with Hermetically sealed MULTI SCROLL compressors fitted inside the indoor unit & first charge of refrigerant & oil ,air cooled condenser, fan section with statically/dynamically balanced centrifugal blower driven by a TEFC squirrel cage three speed motor, Multi rows cooling coil of copper with aluminium fins etc. The enclosures shall be fabricated of M.S. The Package unit shall be equipped with synthetic fiber filter, insulated drain pan, controls all encased in a unit. The casing shall be factory powder coated. Electrical panel board for Package units shall comprise of SFU's, Fuses, Voltage scanner, complete with overload, low voltage, high voltage & phase imbalance protection. Along with VI Pads complete with all ancillaries including MS painted stand for Outdoor units of suitable size, foundation and allied minor civil works as per instructions of engineer in charge of following ratings including electric control panel & fitting as per specifications.				
1.1	16.5-17 TR nominal capacity suitable for at least 6600 CFM air capacity. (with 3 compressors)	Nos	2		
1.2	11-11.5 TR nominal capacity suitable for at least 4400 CFM air capacity. (with 2 compressors)	Nos	11		
2	DUCTABLE SPLIT AIR CONDITIONERS Supplying, Installation, Testing and Commissioning of ductable split air conditioners fitting with twin scroll compressors complete with all ancillaries including MS painted stand for Outdoor units of suitable size, foundation and allied minor civil works as per instructions of engineer in charge of following ratings including electric control panel & fitting as per specifications.				

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- 2.1 5-5.5 TR nominal capacity outdoor unit with Nos 2
matching capacity indoor unit suitable for at
least 2200 CFM air capacity. (Ductable type).

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S.No.	Description	Unit	Qty	Rate	Amount
3	Supply, installation, testing & commissioning of (BEE star rated Minimum 3 star) hi-wall split unit complete with refrigerant liquid line and insulated suction line piping with nitrile foam insulation (upto 4 RM), electrical cabling between condenser & evaporator, MS base frame / platform duly epoxy painted for indoor & outdoor units. (For Outdoor units weather protective paint to be provided after taking due approval.) along with suitable capacity copper wound stabilizers of 2 TR capacity as per specifications	Nos	2		
Total Part A					

Part-B : Lowside

1	REFRIGERANT PIPING Supplying, Installation, Testing and Commissioning of Refrigerant piping complete with all fittings such as bends, tees, elbows etc. including insulation as per specifications. The quoted rates shall include rates for chiseling, making good of wall and clamps etc.				
1.1	Refrigerant piping for 16.5/17 TR units (for 3 circuits – 3 ie 3 suction and 3 discharge lines)	Rmt	30		
1.2	Refrigerant piping for 11/11.5 TR units (for 2 circuits - ie 2 Suction and 2 discharge lines)	Rmt	165		
1.3	Refrigerant piping for 5.5 TR units (for 1 circuits)	Rmt	24		
2	REFRIGERANT PIPING Supplying, Installation, Testing and Commissioning of Refrigerant piping complete with all fittings such as bends, tees, elbows etc. including insulation as per specifications. The quoted rates shall include rates for chiseling, making good of wall and clamps etc.				
2.1	Refrigerant piping for 2 TR split units in addition to the 4 RM of refrigerant piping already included in part A above	Rmt	20		
3	Supply, Installation, testing and commissioning of PPRC piping complete with fittings, supports as per specifications				
3.1	25 mm Dia	Rmt	180		

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S.No.	Description	Unit	Qty	Rate	Amount
4	Supply, installation, testing and commissioning of factory fabricated sheet metal ducting complete with supports, dampers etc. as per IS 655 and approved drawing and as per specifications of below gauges:				
4.1	24 Gauge	Sqm.	650		
4.2	22 Gauge	Sqm.	900		
5	Supply, installation, testing and commissioning of closed cell Nitrile rubber insulation of following thickness applied with Proper adhesive and sealed with 75 mm wide Aluminium Tape on all longitudinal / transverse joints complete as per specifications. 9 mm thick on ducts in conditioned space	Sqm.	1600		
6	Supply, installation, testing and commissioning of 32 kg/m ³ density fiberglass insulation in the form of 25 mm Thick Fiber Glass boards, 2 Layers of Tissue paper finished with 28 gauge perforated Aluminum sheet with nuts, bolts complete as per specifications. 25 mm thickness acoustic lining	Sqm.	1400		
7	Providing and fixing Fire retardant non porous double layer flexible connection between each indoor unit and duct.	Nos	15		
8	Supply, installation, testing and balancing of powder coated extruded aluminum square shape ceiling diffusers with removable core and anti smudge ring & aluminum volume control dampers as per approved drawings and specifications.	Sqm.	2		
9	Supply, installation, testing and balancing of Powder coated extruded aluminum construction square shape return air diffusers with removable core, anti smudge ring & without volume control damper as per approved drawings and specifications.	Sqm	3		
10	Supply, Installation, Testing and Balancing of Powder coated extruded aluminum construction Linear Grilles as per approved drawings and specifications. Quoted price shall be without volume control damper at the location of supply	Sqm	50		

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air collar

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S.No.	Description	Unit	Qty	Rate	Amount
11	Supply, installation, testing and balancing of powder coated extruded supply air aluminum grills with aluminum volume control dampers as per approved drawings and specifications.	Sqm	1		
12	Supply, installation, testing and balancing of powder coated extruded return air aluminum grills without aluminum volume control dampers as per approved drawings and specifications.	Sqm	1		
13	Supplying & fixing of opposed blade aluminum construction volume control dampers in supply air duct collars as per approved drawings and as per approved drawings and specifications.	Sqm.	16		
14	Supply, installation, testing and balancing of inlet air louvers with bird screen and volume damper for fresh air in powder coated extruded aluminum construction as per specifications and approved shop drawings.	Sqm.	3		
15	Fire Damper with Control Mechanism				
15.1	Fire Damper Supplying, fixing, testing and commissioning of motor actuated Fire Dampers of at least 1.5 hour fire rating in supply air duct at wall crossing of AHU room/as and where required, of requires sizes including control wiring. The damper shall be motorized and spring return so as to close the damper in the event of a fire signal which shall be provided by smoke sensor/detector in AHU room as per specifications and as required. The spring return action shall be in-built mechanism and not externally mounted. The control wiring shall be interlocked ion such a way that along with actuation of damper-closing mechanism, the AHU fan motor gets automatically switched off. Fire damper as described above, as per specifications and complete in all respects.	Sqm	6		
15.2	Electric Actuator Electric actuator with necessary linkage to actuate fire dampers complete with required wiring and associated accessories. Note: Fire dampers shall be supplied with sensors/actuators/control etc duly factory fitted and tested at manufacturers works and certificate to this effect produced along with delivery of fire damper.	Nos.	13		

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Total part B

Grand Total (Part-A + Part B)