Bharat Heavy Electricals Limited
(High Pressure Boiler Plant)
Tiruchirappalli – 620014, TAMIL NADU, INDIA
MATERIALS MANAGEMENT / CAPITAL EQUIPMENT

An ISO 9001 Company

ENQUIRY **NOTICE INVITING TENDER**	Phone: +91 431 257 7653 Fax : +91 431 252 0719 Email : skaruna@bheltry.co.in Web : www.bhel.com

TWO PART BID Tender to be submitted in Two Parts	**Enquiry Number:** **2621100150**	**Enquiry Date:** **20.09.2011**	**Due date for submission of quotation :** **20.10.2011**

You are requested to quote the Enquiry number date and due date in all your correspondences. This is only a request for quotation and not an order
Please note that under any circumstances both delayed offer and late offers will not be considered. Hence vendors are requested to ensure that the offer is reaching physically our office before 14.00 Hrs on the date of tender opening

Item No.	Item Description	Quantity
10	**HVAC System covering** **1.Fresh Air System** **2. Ventilation System** **3.Airconditioners** **4.Building Management System as per the technical Specification, scope & commercial conditions applicable (to be downloaded from web site www.bhel.com or http://tenders.gov.in)**	**01 Set (Each).**

Important Points to be taken care during the submission of offer:-

1. **All the Items mentioned in the enquiry as per scope of supply attached covering all the systems mentioned above shall be procured from a Single Vendor (Combined L1). However price break up details for each system should be given in the price bid.**
2. **Check list to be filled and enclosed along with the offer failing which, the offer will not be considered for evaluation.**
3. **Guaratee for the materials to be 18 months from the date of supply or 12 months from the date of commissioning of the system.**
4. **Price Bid for the AMC should be submitted in a separate sealed cover.**

BHEL's General guidelines /instructions including bank guarantee formats and list of consortium banks, commercial terms checklist can be downloaded from BHEL web site http://www.bhel.com or from the government tender website http://tenders.gov.in (public sector units > Bharat Heavy Electricals Limited page) Tender Enquiry reference "2621100150"

Tenders should reach us before 14:00 hours on the due date Tenders will be opened at 14:30 hours on the due date Tenders would be opened in presence of the tenderers who have submitted their offers and who may like to be present	Yours faithfully, For **BHARAT HEAVY ELECTRICALS LIMITED** Manager / MM / Capital Equipment S.KARUNANIDHY Manager MM / Capital Equipment BHEL. TRICHY-620 014

QUALIFICATION CRITERIA

Supply, Installation, Testing & Commissioning of Air conditioning system (Digital compressor with variable refrigerant flow system), Fresh air & Ventilation system and building management system for the administrative building at Thirumayam BHEL project.		
	QUALIFICATION CRITERIA	
S.No	**Description**	**Vendor to specify details**
1	Only those vendors, who have Supplied and commissioned such type of airconditioning system (Digital compressor with variable refrigerant flow system), Fresh air & Ventilation system and building management system for at least three companeies in the past five years and such item should be working satisfactorily for a minimum period of one year after completion of commissioning as on the date of opening of this tender.	
2	The vendor should submit following details which are necessary for qualifying their offer.	
2.1	Name and postal address of the customer / company where similar equipment commissioned.	
2.2	Name and designation of the contact person of the customer.	
2.3	Phone, FAX no and email address of the contact person of the customer.	
2.4	Along with Technical offer, the Vendor should submit performance certificate from minimum **one** customer for the satisfactory performance of the same, supplied to them in the customers letter head.	
3	BHEL reserves the right to verify the information provided by vendor. In case the information provided by vendor is found to be false / incorrect, the offer shall be rejected.	

SCOPE OF SUPPLY

FRESH AIR SYSTEM (As per applicable latest ASHRAE Standard)

LOCATION: Administrative Office Building

I - SCOPE OF SUPPLY			
ITEM NO:	**DESCRIPTION**	**MINIMUM**	**QTY**
1	Supply of INLINE FANS (Fresh air) suitable for installing in any position in vertical or horizontal ducts with pre-filter. The casing shall be double skin, internally acoustically lined and constructed of galvanised steel. Motor shall be suitable for 415 + or - 10% volts, 50 cycles, 3 phase of energy efficient eff1 type complying to IS325.		
	Toilet Fresh air – 350CFM Capacity.	Nos	12
2	Supply of Fresh air propeller fans. These fans shall be suitable for outdoor duty. Motor shall be suitable for 415 + or - 10% volts, 50 cycles, 3 phase of energy efficient eff1 type complying to IS325.		
	Toilet Fresh air – 100CFM Capacity.	Nos	14
3	Supply of IR movement detector for Toilet exhaust fan (with pet immunity) make and model to be specified in the offer.	Nos	26
4	Supply of GSS Ducting as per ISI Standards and specification		
a	0.8mm thickness	sqm	50
b	0.63mm thickness	sqm	250
5	Supply of Canvass connections for inline fans to reduce vibration & noise level	Nos	12
6	Supply of Powder coated, extruded aluminium Exhaust air grille with volume control dampers for Toilets		
	150 x 150 mm Exhaust air grille for Toilets	Nos	60
7	Supply of aluminium Fresh air intake louver with pre filter	sqm	12
8	Supply of Volume Control Dampers made out of 1.6 mm thick galvanised sheet steel frame and blades of 1.6 mm galvanised sheet steel with linkages, operating handle & depth of 150mm with 40mm flanges all around suitable for manual control locations show.	sqm	5
II - INSTALLATION, TESTING & COMMISSIONING			
	Installation, testing and commissioning of above supplies Item No: 1 to 8.	Lot	1
Note :	Detailed specification, requirments / vendor makes / drawings has to be refered to the attached specification.		
	Comprehensive Maintenance: Rates to be given for 5 years comprehensive AMC after the guarantee or warrantee period of one year.		

VENTILATION SYSTEM (As per applicable latest ASHRAE Standard)

LOCATION: Administrative Office Building

I - SCOPE OF SUPPLY			
ITEM NO:	**DESCRIPTION**	**MINIMUM**	**QTY**
1	Supply of INLINE FANS suitable for installing in any position in vertical or horizontal ducts with pre-filter. The casing shall be double skin, internally acoustically lined and constructed of galvanised steel. Motor shall be suitable for 415 + or - 10% volts, 50 cycles, 3 phase of energy efficient eff1 type complying to IS325.		
	Toilet Exhaust – 500CFM Capacity.	Nos	12
2	Supply of Exhaust propeller fans. These fans shall be suitable for outdoor duty. Motor shall be suitable for 415 + or – 10% volts, 50 cycles, 3 phase of energy efficient eff1 type complying to IS325.		
	Toilet Exhaust – 100CFM Capacity.	Nos	14
3	Supply of IR movement detector for Toilet exhaust fan (with pet immunity) make and model to be specified in the offer.	Nos	26
4	Supply of GSS Ducting as per ISI Standards and specification		
a	0.8mm thickness	sqm	50
b	0.63mm thickness	sqm	250
5	Supply of Canvass connections for inline fans to reduce vibration & noise level	Nos	12
6	Supply of Powder coated, extruded aluminium Exhaust air grille with volume control dampers for Toilets		
	150 x 150 mm Exhaust air grille for Toilets	Nos	60
7	Supply of Volume Control Dampers made out of 1.6 mm thick galvanised sheet steel frame and blades of 1.6 mm galvanised sheet steel with linkages, operating handle & depth of 150mm with 40mm flanges all around suitable for manual control locations show.	sqm	5
II - INSTALLATION, TESTING & COMMISSIONING			
	Installation, testing and commissioning of above supplies Item No: 1 to 7.	Lot	1
Note :	Detailed specification, requirments / vendor makes / drawings has to be refered to the attached specification.		
	Comprehensive Maintenance : Rates to be given for 5 years comprehensive AMC after the guarantee or warrantee period of one year.		

AIR CONDITIONING SYSTEM-AC UNITS

LOCATION: Administrative Office Building

I - SCOPE OF SUPPLY			
SUPPLY OF FOLLOWING ITEMS:			
ITEM NO:	**DESCRIPTION**	**MINIMUM**	**QTY**
1	**Supply of digital Comprressor with Variable Refrigerant Flow system** (with R-410 A) connectable to multiple indoor units. Outdoor unit shall be factory assembled weather proof casing constructed from heavy gauge mild steel panels with epoxy coated painting. The unit shall be completely factory wired and tested with necessary controls. The compressor shall be highly efficeint Digital scroll type controller. The aluminium fins shall be covered with anti-corrosion resin. Unit shall be equipped wiith oil recovery system to ensure stable operation with long refrigerant piping. The unit shall be compatible for BMS operation.		
a	14HP - COP not less than 3.85	Nos	3
b	16HP - COP not less than 3.7	Nos	2
c	20HP - COP not less than 3.25	Nos	20
Note:	1) All the machines shall be selected with minimum COP at 100% load as mentioned above		
	2) Anti corrosive treatment of outdoor is must		
2	Supply of indoor Units shall be either ceiling mounted ductable type or Hi wall split type as specified. The indoor unit shall have independent electronic control valve to control the refrigerant folw rate respond to variations of the airconditioning load of the room. The fan shall be aerodynamically designed turbo multiblade type. Statically and dynamically balanced to ensure lowest noise. The cooling coil shall be made of seamless copper tube. The tube shall be Hydraulically or mechanically expanded and tested for 21Kg/cm2. Indoor units shall have a wireless remote control.		
(i)	Supply of ductable Units:		
a	0.8 TR Duct type unit	Nos	12
b	1.0 TR Duct type unit	No	1
c	1.5 TR Duct type unit	Nos	33
d	2.0 TR Duct type unit	No	1
e	2.5 TR Duct type unit	Nos	11
f	3.0 TR Duct type unit	Nos	15
g	3.5 TR Duct type unit - High static duct	Nos	2
h	6.0 TR Duct type unit - High static duct	Nos	27

i	8.0 TR Duct type unit - High static duct	Nos	18
(ii) a	Supply of 5 star rated 2.0 TR Split AC unit with cordless remote. Indoor unit & outdoor unit coils shall be made of seamless copper tube. Preferable make of airconditioner: CARRIER / LG / VOLTAS / GODREJ / BLUE STAR / NATIONAL/'O'GENERAL/HITACHI/ELECTROLUX/SAMSUNG / DAIKIN. Guarantee: Minimum 5 years guarantee required for compressors.	Nos	13
b	Supply of metallic stand for outdoor unit	Nos	13
c	Supply of 5 KVA voltage stabilizer wall mounting type. Preferable make of voltage stabilizer: EVEREST / ORICON / SAKTHI / V-GUARD / VOLTAS. Guarantee: Minimum 1 year guarantee required for the voltage stablizers.	Nos	13
3	Supply of refnet joints / branch distributors for indoor and out door units.	Lot	1
4	Supply of web based Centralised controller with schedule control and monitoring features through internet.	Lot	1
5	Supply of remote controller for below mentioned units		
a	Cordless remotes for ductable units with necessary accessories	Nos	100
b	Corded remoted for ductable units	Nos	50
6	Supply of suction Line of 18G or 19G Copper tube with 19mm thick insulation by nitril rubber tubular covered by polyshield for inter connecting the indoor units and outdoor units.		
a	12.70mm (OD)	Rmt	275
b	15.88mm (OD)	Rmt	850
c	19.05mm (OD)	Rmt	175
d	22.23mm (OD)	Rmt	300
e	28.58mm (OD)	Rmt	375
f	34.93mm (OD)	Rmt	325
g	41.28mm (OD)	Rmt	375
7	Supply of liquid Line of 19G or 20G Copper tube with 13mm thick insulation by nitril rubber tubular covered by polyshield for inter connecting the indoor units and outdoor units.		
a	6.35mm (OD)	Rmt	300
b	9.53mm (OD)	Rmt	1000
c	12.70mm (OD)	Rmt	350
d	15.88mm (OD)	Rmt	300
e	19.05mm (OD)	Rmt	900

8	Supply of G.I. Tray support and Covered with G.I. Sheet for exposed copper tube at terrace level.	Rmt	100
9 a	Supply of 3 Core x 1.5 sq.mm copper cable for inter conecting between indoor units and outdoor units.	Rmt	7000
b	Supply of PVC conduit for the inter conecting above cable between indoor units and outdoor units.	Rmt	7000
10	Supply of oriplast PVC Drain piping		
a	25 mm dia	Rmt	1500
b	32 mm dia	Rmt	500
11	Supply of under deck insulation for exposed roofs 50mm thick fire proof thermocole with aluminium foil faced and all accessories	Sqm	3000
12	Supply of R-410 A Gas Charging for VRF systems	Lot	1
AIR CONDITIONING SYSTEM-DUCTING			
13	Supply of GSS Ducting as per ISI Standards and specification and providing openings wherever required in the existing civil structure and fixing of clamps, supports, hangs, etc.,		
a	0.8mm thick	Sqm	300
b	0.63mm thick	Sqm	1000
c	1.0 mm thick (For hot air removal from outdoor unit)	Sqm	250
14	Supply of canvass connections for all indoor units	Nos	143
15	Supply of powder coated, extruded aluminium grille without volume control dampers and fix up in positions with necessary frames, beedings and finished complete in coordination with civil works for use. Opening wherever required in the existing civil structure and fixing of clamps, supports, hangers, etc., required for running the pipelines, cables, duct etc.,.		
a	100mm linear grills	Rmt	600
16	Supply of thermal insulation of complete supply air ducting using xlpe of 6 mm thick with adhesive tape etc	Sqm	600
17	Supply of accoustic Insulation using Arma sound or equivalent material with 9mm thick.	Sqm	600

18	Supply of volume Control Dampers made out of 1.6 mm thick galvanised sheet steel frame and blades of 1.6 mm galvanised sheet steel with linkages, operating handle & depth of 150mm with 40mm flanges all around suitable for manual control locations show	Nos	150
19	Supply of trap door with two leaves using 63.5mmX38.5mm Size Teak Wood for the Outer frames it has to be positioned and fixed rigidly, sides grounted to the walls/ suspended from the Ceiling using G.I. stop angles. The frame work will be fixed with 18mm thick MR Grade plywood (water proof) shutters and the edges of the plywood to be sealed with 25 x 10mm size teak wood lipping. The shutteres to be provided with stainless steel bearing type concealed hinges, S.S. latch, with two doors etc., The exposed plywood surface to be painted with one coat of primer, two coats of putty and two coats of premium emulsion paint of approved colour etc., complete retardant properties as per the directions by the Engineer in Charge .	sqm	210.53
20	Supply of wooden false ceiling using 63.5 x 38.5mm size Teak wood to form the grid of size: as per the design suspended from the ceiling using G.I stop hangers. The frame work will be fixed with 12mm thick MR Grade (water proof) make plywood to have a seemless surface and will be painted with one coat of wood primer, two coats of premium emulsion paint of approved colour. All concealed surfaces of the wood should be treated with one coat of wood preservative, etc., complete.	Sqm	800
II - INSTALLATION, TESTING & COMMISSIONING			
	Installation, testing and commissioning of above supplies Item No: 1 to 20.	Lot	1
Note :	Detailed specification, requirments / vendor makes / drawings has to be refered to the attached specification.		
	Comprehensive Maintenance : Rates to be given for 5 years comprehensive AMC after the guarantee or warrantee period of one year.		

BUILDING MANAGEMENT SYSTEM

LOCATION: Administrative Office Building

	I. SCOPE OF SUPPLY		
	SUPPLY OF FOLLOWING ITEMS:		
ITEM NO:	**DESCRIPTION**		**MINIMUM QTY**
1	Supply of control Wiring of 4C x 1.0 sq.mm armoured copper cable for central monitor controllers of VRV / VRF system.	Rmt	2500
2	Supply of controller and software for the configuration of indoor and outdoor units of VRV / VRF system.	No	1
II. INSTALLATION TESTING AND COMMISSIONING			
	Installation, testing and commissioning of above supplies Item No: 1 and 2.	Lot	1

TENDER DOCUMENT FOR HVAC SYSTEM

1. SCOPE OF SUPPLIES

The central Heating, Ventilation and Air-Conditioning (HVAC) system shall comprise of following:

a. VRF Outdoor Units & Ductable Split Out Door Units
b. Indoor Units like, slim ceiling mounted ductable type and Hi- wall Split units,
c. Refrigerant piping & Refnet joints (gas and liquid Line)
d. Sheet metal ducts inclusive of external insulation, acoustic lining, canvas connections, silencers, volume control dampers and smoke/fire dampers as required.
e. Supply and return air registers and diffusers.
f. Insulation of pipes.
g. Vibration isolators for all HVAC equipment.
h. Automatic controls and instruments.
i. Cutting holes, chases and the like through all types of non structural walls, and finishings for all services crossings, including sealing, frame work, fire proofing, providing sleeves, cover plates, making good structure and finishes to an approved standard.
j. Balancing, testing and commissioning of the entire HVAC and mechanical ventilation installation.
k. Test reports, list of recommended spares, as-installed drawings, operation and maintenance manual for the entire HVAC installation.
l. Training of Owner's Staff.

m. Building Automation system

The VRF system shall be capable of working both cooling & heating mode automatically. The necessary control interlocking arrangement shall be provided in the main controller for seasonal selection of heating or cooling and avoid any mishandling during other seasons by occupants.
Each IDU shall be provided with a display thermostat with the following options:

- Operating mode : On/Off / Fan Speed / Temp.
- Mode Change : Locked (shall be changed from master controller only)
- Auto swing : required
- Sleep mode auto

DRAWINGS

The HVAC Drawings listed under Appendix-I, which may be issued with tenders, are diagrammatic only and indicate arrangement of various systems and the extent of work covered in the contract. These Drawings indicate the points of supply and of termination of services and broadly suggest the routes to be followed. Under no circumstances shall dimensions be scaled from these Drawings. The architectural/interiors drawings and details shall be examined for exact location of equipment, controls, grilles and diffusers.

The vendor shall follow the tender drawings in preparation of his drawings, and for subsequent installation work. He shall check the drawings of other trades/services to verify spaces in which his items will be installed. He shall prepare a detailed co-ordinated layout drawing.

The vendor shall examine all architectural, structural, plumbing, electrical and other services drawings and check the as-built works before starting the supplies, report to the BHEL's site representative any discrepancies and obtain clarification. Any changes found essential to coordinate installation of his items with other services and trades, shall be made with prior approval of the Architect/Consultant/BHEL's site representative without additional cost to the BHEL. The data given in the Drawings and Specifications is as exact as could be procured, but its accuracy is not guaranteed.

2. TECHNICAL DATA

Each tenderer shall submit along with his tender, the technical data for all items listed in Appendix-IV in the indicated format. Failure to furnish complete technical data with tenders may result in summary rejection of the tender.

3. DOCUMENTS

3.1 All the manufacturing drawings shall be prepared on computer through AutoCAD System based on Architectural Drawings, site measurements and Interior Designer's Drawings. All heat load calculations shall be done using latest version of HAP only. Within 15 days of the award of the PO, vendor shall furnish, for the approval of the Architect/Consultant, two sets of detailed shop drawings of all equipment and materials including layouts for outdoor unit location plan, fan coil units, ventilation fans; detailed ducting drawings showing exact location of supports, flanges, bends, tee connections, reducers, guide vanes, silencers, distribution grids, volume control dampers, fire dampers, collars, grilles, diffusers; detailed piping drawings showing exact location and type of supports, fittings etc; acoustic lining and external insulation details for ducts, pipe insulation etc; electrical panels inside/outside views, power and control wiring schematics, cable trays, supports and terminations. These drawings shall contain all information required to complete the Project as per specifications and as required by the Architect/Consultant/BHEL's site representative. These Drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, also the details of all related items of work by other vendors. Each drawing shall contain tabulation of all measurable items of equipment/materials/works and progressive cumulative totals from other related drawings to arrive at a variation-in-quantity statement at the completion of all drawings. Minimum 6 sets of drawings shall be submitted after final approval along with CD.

Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufacturers listed in Appendix-III and quoted by the tenderer in technical data part of Appendix - IV.

When the Architect/Consultant makes any amendments in the above drawings, the vendor shall supply two fresh sets of drawings with the amendments duly incorporated along with check prints, for approval. The vendor shall submit further 6 sets of drawings to the BHEL's site representative for the exclusive use by the BHEL's site representative and all other agencies. No material or equipment may be delivered or installed at the job site until the vendor has in his possession, the approved shop drawing for the particular material/equipment/installation & approved technical submittal.

3.2 Drawings shall be submitted for approval two weeks in advance of planned delivery and installation of any material to allow Architect/Consultant ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce drawings at the right time, in accordance with the approved program.

3.3 Manufacturers drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labeled, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted.

3.4 Samples of all materials like grilles, diffusers, controls, insulation, control wires etc shall be submitted to the consultants prior to procurement. After the approval process, these shall be submitted to BHEL's site representative/project managers to be kept in their site office for reference and verification till the completion of the Project. Wherever directed a mockup or sample installation shall be carried out for approval before proceeding for further installation.

3.5 Approval of drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings superceded the PO requirements, nor does it in any way relieve the vendor of the responsibility or requirement to furnish material and perform work as required by the PO.

3.6 Where the vendor proposes to use an item of equipment, other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundation, piping, wiring or any other part of the mechanical, electrical or architectural layouts; all such re-design, and all new drawings and detailing required therefore, shall be prepared by the vendor at his own expense and gotten approved by the Architect/Consultant/ BHEL's site representative. Any delay on such account shall be at the cost of and consequence of the vendor.

3.7 HVAC vendor shall prepare coordinated services drawings based on the drawings prepared by Electrical, Plumbing & Low Voltage to ensure adequate clearances are available for installation of services for each trade.

Where the work of the vendor has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the BHEL's site representative, the vendor shall prepare composite working drawings and sections at a suitable scale, not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the vendor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the BHEL.

3.8 Within a week of approval of all the relevant drawings, the vendor shall submit four copies of a comprehensive variation in quantity statement, and itemized price list of recommended (by manufacturers) imported and local spare parts and tools, covering all equipment and materials in this PO.

4. QUIET OPERATION AND VIBRATION ISOLATION

All equipment shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the BHEL's site representative. In case of rotating machinery sound or vibration noticeable outside the room in which it is installed, or annoyingly noticeable inside its own room, shall be considered objectionable. Such conditions shall be corrected by the vendor at his own expense. The works shall be deemed complete only after the completion of works in all respects. The vendor shall guarantee that the equipment installed shall maintain the specified at dB / NC levels.

5. ACCESSIBILITY

The vendor shall verify the sufficiency of the size of the shaft openings, clearances in cavity walls and suspended ceilings for proper installation of his ducting and piping. His failure to communicate insufficiency of any of the above, shall constitute his acceptance of sufficiency of the same. The vendor shall locate all equipment which must be serviced, operated or maintained in fully accessible positions. The exact location and size of all access panels, required for each concealed control damper, valve or other devices requiring attendance, shall be finalized and communicated in sufficient time, to be provided in the normal course of work. Failing this, the vendor shall make all the necessary repairs and changes at his own expense. Access panel shall be standardized for each piece of equipment / device / accessory and shall be clearly nomenclatured / marked.

6. MATERIALS AND EQUIPMENT

All materials and equipment shall conform to the relevant Indian Standards and shall be of the approved make and design. Makes shall be strictly in conformity with list of approved manufacturers as per Appendix - III.

7. MANUFACTURERS INSTRUCTIONS

Where manufacturer has furnished specific instructions, relating to the material and equipment used in this project, covering points not specifically mentioned in these documents, such instructions shall be followed in all cases.

8. ELECTRICAL INSTALLATION

The electrical work related to air conditioning services, shall be carried out in full knowledge of, and with the complete coordination of the electrical vendor. The electrical installation shall be in total conformity with the control wiring drawings prepared by the vendor and approved by the Architect/Consultant. All air conditioning equipment shall be connected and tested in the presence of an authorized representative of the vendor.

The air conditioning system shall be commissioned only after the vendor has certified in writing that the electrical installation work for air conditioning services has been thoroughly checked, tested and found to be totally satisfactory and in full conformity with the Drawings, Specifications and manufacturers instructions. It is to be clearly understood that the final responsibility for the sufficiency, adequacy and conformity to the requirements, of the electrical installation work for air conditioning services, lies solely with the HVAC vendor.

9. COMPLETION CERTIFICATE

On completion of the Electrical installation for air conditioning, a certificate shall be furnished by the vendor, counter signed by the licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local authority.

10. BALANCING, TESTING AND COMMISSIONING

Balancing of all air and VRF system and all tests as called in the specifications shall be carried out by the vendor through a specialist group, in accordance with the specifications and ASHRAE Guide lines and Standards.

Factory performance witness testing shall be part of the vendor scope to ensure the adequacy of the designated/quoted capacities of each model. All costs relating to performance witness test, at factory with two personnel from BHEL / Consultant shall be included as a part of the vendor scope .

Four copies of the certified manufacturer's performance curves for each piece of equipment, high lighting operational parameters for the project, shall be submitted along with the test certificates. vendor shall also provide four copies of record of all safety and automatic control settings for the entire installation.

The installation shall be tested again after removal of defects and shall be commissioned only after approval by the BHEL's site representative. All tests shall be carried out in the presence of the representatives of the Architect/Consultant and BHEL's site representative.

11. COMPLETION DRAWINGS

Vendor shall periodically submit completion drawings as and when work in all respects is completed in a particular area. These drawings shall be submitted in the form of two sets of CD's / DVD's and 6 sets of drawings on approved scale indicating the work as - installed. These drawings shall clearly indicate complete plant room layouts, ducting and piping layouts, location of wiring and sequencing of automatic controls, location of all concealed piping, valves, controls, dampers, wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The vendor shall frame under glass, in the air-conditioning plant room, one set of these consolidated control diagrams.

12. POWER REQUIREMENT

The vendor shall submit with their tender, their power requirement.

13. LIST OF MAIN DOCUMENTS AND SUBMITTALS

Sl. No.	Items		Clause No.	Remarks
1.	4-Copies of Proforma Invoice 4- sets of Technical Literature Packing Specifications.			
2.	Performance Guarantee			
3.	All Permits / Licenses			
4.	Technical Data			
5.	Manufacturer's Drawings, Catalogues & Other Documents			
6.	Variation in Quantity Statement.			
7.	Electrical Installation – Compliance Certificate.			
8.	Factory witness test for the designed/quoted capacities			
9.	Operating Instructions & Maintenance Manual			
10.	Appendix – IV – Schedule of technical data sheets.			
11.	Testing, Adjusting and Balancing			

Note: The above list is only for guide line of the vendor. The vendor shall thoroughly check all document and submittals required as per the tender document and submit them in time as per the requirement.

'C' APPENDIX – I

LIST OF HVAC DRAWINGS

Drawing No.	Title
300/VY/GV/11	Ground Floor &First Floor Layout
300/VY/GV/11	Second Floor &Third Floor Layout

A P P E N D I X - II

GUARANTEE PROFORMA

GUARANTEE FOR HVAC INSTALLATION

We hereby guarantee the year round Air Conditioning System which we have installed in the Complex described below:

Building :

Location :

Owner :

For a period of 12 months from the date of acceptance of the total installation, WE AGREE TO repair or replace to the satisfaction of the BHEL, any or all such work that may prove defective in workmanship, equipment or materials within that period, ordinary wear and tear and unusual abuse or neglect excluded, together with any other work, which may be damaged or displaced in so doing. In the event of our failure to comply with the above mentioned conditions within a reasonable time, after being notified in writing, we collectively and separately, do hereby authorize the BHEL to proceed to have the defects repaired and made good at our expense, and we shall pay the cost and charges thereof, immediately upon demand.

WE ALSO HEREBY UNDERTAKE to test the entire installation in first SUMMER, WINTER AND MONSOON on following the completion of the installation, to check and do everything necessary to ensure that the specified indoor conditions in all spaces are maintained, that all water and air systems are properly balanced, that all controls are calibrated accurately, and that all units are functioning satisfactorily.

SIGNATURE OF VENDOR
for HVAC INSTALLATION

DATE:

SEAL

APPENDIX - III

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS (HVAC)

Sl.No	Details of Materials / Equipment		Manufacturer's Name
1.	VRV (Indoor and Outdoor Units) & Ductable split units (Out door / Indoor units)		Samsung / Voltas / Bluestar / Carrier / Daikin / LG
2.	Copper Pipes		Mandev Nippon Nissan Totaline
3	Inline/Propeller Fan/Roof extractor Fan		Nadi Kruger Almonard
4	Grille/diffuser		Cosmic Ravistar Air Master
5	Fire Damper		Airmaster Cosmic Ravistar
6	Sound Attenuators		Cosmic Airmaster
7	Anchor Fasteners		Hilti Fischer
8	Cross-linked polyethylene		Trocellen Paramount
9	Fiberglass		UP Twiga Owens Corning

APPENDIX-IV

SCHEDULE OF TECHNICAL DATA

Sl.No.	Description		Technical Requirement
	VRF - OUT DOOR UNITS :		
	(Furnish Data for all ODU Models separately)		
A	GENERAL:		
1	Make & Model		
2	Refrigerant Used		
3	Refrigerant control used		
4	Capacity - HP		
5	No. of Compressors / Machine		
6	No. of Condenser Coil / Machine		
7	No. of Circuits		
8	Type of Fan		
9	No. of Fans per machine		
10	Air Flow rate (CMH)		
11	Operating Condensing Temperature - deg C		
12	Operating Suction temperature - deg C		
13	Heat Exchanger		
14	Overall dimensions including stand		
	mm x mm x mm		
15	Operating Weight - Kg		
16	Minimum clearance required from adjacent Structures - m		
17	Minimum clearance required between two ODU's – m		
18	Whether any platform or pedestal required for Installation? If so, furnish details.		
19	Noise level at a distance of 1 m from the machine at intervals of 1 m along the perimeter - db		
20	Noise level when all the machines are working – db		
B	COMPRESSOR – MOTOR UNIT		
	CONSTANT SPEED SCROL COMPRESSOR :		
	(Furnish Data for each Compressor Model in the Machine Separately)		
1	Nos. per Machine		
2	Make		
3	Model		
4	Type		
5	a. Whether hermetic or semi-hermetic?		
6	Power Consumed - KW		
7	KW / HP		
C	Ceiling Mounted Ductable Units (High Static) :		
1	Air flow rate – CFM (High/Medium/Low)		
2	Coil face area – sqm		
3	Fan velocity – m/s		
4	No. of rows		
5	Fin density – No. of fins/cm		
6	Material of tube		
7	Tube OD – mm		
8	No. of tubes		
9	Length of tubes – mm		
10	Material of fin		
11	Overall weight – Kg		
12	Entering air db – deg C		
13	Leaving air db – deg C		
14	Condensing temperature – deg C		
15	Pressure drop across the coil – mm wg		
16	Is a receiver required? If so, whether receiver included.		
17	Test pressure – Kg		
18	Method of test		
19	Noise level at high/medium/low speed		

20	External Static pressure – Pa		
21	Overall dimensions – mm x mm x mm		
	Note:- Separate/ individual Data sheets to be furnished for individual capacity of the units.		
D	Ceiling Mounted Ductable Units (Low Static) :		
1	Air flow rate – CFM (High/Medium/Low)		
2	Coil face area – sqm		
3	Fan velocity – m/s		
4	No. of rows		
5	Fin density – No. of fins/cm		
6	Material of tube		
7	Tube OD – mm		
8	No. of tubes		
9	Length of tubes – mm		
10	Material of fin		
11	Overall weight – Kg		
12	Entering air db – deg C		
13	Leaving air db – deg C		
14	Condensing temperature – deg C		
15	Pressure drop across the coil – mm wg		
16	Is a receiver required? If so, whether receiver included.		
17	Test pressure – Kg		
18	Method of test		
19	Noise level at high/medium/low speed		
20	External Static pressure – Pa		
21	Overall dimensions – mm x mm x mm		
	Note:- Separate/ individual Data sheets to be furnished for individual capacity of the units.		
E	Wall Mountedunit:		
1	Air flow rate – CFM (High/Medium/Low)		
2	Fan velocity – m/s		
3	Overall weight – Kg		
4	Entering air db – deg C		
5	Leaving air db – deg C		
6	Condensing temperature – deg C		
7	Pressure drop across the coil – mm wg		
8	Drain pump required? If so, whether Drain Pump included.		
9	Test pressure – Kg		
10	Method of test		
11	Noise level at high/medium/low speed		
12	External Static pressure – Pa		
13	Overall dimensions – mm x mm x mm		
	Note:- Separate/ individual Data sheets to be furnished for individual capacity of the units.		

A P P E N D I X - V
LIST OF INDIAN STANDARD CODES

IS : 277 - 1992	Galvanized steel sheet
IS : 655 - 1963 (Reaffirmed to latest)	Metal air ducts.
IS : 659 – 1964 (Reaffirmed to latest)	Air conditioning (Safety Code)
IS : 660 – 1963 (Reaffirmed to latest)	Mechanical Refrigeration (Safety Code)
IS : 732 - 1989	Code of practice for electrical wiring.
IS : 2379 - 1990	Colour code for the identification of pipelines.
IS : 2551 - 1982	Danger notice plate
IS : 3103 – 1975 (Reaffirmed 1999)	Code of practice for Industrial Ventilation.
IS : 4894 - 1987	Centrifugal Fan.
IS : 5133 - 1969 (Part-I) (Reaffirmed to latest)	Boxes for the enclosure of electrical accessories.
IS : 5216 - 1982(Part-I) (Reaffirmed to latest)	Guide for safety procedure and practices in electrical work.
BS : EN:779 – 1993	Filters
ASHRAE Hand Books	American Society of Heating Refrigeration & Air-conditioning.
	Application 2007
	Fundamentals 2007
	Systems & Equipment 2000
	ASHRAE Indoor air quality Standard 62-2001
IEC	Relevant Sections.

'D' TECHNICAL SPECIFICATIONS:

1. BASIS OF DESIGN

The HVAC System for the project is conceptualized based on the Arch Planning & Design Standards to produce a concept which is an integrated as a whole. Conservation of energy, optimization of resources, fire safety & eco-friendly systems are the key factors in the design concept. The overall carpet area works out to be 53,000 Sq.ft for air conditioning excluding toilets areas etc.

A VRF/VRV system consists of an outdoor unit with multiple compressors and different type of indoor units for different zones. For the fresh air is distributed through the treated fresh air units. The VRF/VRV plant can run at a capacity as low as 1 TR.

HVAC BRIEF:

The HVAC system is being designed to have highly economical, functional, provisions for environmental friendly with the concepts of Green building codes and standards. Based on the heat load calculations total air-conditioned peak load works out to be 460 TR. Based on the requirement Variable Refrigerant Flow (VRF) system & Dx system is proposed.

DESIGN REQUIREMENT

LOCATION:

SITE LOCATION Thirumayam.

The outside and inside conditions for the desired facility shall be designed based on below mentioned parameters:

SUMMER	DRY bulb temp 39.4 DEG C	WET bulb temp 27.8DEG C	RH - 41%
MONSOON	DRY bulb temp 28.3 DEG C	WET bulb temp 26.7DEG C	RH - 88 %
WINTER	DRY bulb temp 18.3 DEG C	WET bulb temp 13.9 DEG C	RH - 60 %

INSIDE CONDITIONS:

For all areas

1) Dry Bulb Temperature - 23 +/- 1 Deg C.

2) Relative Humidity - Less than 60%

FRESH AIR :

AS PER ASHRAE 62.1-2007 (Latest)

ASHRAE STANDARD- 62.1-2007									
Occupancy Category	People outdoor Air Rate Rp		Area outdoor Air Rate Ra		Notes	Occupant Density (see note 4)	Combined outdoor Air Rate (see note 5)		Air class
	cfm/person	L/s-person	cfm/ ft²	L/s-m²		#1000ft² or #100m²	cfm/person	L/s-person	
Correctional Facilities									
Cell	5	2.5	0.12	0.6		25	10	4.9	2
Dayroom	5	2.5	0.06	0.3		30	7	3.5	1
Guard stations	5	2.5	0.06	0.3		15	9	4.5	1
Booking / Waiting	7.5	3.8	0.06	0.3		50	9	4.4	2
Education Facilities									
Daycare (through age 4)	10	5	0.18	0.9		25	17	8.6	2
Daycare sick room	10	5	0.18	0.9		25	17	8.6	3
Classrooms(ages 5-8)	10	5	0.12	0.6		25	15	7.4	1
Classrooms(ages 9 Plus)	10	5	0.12	0.6		35	13	6.7	1
Lecture classroom	7.5	5	0.06	0.3		65	8	4.3	1
Lecture hall (fixed seats)	10	3.8	0.06	0.3		150	8	4	1
Art classroom	10	3.8	0.18	0.9		20	19	9.5	2
Science laboratories	10	5	0.18	0.9		25	17	8.6	2
University / College laboratories	10	5	0.18	0.9		25	17	8.6	2
Wood / metal shop	10	5	0.18	0.9		20	19	9.5	2
Computer lab	10	5	0.12	0.6		25	15	7.4	1
Media centre	10	5	0.12	0.6	A	25	15	7.4	1
Music / theater / dance	10	5	0.06	0.3		35	12	5.9	1
Multi-use assembly	7.5	3.8	0.06	0.3		100	8	4.1	1
Foof and Beverage services									
Restaurent dining rooms	7.5	3.8	0.18	0.9		70	10	5.1	2
Cefeterria / fast food dining	7.5	3.8	0.18	0.9		100	9	4.7	2
Bars ,Cocktail lounges	7.5	3.8	0.18	0.9		100	9	4.7	2
General									
Break rooms	5	2.5	0.06	0.3		25	10	5.1	1
Coffee stations	5	2.5	0.06	0.3		20	11	5.5	1
Conference / meeting	5	2.5	0.06	0.3		50	6	3.1	1
corridors	-								
Storage rooms	-				B				
Hotels, Motels, Resorts,Dormitories									
Bedroom/ living room	5	2.5	0.06	0.3		10	11	5.5	1
Barracks sleeping areas	5	2.5	0.06	0.3		20	8	4	1
Laundry rooms, central	5	2.5	0.12	0.6		10	17	8.5	2
Laundry rooms, within dwelling units	5	2.5	0.12	0.6		10	17	8.5	1
Lobbies / prefunction	7.5	3.8	0.06	0.3		30	10	4.8	1
Multi-purpose assembly	5	2.5	0.06	0.3		120	6	2.8	1
Office Buildings									
Office space	5	2.5	0.06	0.3		5	17	8.5	1
Reception areas	5	2.5	0.06	0.3		30	7	3.5	1
Telephone data entry	5	2.5	0.06	0.3		60	6	3	1
Main entry lobbies	5	2.5	0.06	0.3		10	11	5.5	1

Occupancy Category	People outdoor Air Rate Rp		Area outdoor Air Rate Ra		Notes	Occupant Density (see	Combined outdoor Air Rate (see note 5)		Air class
	cfm/person	L/s-person	cfm/ ft²	L/s-m²		#1000ft² or #100m²	cfm/person	L/s-person	
Miscellaneous spaces									
Bank / safe deposit	5	2.5	0.06	0.3		5	17	8.5	2
Computer (not painting)	5	2.5	0.06	0.3		4	20	10	1
Electrical equipment rooms	-	-	0.06	0.3	B	-			1
Elevator machine rooms	-	-	0.12	0.6	B	-			1
Pharmacy	5	2.5	0.18	0.9		10	23	11.5	2
photo studio	5	2.5	0.12	0.6		10	17	8.5	1
Shipping / receiving	-	-	0.12	0.6	B	-			1
Telephone closet	-	-	0	0		-			1
Transpotation waiting	7.5	3.8	0.06	0.3		100	8	4.1	1
Warehouse	-	-	0.06	0.3	B	-			2
Public Assembly spaces									
Auditorium seating area	5	2.5	0.06	0.3		150	5	2.7	1
Places of religious	5	2.5	0.06	0.3		120	6	2.8	1
worship	5	2.5	0.06	0.3		70	6	2.9	1
Legislative chambers	5	2.5	0.06	0.3		50	6	3.1	1
Libraries	5	2.5	0.12	0.6		10	17	8.5	1
Lobbies	5	2.5	0.06	0.3		150	5	2.7	1
Museums(Children's)	7.5	3.8	0.12	0.6		40	11	5.3	1
Museums / galleries	7.5	3.8	0.06	0.3		40	9	4.6	1
Residential									
Dwelling unit	5	2.5	0.06	0.3	F,G	F			1
Commom corridor	-	-	0.06	0.3					1
Retail									
Sales	7.5	3.8	0.12	0.6		15	16	7.8	2
Mall common areas	7.5	3.8	0.06	0.3		40	9	4.6	1
Barber shop	7.5	3.8	0.06	0.3		25	10	5	2
Beauty and nail salons	20	10	0.12	0.6		25	25	12.4	2
Pet shops (animal areas	7.5	3.8	0.18	0.9		10	26	12.8	2
Supermarket	7.5	3.8	0.06	0.3		8	15	7.6	1
Coin operated laundries	7.5	3.8	0.06	0.3		20	11	5.3	2
Sports and Entertainment									
Sports area (play area)	-	-	0.03	1.5	B	-	-	-	1
Gym stadium (play area)	-	-	0.03	1.5		30	-	-	2
Spectator area	7.5	3.8	0.06	0.3		150	8	4	1
swimming (pool & deck)	-	-	0.48	2.4	C	-	-	10.3	2
Disco / dance floor	20	10	0.06	0.3		100	21	10.8	1
Health club / aerobics room	20	10	0.06	0.3		40	22	13	2
Health club / weight room	20	10	0.06	0.3		10	26	6.5	2
Bowling alley (seating)	10	5	0.12	0.6		40	13	4.6	1
Gambling casinos	7.5	3.8	0.18	0.9		120	9	8.3	1
Game	7.5	3.8	0.18	0.9		20	17	5.4	1
stages, studios	10	5	0.06	0.3	D	70	11	1.2	1

The world focus has shifted from the environment to ‘Invironment’. This is a new terminology, being used increasingly to focus on the Indoor Air Quality (IAQ) and its effect on human health. While the outdoor environment continues to be of concern, the indoor environment is receiving increased attention as more information has become available on the presence and effect of indoor contaminants.

HVAC SYSTEM PROPOSED & DESCRIPTION

A Zonal air conditioning system shall be designed to provide year round thermal environmental control for all air-conditioned areas.

The VRV (Variable Refrigerant Volume) system consists of an outdoor unit with the compressors, Refrigerant Pipes and the different types of indoor units. The VRV plant can run at a capacity as low as 1 TR. VRV system offers saving in space, and running cost.

The indoor and the outdoor units are connected through the refrigerant pipes.

The fresh air intake for the Ceiling suspended units shall be through the Inline fans. Inline fans catering the fresh air to the CSUs and indoor units shall be placed in the in the area as per the drawing. The fresh air louvers on either side to be provided.

Air distribution into conditioned space shall be through insulated galvanized sheet metal ducting and through ceiling mounted supply air diffusers/grilles. Each diffuser shall have an acoustically treated plenum connected to branch ducts by factory insulated flexible ducts.

Kitchen shall be provided with mechanical ventilation system. The system shall consist of inline type fan, fresh air grille with filters, air distribution system with grilles, electrical panel, power cabling, control wiring and earthing. Fresh air shall be drawn from outside and supplied by means of grilles.

VARIABLE REFRIGERANT VOLUME (VRV) SYSTEM BRIEF :

The VRV system comprises of outdoor condensing units, Indoor units, Refrigerant copper piping, Power and control cables and remote/centralized controller for operating the system. The indoor temperature sensor, according to the actual load of the indoor unit, controls the electronic expansion valve on the refrigerant medium pipe of the indoor unit. And it controls the compressor of the outdoor unit according to the change in the refrigerant medium pressure, varying the refrigerant volume of the system. In this way, the air conditioning system can adjust itself automatically to meet the needs of the change in the indoor load so as to attain the goal of conserving energy. The refrigerant piping of the variable refrigerant volume air conditioning system can be 100 – 150 meters long, and the height difference can be 50 meters. So there is a lot of flexibility to arrange the outdoor unit to avoid the conflict between the positioning of the outdoor unit and the architectural effect. The variable refrigerant volume air conditioning system has a high degree of intellectual control, with every indoor unit being able to directly start the air-conditioning system, freely setting and regulating the temperature, the volume and direction of the current, and the mode. Every indoor unit can separately control its start and close, and set and regulate its operations, so that it can meet the individual needs of the end-users. t is generally recognized that the variable refrigerant volume air conditioning system, because it is energy-efficient and easy to use, can be installed in residential buildings as well as medium and small- sized public buildings. As a matter of fact, this system has been installed in medium and small-sized office blocks, stores, restaurants and residential buildings, showing a growing trend. Excellent part load system performance delivering maximum comfort for minimal power consumption on the complete application temperature range. The diversity on the outdoor on the indoor installed units can be applied which reduces the power requirement.

The outdoor air cooled condensing units are easily located on the Terrace. Variety of indoor units like fan coil units, ductable ceiling suspended units, cassette units, high wall type units and floor mounted packaged units to suit the requirements at individual locations in a premise and to meet the special needs and also available in various capacities. Centralized control is also possible in addition to the individual remote control which is possible to be hooked to Building Management System.

Compared with the traditional central air-conditioning system, the most striking features of the variable refrigerant volume air conditioning system is easy to install, and flexible to operate. It can be installed, according to the availability of investment and the needs of decoration, by block, by section, by floor, by household, by phase and by batch. Operation of traditional central air-conditioning system is totally pre-designed by management side in accordance with time. It demands considerable high-energy consumption in low-loading operation, thus it cannot meet special needs of users. The variable refrigerant volume air conditioning system can make it true that each room is independently controlled. The output of outdoor machine can be automatically adjusted with the change of indoor working load, so the system can run with low cost round the hour as per user's actual needs. It is fit for use in holidays and in extra work shift.

2. SCOPE OF DESIGN

VRV (Variable Refrigerant Volume) system Design consisting of Outdoor units, Indoor Units and Refrigerant Piping.

Space allocation for Outdoor Units at Terrace Floor.

Space allocation of ductable fan coil Units, high wall type units for all the areas showing scheme drawing of all usable spaces like

Forced Ventilation system design for Toilets.

To maintain Indoor Air quality by appropriate Fresh air allocation.

ADVANTAGES OF SYSTEM CONTROLLER IN A VRV SYSTEM:

a.Remote control with corded or cordless is possible

b. System controllers can control multiple units – acts like mini BMS system

c. Compatible for BMS system

d. Individual controls & setting from remote control or system controller

e. Group Timer setting

f. Group fan speed controller

g. Open protocol for BMS hooking

APPLICABLE STANDARDS:

Basically Air conditioning system design shall be done as per the latest ASHRAE standards. Also other applicable standards shall be considered as guidelines are mentioned as under:

a. American Society of Heating Refrigeration Air conditioning Engineers (ASHRAE)

b. Fresh air as per Green building standards

c. IS wherever applicable

d. SMACNA standards

e. National Building Codes (NBC Codes)

f. ECBC Standards

g. NFPA 90 A installation of air conditioning and ventilation system

h. AMCA standards

2.1 VRF TYPE:

Unit shall be a VRF system Digital scroll with vapour injection technology for application with R410 A refrigerant air cooled, variable refrigerant flow air conditioner consisting of one outdoor unit and multiple indoor units. Each indoor unit shall have suitable capacity to cool independently for the requirement of the respective spaces.

It shall be possible to connect multiple indoor units on respective refrigerant circuits as shown in the drawings/BOQ. The indoor units can be of different type and also controlled individually. Following type of indoor units is envisaged to be connected to the system:

- Ceiling mounted ductable type.
- Wall mounted Hi-Wall type.
- Slim Ceiling mounted ductable type.

Compressor installed in outdoor unit shall be equipped with digital controller, and capable of changing the rotating speed to follow variations in cooling. Outdoor unit shall be suitable for mix-match connection of all type of indoor units.

The refrigerant piping between indoor units and out door units shall be extended up to 150m with maximum 50 m level difference. Oil recovery system shall be designed to operate without disturbance to normal operation cycle of the system / compressor.

Both indoor unit and outdoor unit shall be factory assembled, tested and filled with first charge of refrigerant before delivery at site.

2.2 OUT DOOR UNIT:

The outdoor unit shall be factory assembled, weather proof casing constructed from heavy gauge galvanized steel sheet with powder coated finish.

All outdoor units above 12 HP rating shall have minimum three numbers scroll compressors out of which one compressor shall be Variable based.

Each refrigeration cycle shall be equipped with scroll compressors, solenoid valve, heat exchanger, an accumulator, 4-way valve and flare connection parts

In case of outdoor units with multiple compressors, the operation shall not be disrupted with failure of any compressor.

The noise level shall not be more than 60 dB (A) at normal operation measured horizontally 1m away and 1.5 m above ground level.

The unit shall be provided with microprocessor control panel.

The outdoor fans shall be plastic propeller type, dynamically balanced. The fan shall be directly driven by a suitable motor for vertical flow discharge. The fan motor shall be permanently lubricated and be protected from ingress of water.

The compressor shall be protected against breakdown by a quick response over current relay, a high pressure switch, a wrap around type oil heater and discharge gas thermistor.

2.3 LOW NOISE MODE AT NIGHT:

The outdoor unit of variable refrigerant flow system has a peculiar function of night shift setting, which reduces the noise level by 5 Db at night when operating at full capacity compared with the normal operation in daytime.

2.4 COMPRESSOR:

The compressor shall be high efficiency scroll type and capable for capacity controlling. It shall change the speed / refrigerant mass flow rate in accordance to the variation in cooling load requirement.

All outdoor units shall have multiple steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated. Forced lubrication may also be employed.

2.5 OUTDOOR HEAT EXCHANGER:

The Heat Exchanger shall be constructed with copper tubes mechanically bonded to aluminium fins to form a cross fan coil and larger surface area.

The fins shall have anticorrosion treatment for Heat Exchanger Coil. The treatment shall be suitable for areas of high pollution, moisture and salt laden air.

The casings, fans, motors etc. shall also be with anticorrosion treatment as a standard features.

The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical / horizontal discharge and shall be capable of handling minimum 6 mm external pressure drop. Each fan shall have a safety guard.

2.6 REFRIGERANT CIRCUIT:

The Refrigerant Circuit shall include a liquid receiver /accumulator, liquid & gas shut off valves and a solenoid valve. All necessary safety devices shall be provided to ensure the safety operation of the system.

2.7 SAFETY DEVICES:

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

Following safety devices shall be part of the outdoor unit high pressure switch, low pressure switch, fuse, crankcase heater, fusible plug, over current protection for inverter, and short recycling guard timer.

2.8 PIPING:

All connections of Refrigerant piping shall be in high grade Copper of Refrigeration quality and material test Certificates.

All connections, tees, reducers etc. shall be standard make fittings.

Insulation of cold lines shall be carried out with Armaflex / K-Flex / equiv. insulation sheets and tubes of appropriate thickness so that condensation does not occur. Necessary external coating protection shall be given for the complete refrigerant piping.

For individual Piping 50 / 100 mm wide Aluminium Tape shall be used at joints of Piping with Bands for identification.

2.9 OIL RECOVERY SYSTEM:

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigerant piping.

System shall be designed for proper oil return to compressor along with the distribution of oil to individual compressor.

The refrigerant piping shall be extended upped 150 Mtr with 50 Mtr level differences.

2.10 INDOOR UNITS:

Units shall be factory assembled, wired, piped and tested.

Units shall have DX coils with copper tubes and bonded aluminium fins for highly efficient heat transfer.

Units shall have Centrifugal fans for adequate amount of Air circulation and low Noise.

Units shall have inlet filters, which are easily cleanable and replaceable.

All components of Units are easily accessible for connection, repairs and maintenance.

Units shall have very low noise.

All units with Factory manufactured Units, Grills shall have auto swing feature for proper Air distribution.

All units shall be controlled by electronic Expansion Valves only.

All units mounted inside the ceiling shall have fans capable of sustaining duct connections, and special filters if necessary.

All units shall have adequate insulation or Lining to avoid condensation.

2.11 CEILING MOUNTED DUCTABLE TYPE UNIT:

Unit shall be suitable for ceiling mounted type. The unit shall include pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel. The unit shall have high static fan for ductable arrangement.

All ductable type indoor units below 8 HP shall have three speed fan motors

2.12 CENTRAL REMOTE CONTROLLER:

A multi-functional centralized controller (central remote controller) shall be supplied as an optional accessory.

The controller shall be able to control outdoor units and indoor units.

- Temperature setting for each zone, or group, or indoor unit.
- On/Off as a zone or individual unit.
- Indication of operating condition.
- Select ON of all operation modes for each zone.
- The controller shall have wide screen liquid crystal display and shall be wired by a non polar 2 wire transmission cable to a distance of 1000m away from the indoor unit.
- The controller shall be integrated to BAS system thru software for monitoring & controlling of all above parameters including start/ stop of each indoor / out door unit. All necessary interface cards / units should be supplied as a part of the system to integrate to the BAS Software.

2.13 CONDENSATE:

1" dia PVC pipes & fittings shall be used from condensate from Evaporator Unit to drain point. The joints shall be properly sealed so that there is no water leakage. U-trap as required shall be provided at the end. Additional insulation drain tray shall be provided below the Evaporator Unit, if required.

2.14 MOUNTING:

All indoor units shall be mounted with Brackets, Hangers etc. with proper size anchor Fasteners.

3.0 FRESH AIR INTAKES:

Extruded aluminium construction duly anodized (20 microns and above) fresh air louvers with bird screen and dampers shall be provided in the clear openings in masonry walls of the air handling unit rooms having at least one external wall. Louvers, damper, pre-filters, ducts and fresh air fan with speed regulator shall be provided as shown on Drawings and in Schedule of Quantities. Fresh air dampers shall be of the interlocking, opposed-blade louver type. Blades shall be made of extruded aluminium construction and shall be rattle-free. Dampers shall be similar to those specified in "Air Distribution". Fresh air fans and fresh air intakes shall be as per the requirements of Schedule of Quantities.

3.1 PAINTING

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

3.2 PERFORMANCE DATA

Air handling unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data, with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the installation.

3.3 TESTING

Cooling capacity of various air handling unit models be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

DUCTABLE SPLIT TYPE DX UNITS

1.1 Cabinet

The shell shall be constructed out of corrosion resistance epoxy coated GI sheets of 18 SWG thick and the back panel can be made out of 20 SWG CR epoxy coated sheet metal. All panels should be of easily removable type for maintenance. Coil and blower section shall be internally lined with 12 mm thick resin bonded fiberglass and covered with nylon netting OR suitable similar material.

1.2 Evaporator Coil

The cooling coil shall be made out of 9.5 mm OD Copper tubes with external mechanically bonded Aluminum fins, with a fin spacing of not less than 5 fins/cm. The cooling coil shall have sufficient face area, so that the face velocity shall not exceed 165 m/min. A corrosion resistant drain pan shall be provided beneath the cooling coil, along with an outlet nozzle of not less than 40 mm dia. for drain connection. Washable type synthetic fabric media pre-filters of filtration efficiency of 90 % down to 20 microns shall be provided ahead of the cooling coil. The filter shall be easily removable for cleaning purposes.

1.3 Evaporator Fan

The evaporator fan shall be of Centrifugal type with DIDW impeller. The fan and the drive shaft shall be statically and dynamically balanced. The fan shall be either directly driven OR belt driven by a suitably rated TEFC squirrel cage motor rated for 415 V, 3 phase, 50 Hz power supply. The motor shall be factory wired and brought out to a terminal block mounted on the outside of the unit, to facilitate easy wiring at site. The fan shall be quiet in operation and the noise level should not exceed 60 dBA.

1.4 Compressor

Compressors offered shall be of Hermetic scroll type, suitable for operating with R- 410A refrigerant. The motor shall be rated for 415 V, 3 phase, 50 Hz power supply and should be capable of operating under +/- 10 % fluctuations in the supply voltage. If multiple compressors are offered for the specified split units, then each of the compressors shall be of equal capacity. Moreover, an electronic temperature controller shall be provided which shall automatically and progressively trip the compressors under partial load conditions. The compressors shall be housed in the in the air cooled condensing unit.

1.5 Air Cooled Condensing Unit

The condensing unit shall be designed for out door installation and hence be of weather proof construction. This shall house the Compressor(s) and the air cooled condenser. The condenser coil shall be with 9.5 mm OD Copper tubes and minimum 26 SWG mechanically bonded aluminum fins, with a fin spacing of not less than 5 fins/cm. The coil should be adequately sized to handle the the design heat rejection and also provide sub cooling. The coil should be designed to work under a peak ambient temperature of 41 Deg C. The air cooled condenser fan shall ideally be propeller type and should be selected for low speed and quite operation. The noise level should not exceed 75 dBA.

1.6 Refrigerant System & Controls

The refrigerant piping interconnecting the indoor and outdoor units shall, preferably hard drawn copper tubes and with brazed joints. The system shall be complete with all necessary controls & fixtures like, shut off valves, strainers, thermostatic expansion valves, HP/LP safety cut outs etc.. Solid state temperature sensors for setting and controlling the temperature shall be provided.

1.7 Electrical

The units shall be supplied with a control panel, which shall house the complete electrical switch gear. For ductable split units, the panel shall be remotely located in an accessible location close to the indoor unit. All necessary contactors, over load relays, anti-recycle timer relays etc.. Shall be housed within this panel. Main power supply, if not specified otherwise in the BOQ or elsewhere, shall be terminated by the client in this panel and feeder cables to feed power to the out door condensing units shall be carried out by the AC contractor only.

1.8 Control Panel

The ductable split units shall be supplied with micro-processor based control system. The system shall have digital display of the return air temperature and the set point temperature.

The following safety features shall be provided and the same shall have LED indications:

- Under voltage / over voltage trip.
- Phase Failure / Phase reversal trip.
- High Pressure trip (comp1 & comp2 for dual circuits)
- Compressor O/L trip (comp1 & comp2 for dual circuits)
- Fan fails indication.

The following mode selection shall be provided:

- Fan Mode,
- Cool Mode.

The panel shall allow temperature set point adjustment.

<u>REFRIGERANT PIPING</u>

1.1 General: The scope of this section covers supply, laying, testing and commissioning of copper refrigerant piping. The tender drawings enclosed depict the schematic layout for the refrigerant piping routing. The vendor shall prepare his working drawings for approval by the BHEL before execution at site.

1.2 Hard drawn copper pipes shall be used for the refrigerant piping.

1.3 Refrigerant pipe sizes indicated in the tender is only tentative and the vendor shall confirm the same.

1.4 Refrigerant piping shall be designed as per the requirement of the system. Suction risers shall be designed as per the minimum load requirement of the system. The vendor shall submit the design calculations for the same for the consultant's approval and then execute the same at site.

1.5 Testing:

a. Pipes after full brazing / soldering are completed shall be pressure tested, without giving connections to the equipment. Pipes could be tested in sections and after testing the ends should be capped. No insulation or painting for the pipes shall be carried out before the pressure testing is completed and approved by their Engineer in-charge.

b. All pipes shall be tested for pressure as under:

i) 600 psig for the piping system.

In all the above cases the system should hold the pressure for 24 hours without any drop. The pressure testing and pressure reading should be inspected and approved by the Engineer in-charge. Any defects or leakage found during pressure testing shall be rectified and tests re-conducted.

c. The vendor shall organize arrangements for pressure testing.

d. Since hermetic / semi-hermetic compressors are proposed to be used, pressure testing should be carried out with dry Nitrogen gas. After pressure testing is completed successfully, the gas shall be vented, the system vaccumed, tested for vaccum test and then charged with refrigerant gas.

1.6 Measurements:

The pipes, for payment purposes, shall be measured as under:

The pipe lengths specified in the BOQ shall deemed to be inclusive of all fittings like Bends, Elbows, Reducers, Pipe supports, clamps etc. These will not be measured separately and paid for. The pipes shall be in unit length rounded off to the nearest centimeter and measured along the centre line of the pipe and fittings. The rates quoted shall also be inclusive of necessary painting as specified.

Condensate, drain piping and Refrigerant piping insulation:

Vidoflex / equivalent – 13mm thickness – closed cell electrometric Nitrile rubber with conductivity rating of K = 0.035W (m.k) at 0 deg C, condensation control, fire resistance. Flame and smoke proof. Density = 4.6pound /cu.ft (0.06 gm/ cm3. The application method shall prevent the ingress of moisture through the insulation to the cold surface.

Insulation shall fit closely to the pipe work and other surfaces without gaps between joint. Each section of preformed insulation shall secured to the pipe by means of circumferential bands of non-corrodible metal, plastics, fabric or glass fibre reinforced tape set in site-applied adhesive. Flexible closed – cell insulation shall be sleeve mounted on piping or shall be split, snap fitted and all joints secured with adhesive recommended by the insulation manufacturer.

At all points of support, the insulation, outer covering and vapour seal, shall not be pierced or fouled by the supports. The insulation at supports shall be material of sufficient compressive strength to carry the loads transmitted to the supports. The load-bearing insulation shall be extended on each side of such locations.

TEST READINGS

The following minimum readings shall be taken after commissioning and balancing of the complete Air Conditioning System. From the test readings the equipment capacities shall be computed and the quoted capacities should be established. Any discrepancies found out should be rectify free of cost. The Air conditioning Plant will be taken over by the BHEL only after successful completion of the above.

Compressor:
Suction Pressure - Kg / sq.cm. :
Suction Temperature - deg C :
Discharge Pressure - Kg / sq.cm:
Condensing Temperature - deg C :
Voltage - volts:
Computed compressor capacity based on the above operating parameters and compressor rating charts:

II. Air- Cooled Condenser:
Entering air temperature - deg C:
Leaving air temperature - deg C:
Air flow as measured through condenser coil: CMH
Calculated condenser heat rejection from the above
Kcal / hour:

III. Evaporator Coil:
Entering air dry bulb temperature - deg C:
Entering air wet bulb temperature - deg C:
Leaving air dry bulb temperature - deg C:
Leaving air wet bulb temperature - deg C:
Air flow rate across cooling coil - CMH:
Calculated coil capacity Kcal / hour:
Fresh air flow rate - CMH:
Fan motor current - Amps:
Power consumed by fan motor - KW:

IV. Inside Conditions:
Dry bulb and RH readings at every 10 sqmtrs
Conditioned area shall be recorded and tabulated.
This shall be carried out using digital temp. &
Humidity measuring instruments. :

4.0 FANS

4.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of centrifugal, in-line and Propeller type fans and roof mounted units conforming to these Specifications and in accordance with the requirement of Drawings and Schedule of Quantities.

4.1.2 TYPE

In-line & propeller fans shall be of the type as indicated on Drawings and identified in Schedule of Quantities.

4.1.3 CAPACITY

The air-moving capacity of fans shall be as shown on Drawings and in Schedule of Quantities.

4.2 PROPELLER FAN

Propeller fan shall be direct-driven, three or four blade type, mounted on a steel mounting plate with orifice ring.

a. Mounting Plate shall be of steel construction, square with streamlined venturi inlet (reversed for supply applications) coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

b. Fan Blades shall be constructed of aluminium or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works.

c. Shaft shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed thru the full range of specified fan speeds.

d. Motor shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 1000 rpm for fans 60 cm dia or larger and 1440 rpm for fans 45 cm dia and smaller. Motors for larger fans shall be suitable for 415±6% volts, 50 cycles 3 phase power supply, and for smaller fans shall be suitable for 220 ± 6% volts, 50 cycles single phase power supply. Motors shall be suitable for either horizontal or vertical service as indicated on Drawings and in Schedule of Quantities.

e. Accessories: The following accessories shall be provided with propeller fans :
   i. Wire guard on inlet side and bird screen at the outlet.
   ii. Fixed or gravity louvers built into a steel frame at the outlet.
   iii. Regulator for controlling fan speed for single phase fan motor.
   iv. Single phase preventer for 3 phase fans.

air from re-entering the fan when fan is not in operation, thus sealing completely in closed position. Damper shall be chatter-proof under all conditions.

f. Vibration Isolation: The motor and fan assembly shall be isolated from the base with vibration isolators.

4.3 PERFORMANCE DATA

All fans shall be selected for the lowest operating noise level. Capacity ratings, power consumption, with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation.

4.4 TESTING

Capacity of all fans shall be measured by an anemometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

5.0 DRAIN PIPING

a. All pipes to be used for condensate drain and fittings shall be Blue HDPE Pipe.
b. All jointing in the pipe system shall be by Fusion joints by fusion welding machine.
c. All pipes supports shall be mild steel, thoroughly cleaned and given one primary coat of red oxide paint before being installed.
d. All equipment and valve connections, or connections to any other mating pipes shall be through flanges required for the mating connections. Fittings & flanges shall form part of piping and are not separately identified in Schedule of Quantities.
e. Gate valves shall be similar to those specified for condensing piping.
f. For proper drainage of AHU-C Condensate, 'U' trap shall be provided in the drain piping.
g. All condensate drain piping shall be insulated and painted as per the section "Insulation" as indicated in Schedule of Quantities.

6.0 REFRIGERANT PIPING

a. All refrigerant pipes and fittings shall be hard drawn copper tubes and wrought copper / brass fittings suitable for connection with silver solder / phos-copper.

b. 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 carbon-dioxide / nitrogen.

c. Refrigerant lines shall be sized to limit pressure drop between the evaporator and condensing unit to less than 0.2 kg per sq.cm.

d. Sight glass with moisture indicator and removable type combination dryer cum filter with MS housing and brass wire mesh / punched brass sheet shall be installed in liquid line of the refrigeration system incorporating a three valve by pass. After ninety days of operation, liquid line drier cartridges shall be replaced.

e. Heat exchanger shall be MS heavy duty pipe in pipe type and without any joint in the inner pipe.

f. Horizontal suction line shall be pitched towards the compressor and no reducers shall be provided for proper oil return.

g. After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using Freon mixed with nitrogen / carbon-dioxide at a pressure of 20 kg per sq. cm (high side) and 10 kg per sq. cm (low side). Pressure shall be maintained in the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm of mercury and held for 24 hours. Vacuum shall be checked with a vacuum gage.

h. All refrigeration piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturer.

7.0 PIPING INSTALLATION

a. Design Drawings indicate schematically the size and location of pipes. The Contractor, on award of the work, shall prepare detailed shop drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and Refnet Joints and all pipe supports. He must keep in view the specific openings in the building through which pipes are designed to pass.

b. Piping shall be properly supported on, or suspended from, stands, clamps, and hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency.

c. Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated black. Where pipe and clamps are of dissimilar materials, a gasket shall be provided in between. Spacing of pipe supports shall not exceed the following :

Pipe size	Spacing between supports	Rod Size
Upto 12 mm	1.5 Meter	10 mm
15 to 25 mm	2.0 meter	10 mm
30 to 150 mm	2.0 meter	10 mm
Over 150 mm	2.5 meter	12.5 mm

d. Vertical pipes passing through floors shall be plumb and parallel to wall. Pipes shall be supported on alternate floor. MS cleats shall be welded on pipes and rest on MS channel placed on the floor with 15 mm thick resistoflex pads between the cleat and channel. U clamps with resistoflex sheet shall be provided to keep the pipe in position.

e. Bull heading in water/refrigerant piping shall be avoided.

f. Pipe sleeves at least 3 mm thick, 50 mm / 100 mm larger in diameter than condenser / chilled water pipes respectively shall be provided wherever pipes pass through retaining wall and slab. Annular space shall be filled with fiberglass and finished with retainer rings welded on the ends of the sleeve.

g. Wherever pipes pass through the brick or masonry / slab openings, the gaps shall be sealed with **fire sealant** such as fire barrier caulks.

h. Insulated piping shall be supported in such a manner as not to put under pressure on the insulation. 20 gauge metal sheets shall be provided between the insulation and the clamp, saddle or roller, extending at least 15 cm on both sides of the clamp, saddles or roller.

i. All piping work shall be carried out in a workmen like manner, causing minimum disturbance to the existing services, buildings and structure. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipes, supports, and pressure testing for each area shall be carried out in one stretch.

j. Cut-outs in the floor slabs for installing the various pipes are indicated in the Drawings. vendor shall carefully examine the cut-outs provided and clearly point out where the cut-outs shown in the Drawings do not meet with the requirements.

k. The vendor shall make sure that the clamps, brackets, clamp saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

l. All pipes shall be accurately cut to the required size in accordance with relevant BIS Codes, edges beveled and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.

m. Flanged inspection pieces 1.5 meters long, with bolted flanges on both ends, shall be provided no more than 30 meters centers, or where-ever shown in Approved-for-Construction shop drawings, to facilitate future cleaning of all welded pipes.

n. All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters and wrapped with three layers of fiber glass tissue, each layer laid in bitumen.

o. Insulated buried pipes shall be cleaned, de-rusted, then coated with rust-resistant primer and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters. Insulation shall be applied as per the section “Insulation”, wrapped with GI wire and covered with polyethylene sheet. Two coats (each 6 mm thick) of cement plaster shall be applied over chicken wire mesh lath. Where indicated in Schedule of Quantities, buried insulated pipes shall be water-proofed using coat of Shalibond, or approved adhesive, over the plastered surface; wrapping one layer of fiber glass RP tissue and one layer of roofing tar felt with sufficient overlaps, set and sealed with the adhesive, held in position by 16 gage G.I wire tied at 15 cm intervals.

8.0 AIR DISTRIBUTION

8.1 SCOPE

The scope of this section comprises supply fabrication installation and testing of all sheet metal / aluminium ducts, supply installation testing and balancing of all grilles registers and diffusers, in accordance with these specifications and the general arrangement shown on the Drawings.

8.2 DUCT MATERIALS

All ducts shall be fabricated from galvanized steel sheets / aluminium sheets of the following thickness as indicated in Schedule of Quantities.

	G S S	ALUMINIUM
Rectangular ducts up to 75 cm	24 gauge	22 gauge

Sheet metal ducts shall be fabricated out of galvanized steel sheets. Fabrication of ducts shall be through well conditioned Triplex lock former or multiple lock formers, conforming to relevant BIS00000 Codes. Sheets used shall be produced by Hot Dip Process and galvanizing shall be Class VII - Light Coating of zinc, Nominal 180 gm /Sq m surface area.

Samples of sheet from each lot selected at random by BHEL’s site representative shall be subject to approval & gotten tested for thickness and zinc coating at vendor’s expenses.

8.3 All ducts shall be made and installed in workmanlike manner, generally conforming to relevant BIS Codes. Round exposed ducts shall be die-formed for achieving perfect circle configuration.

a. Ducts so identified on the Drawings shall be acoustically lined and 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 accoustic lining where required and indicated in Schedule of Quantities.

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

c. All exposed ducts up to 60 cm width within conditioned spaces shall have slip joints - or flanged joints. The internal ends of slip joints shall be in the direction of air flow. Ducts and accessories within ceiling spaces, visible from air conditioned areas shall be provided with two coats of mat black finish paint.

d. Changes in dimensions and shape of ducts shall be gradual. Air-turns (Vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

e. Ducts shall be made 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.

f. 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 gage GSS / 16 gauge aluminium, thoroughly stiffened with 25 mm x 25 mm x 3 mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Doors shall be not less than 45 cm x 45 cm in size.

g. Plenums shall be panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards G S sheet and riveting shall be done from outside.

h. Self adhesive rubber lining minimum 5 mm thick instead of felt shall be used between duct flanges and between duct and duct supports *in* all ducting installation.

8.4 All ducts shall be installed generally as per tender Drawings, and in strict accordance with approved drawings to be prepared by the vendor .

a. The vendor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of BHEL's site representative in all its parts and details.

b. All necessary allowances and provisions shall be made by the vendor 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 area being maintained) all as per the site requirements.

c. If a duct cannot be run as shown on the Drawings, the vendor shall install the duct between the required points by any path available, in accordance with other services and as per approval of BHEL's site representative.

d. All duct work 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 under ducts at no greater than 2 meter centre. All vertical duct work 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 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.

e. Ducting over furred ceiling shall be supported from the slab above, or from beams, after obtaining approval of BHEL's site representative. 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 vendor 's work in the building.

g. Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick *TF quality expanded polystyrene around the duct and totally covered with fire sealant such as fire barrier mortar for complete sealing.*

h. All ducts shall be totally free from vibration under all conditions of operation. Whenever duct work 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 10 cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting duct work 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.

i Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

8.5 DAMPERS

a. Dampers: All duct dampers shall be opposed blade louver dampers of robust 16 G GSS construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.

b. Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting device shall be made robust, easily operable and accessible through suitable access door in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.

c. Dampers shall be placed in ducts at every branch supply or return air duct connection, whether or not indicated on the Drawings, for the proper volume control and balancing of the air distribution system.

8.6 FIRE & SMOKE DAMPERS

a. All supply and return air ducts at AHU room crossings and at all floor crossings shall be provided with Motor operated Fire & smoke damper of at least 90 minutes rating as per UL555/1995 tested by CBRI. These shall be of multi-leaf type and provided with Spring Return electrical actuator having its own thermal trip for ambient air temperature outside the duct and air temperature inside the duct. Actuator shall have Form fit type of mounting, metal enclosure and guaranteed long life span.

b. Fire damper blades and outer frames shall be of 16G galvanized steel construction fitted with 18 gage extended sleeves on both sides. The damper blade shall be pivoted on both ends using chrome plated spindles in self lubricated bronze bushes. Stop seals shall be provided on top and bottom of the damper housing made of 16G galvanized sheet steel. For preventing smoke leakage metallic compression seals will be provided.

c. The electric actuator shall be energized either upon receiving a signal from smoke detector installed in AHU room supply air duct / return air duct or temperature sensor. The fire damper shall also close upon sensing temperature rise in supply air ducts thru the electronic temperature sensor.

d. Each damper shall be provided with its own control panel, mounted on the wall and suitable for 240 VAC supply. This control panel shall be suitable for spring return actuator and shall have at least the following features:

Potential free contacts for AHU fan ON/ Off and remote alarm indication.
Accept signal from external smoke / fire detection system for tripping the electrical actuator.
Test and reset facility.
Indicating lights / contacts to indicate the following status:
Power Supply On
Alarm
Damper open and close position.

e. Actuators shall be mounted on the sleeve by the damper supplier in his shop and shall furnish test certificate for satisfactory operation of each Motor Operated Damper in conjunction with it's control panel. Control panel shall be wall mounted type.

f. It shall be HVAC vendor's responsibility to co-ordinate with the Fire Alarm System vendor for correctly hooking up the Motor Operated Damper to Fire Detection / Fire Management System. All necessary materials for hooking up shall be supplied and installed by HVAC vendor under close co-ordination with the fire protection system vendor.

g. HVAC vendor shall demonstrate the testing of all Dampers and its control panel after necessary hook up with the fire protection / fire management system is carried out by energizing all the smoke detectors with the help of smoke.

h. HVAC vendor shall provide Fire retardant cables wherever required for satisfactory operation and control of the Damper.

i. HVAC vendor shall strictly follow the instructions of the Damper Supplier or avail his services at site before carrying out testing at site.

j. Fire/smoke damper shall be provided with factory fitted sleeves; however, access doors shall be provided in the ducts within AHU room in accordance with the manufacturer's recommendations.

k. The vendor shall also furnish to the BHEL, the necessary additional spare actuators and temperature sensor (a minimum of 5% of the total number installed) at the time of commissioning of the installation.

8.7 SUPPLY AND RETURN AIR REGISTERS

Supply & return air registers shall be of either steel or aluminium sections as specified in schedule of quantities. Steel construction registers shall have primer Coat finish whereas extruded aluminium registers shall be either Anodized or Powder Coated as specified in Schedule of Quantities. These registers shall have individually adjustable louvers both horizontal and vertical. Supply air registers shall be provided with key operated opposed blade extruded aluminium volume control damper anodized in matt black shade.

The registers shall be suitable for fixing arrangement having concealed screws as approved by Architect. Linear continuous supply cum return air register shall be extruded aluminium construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides only (none on top & bottom). The thickness of the fixed bar louvers shall be minimum 5.5 mm in front and 3.8 mm in rear with rounded edges. Flanges on the two sides shall be 20 mm/30 mm wide as approved by Architect. The grilles shall be

suitable for concealed fixing. Volume control dampers of extruded aluminium anodized in black colour shall be provided in supply air duct collars. For fan coil units horizontal fixed bar grilles as described above shall be provided with flanges on four sides, and the core shall be & suitable for clip fixing, permitting its removal without disturbing the flanges.

a. All registers shall be selected in consultation with the Architect. Different spaces shall require horizontal or vertical face bars, and different width of margin frames. These shall be procured only after obtaining written approval from Architect for each type of register.

b. All registers shall have a soft continuous rubber/foam gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers for air flow shall not be less than 66 percent of gross face area.

c. Registers specified with individually adjustable bars shall have adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to +45 degree horizontal arc and up to 30 degree deflection downwards. Bars shall hold deflection settings under all conditions of velocity and pressure.

d. Bar longer than 45 cm shall be reinforced by set-back vertical members of approved thickness.

e. All volume control dampers shall be anodized aluminium in mat black shade.

8.8 SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be as shown on the Drawings and indicated in Schedule of Quantities. Mild steel diffusers/dampers shall be factory coated with rust-resistant primer. Aluminium diffusers shall be powder coated & made from extruded aluminium section as specified in schedule of quantities.

a. Rectangular Diffusers shall be steel / extruded aluminium construction, square & rectangular diffusers with flush fixed pattern for different spaces as per schedule of quantities These shall be selected in consultation with the Architect. These shall be procured only after obtaining written approval from Architect for each type of diffuser.

b. Supply air diffusers shall be equipped with fixed air distribution grids, removable key-operated volume control dampers, and anti-smudge rings as required in specific applications, and as per requirements of schedule of quantities. All extruded aluminium diffusers shall be provided with removable central core and concealed key operation for volume control damper.

c. Linear Diffuser shall be extruded aluminium construction with removable core, one or two way blow type. Supply air diffusers shall be provided with volume control/ balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with the Architect, and provided as per requirements of schedule of quantities. All diffusers shall have volume control dampers of extruded aluminium construction anodized in mat black shade.

d. Slot Diffuser shall be extruded aluminium construction multi slot type with air pattern controller provided in each slot. Supply air diffusers shall be provided with Hit & Miss volume control dampers in each slot of the supply air diffusers. Diffusers for different spaces shall be selected in consultation with the Architect and provided as per requirement of Schedule of Quantities.

8.9 MEASUREMENTS FOR DUCTING

Unless otherwise specified, measurements for ducting for the project shall be on the basis of centre-line measurements described herewith :

a. Duct Work 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 centre 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 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 centre line 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 centre line.

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 3 mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber / access panel, splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the Specifications. These accessories shall NOT be separately measured nor paid for.

b. Special Items for Air Distribution shall be measured by the cross-section area perpendicular to air flow, as identified herewith:

i. Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.

ii. Diffusers - cross section area for air flow at discharge area, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

iii. Linear diffusers - shall be measured by cross-sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

iv. 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.

v. 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.

vi. Kitchen Hoods - shall be measured by their cross sectional area at the capture point of fumes, parallel to the surface of kitchen equipment. Quoted rates shall include the grease filters, provision for hood light, suspension arrangement for the hood, profile to direct the air to ventilation ducts and provision for removable drip tray.

8.10 TESTING AND BALANCING

After the installation of the entire air distribution system is completed in all respects, all ducts shall be tested for air leaks by visual inspection.

The entire air distribution system shall be balanced using an anemometer. Measured air quantities at fan discharge and at various outlets shall be identical to or less/excess than 5 percent in excess of those 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. Complete air balance report shall be submitted for scrutiny and approval, and four copies of the approved balance report shall be provided with completion documents.

9.0 INSULATION

9.1 SCOPE

The scope of this section comprises the supply and application of insulation conforming to these specifications.

9.2 MATERIAL

Insulation material for Duct & Pipe insulation shall be Cross linked polyethylene insulation having a low & stable 'K' value of 0.027 – 0.029 k.cal/hr.m deg C (at 0 deg C to 23 deg C) with bulk density of 28+/- 4 kg/cum, Fire retardant in self extinguishing non-dripping fire rating class – 1 as per BS: 467 part 7, negligible water vapour permeability having good zone resistance, non fiber erosion and should be CFC free

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's test certificate for thermal conductivity values, density, water vapour permeability and fire properties. Samples of insulation material from each lot delivered at site may be selected by BHEL's site representative and gotten tested for thermal conductivity and density at vendor's cost. Adhesive used for sealing the insulation shall be non-flammable, vapour proof adhesive strictly as per manufacturer's recommendations.

9.3 DUCT ACOUSTIC LINING

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 covered with adhesive, and provided with 26 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 form a frame work of 60 x 60 cms square. Cut panels 60 x 60 cms of resin bonded fiber glass 25 mm thick, density of 32+/- 4 kg/cum shall be fitted in the squares.

These insulation panels shall be fixed to the sheet metal with cold setting adhesive compound. The inner most surfaces shall be covered with fiberglass tissue and 28 gauge perforated aluminium sheet having at least 15 percent perforations. The aluminium sheet shall be screwed to GI channels using cup washer and neatly finished to give true inside surface.

9.4 DUCT INSULATION

External thermal insulation shall be provided as follows :

Chemically crossed linked closed cell FR-XPE plain polyethylene insulation grade for supply air having a low & stable 'K' value of 0.027 – 0.029 k.cal/hr.m.deg C (at 0 deg c to 23 deg C) with minimum density of 28+/- 4 kg/cum, fire retardant in self extinguishing non –dripping. Fire rating class – 1 negligible water vapour permeability having good zone resistance, non – fiber erosion and should be CFC free.
The thickness of insulation 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. Apply 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 by providing 6 mm thick 50 mm wide nitrile rubber tape. The adhesive shall be strictly as recommended by the manufacturer.

9.5 PIPING INSULATION

All refrigerant and condensate drain piping shall be insulated with cross linked polyethylene insulation in the manner specified herein. Cross linked polyethylene insulation having a low & stable 'K' value of 0.027 – 0.029 k.cal/hr.m deg C (at 0 deg C to 23 deg C) with bulk density of 28+/- 4 kg/cum, Fire retardant in self extinguishing non-dripping fire rating class – 1 as per BS: 467 part 7, negligible water vapour permeability having good zone resistance, non fiber erosion and should be CFC free. Before applying insulation, all pipes shall be brushed and cleaned. For copper pipes insulation shall be applied as follows or as specified in drawings or schedule of quantity:

Pipe size (mm)	Thickness of Cross-linked polyethylene foam insulation
6.4 OD to 12.7 OD Refrigerants pipes	9 mm
Above 15.9 OD Refrigerants pipes	13 mm
25 mm to 50 mm Condensate drain pipes	13 mm

Insulating material in tube form shall be sleeved on the pipes. On piping, slit opened tube from insulating material shall be placed over the pipe and adhesive shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre. Wherever flat sheets shall be used it shall be cut out in correct dimension using correct tools. Scissors or Hacksaw-blade shall not be allowed. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. All longitudinal and transverse joints shall be sealed by providing 6 mm thick, 50 mm wide nitrile rubber tape. The adhesive shall be strictly as recommended by the manufacturer. The insulation shall be continuous over the entire run of piping and Ref net.

Manufacturer's installation manual shall be submitted and followed for full compliance. All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labeled (S.R. or R.R.) and provided with 150 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of gas and liquid shall also be marked.

9.6 PROTECTIVE COATING OVER INSULATION

To provide mechanical strength and protection from damage all pipe / duct insulated with nitrile rubber as indicated in BOQ shall be covered with fiberglass fabric of 7 mil minimum thickness.

Insulated pipes & ducts exposed to UV rays shall be covered with fiberglass fabric. Over fabric one coat of fire proof epoxy or acrylic compound shall be applied. The coat shall be allowed to cure to non stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface.

Closed cell cross linked polyethylene foam shall be provided with factory laminated metallised film foil.

9.7 MEASUREMENT OF INSULATION

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of centre line measurements described herewith

a. 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.

b. Duct Insulation and Acoustic Lining 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.

10.0 QUALITY ASSURANCE, INSPECTION, TESTING AND COMMISSIONING

10.1 SCOPE

The following quality assurance, inspection, testing and commissioning procedures shall be required to be carried out upon award of Purchased Order.

I. Provide quality assurance Programme (QAP), works quality assurance Programme (WQAP), field quality assurance Programme (FQAP) and quality plan.
II. Tests at manufacturer's works.
III. Perform site tests and commissioning.

10.2 SUBMITTALS

I. After award of Purchased Order following information shall be submitted.
   a. Quality Assurance Programme (QAP)
   b. Works Quality Assurance Programme (WQAP)
   c. Field Quality Assurance Programme (FQAP)
II. For inspection and testing, submit inspection and testing procedures, Programme , and record sheets applicable at each hold point.
III. After completion of testing, submit test records, packaging, transportation and storage instructions and methods.
IV. For site installation and commissioning, submit installation methods or procedures, notification and procedures for pre-commission and commissioning.
V. After commissioning, submit site test records, as-built drawings, manufacturer's operation maintenance manuals and list of recommended spares and tools.

10.3 QUALITY ASSURANCE CONCEPT AND CONTROL

I. Minimum requirements for establishing and implementing a quality assurance Programme shall be applied to all aspects of the work necessary for carrying out the contract. Quality assurance shall extend to material parts, components, systems and services as a means of obtaining and sustaining the reliability of critical items, operating performance, maintenance and safety.

II. Acceptance of the vendor's quality assurance Programme does not relieve the vendor's obligation to comply with the requirement of the contract document. If the Programme is found to be ineffective, then the BHEL's site representative reserves the right to request for necessary revisions of the Programme.

III. The vendor is required to produce readily identifiable documentary evidence covering the extent and details of both his and his sub vendor's quality assurances system as follows:

   a. Quality Assurance Programme (QAP)
   b. Works Quality Assurance Programme (WQAP)
   c. Field Quality Assurance Programme (FQAP)
   d. Quality Plan.

IV. These documents shall be prepared separately and submitted to the BHEL's site representative at the time of starting the work.
V. Quality Plan and Manual shall be prepared by the vendor for all items and services to be supplied, after the purchased order has been placed, but before commencement of work, and shall be subject to evaluation and acceptance by the BHEL's site representative before start of work.

10.4 QUALITY PLAN

I. The vendor shall be required to prepare manufacturing and construction/erection quality plans for all equipment items and services. The quality plan shall also define the involvement of BHEL's site representative in the inspection and test programs.

II. The Quality Plan shall incorporate as appropriate:
   a. Charts indicating flow of materials, parts and components through manufacturing quality control inspection and test to delivery and erection.
   b. The charts shall indicate the location of hold points for quality control, inspection and test beyond which manufacture shall not continue until the action required by the hold point is met, and the documentation required is generated.
   c. The control documents associated with each hold point, i.e. drawings, material, specification, Works Process Schedule (WPS), Process Quality Records (PQR), quality control methods and procedures and acceptance standards.

10.5 INSPECTION AND TESTING

I. All equipment and components supplied may be subjected to inspection and tests by the Consultant/ BHEL's site representative during manufacture, erection/installation and after completion. The inspection and tests shall include but not be limited by the requirements of this PO document. Prior to inspection and testing, the equipment shall undergo pre-service cleaning and protection.

II. Tenderers shall state and guarantee the technical particulars listed in the Schedule of Technical Data. These guarantees and particulars shall be binding and shall not be varied without the written permission of the BHEL's site representative.

III. No tolerances shall be allowed other than the tolerances specified or permitted in the relevant approved Standards, unless otherwise stated.

IV. If the guaranteed performance of any item of equipment is not met and / or if any item fails to comply with the specification requirement in any respect whatsoever at any stage of manufacture, test or erection, the BHEL's site representative may reject the item, or defective component thereof, whichever he considers necessary; and after adjustment or modification as directed by the BHEL's site representative, the vendor shall submit the item for further inspection and /or test.

V. The approval of the BHEL's site representative of inspection and/or test results shall not prejudice the right of the BHEL's site representative to reject an item of equipment if it does not comply with the PO document when erected, does not or prove completely satisfactory in service.

VI. The vendor shall be responsible for the timely transmission of the relevant and appropriate sections of the PO document to manufacturers and sub- vendor for the proper execution of all tests at their works as per PO specifications.

10.6 TESTS AT MANUFACTURER'S WORKS

I. All tests to be performed during manufacture, fabrication and inspection shall be agreed with the Consultant/ BHEL's site representative prior to commencement of the work. The vendor shall prepare the details of the schedule and submit these to the Consultant/ BHEL's site representative for approval. It must be ensured that adequate relevant information on the design code/standard employed, the manufacture /fabrication/assembly procedure and the attendant quality control steps proposed are made available to the Consultant/BHEL's site representative who will mark in the appropriate spaces his intention to attend or waive the invited tests, or inspections.

II. A minimum of twenty-one days' notice of the readiness of equipment for test or inspection shall be provided to the BHEL's site representative by the vendor (whether the tests be held at the vendor's of Sub- vendor's works). The subject items should remain available for BHEL's site representative inspection and test up to a minimum 10 days beyond the agreed date of witnessing the test. Every facility in respect of access, drawings, instruments and manpower shall be provided by the vendor and sub- vendor to enable the BHEL's site representative to carry out the necessary inspection and testing of the Plant.

III. No plant shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, all tests called for have been successfully carried out in the presence of the BHEL's site representative or approved for shipment, or alternatively inspection has been waived.

IV. Functional electrical, mechanical and hydraulic tests shall be carried out on completed assemblies in the works. The extent of these tests and method of recording the results shall be submitted to, and agreed by, the BHEL's site representative in sufficient time to enable the tests to be satisfactorily witnesses, or if necessary for any changes required to the proposed program of tests to be agreed.

V. The Consultant/BHEL's site representative reserves the right to visit the Manufacturer's works at any reasonable time during fabrication of equipment and to familiarize himself with the progress made and the quantity of the work to date.

VI. Within 30 days of completion of any tests, triplicate sets of all principal test records, test certificates and correction and performance curves shall be supplied to the BHEL's site representative.

VII. These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the BHEL's site representative or not. The information given on such test certificates and curves shall be

sufficient to identify the material or equipment to which the certificate refers and should also bear the relevant reference title.

VIII. When all equipment has been tested, the test certificates from all works and site tests shall be compiled by the vendor into volumes and bound in an approved from complete with index and four copies of each volume shall be supplied to Consultant/ BHEL's site representative.

IX. Stage wise inspection of equipment in factory is waived.

10.7 PERFORMANCE TESTS AT MANUFACTURER'S WOKS

I. All equipment may be subjected to routine performance tests at the Manufacturer's Works in accordance with the relevant ANSI, ASME, ASTM, BIS standard including operating tests of complete assemblies to ensure correct operation of apparatus and components.

II. Pumps, fans, compressor, and other rotating equipment shall be given full load tests, and run to 15% over speed for 5 minutes to check vibration. Main and auxiliary gear boxes shall be subjected to shock load tests and a six-hour endurance run at rated speed and maximum torque.

III. The vendor shall submit single line diagrams including the layout of the Plant together with the location of test instrumentation and the principal dimensions of the layout. All calculations to derive performance data shall be made strictly in accordance with format given in the approved standards. Any alterations or deviations from the approved standard test layout or formulae shall be subjected to the prior approval of the BHEL's Site Representative.

IV. The performance test shall be conducted over the full operating range of the pump to a closed valve condition and a minimum of five measurement points covering the full range shall be taken. Curves indicating Quality vs. Head, Quantity vs. Power absorbed, and Quantity vs. Pump efficiency shall be provided. In addition a curve of the NPSH required vs. Quantity shall be provided except when the suction conditions do not require this test. Any proposal for the omission of this test shall be to the approval of the Consultant/ BHEL's site representative.

V. On completion of the tests the vendor shall submit a report showing the test results obtained together with the curves corrected to the site operating conditions.

'E' SCHEDULE OF QUANTITIES

11.0 PREAMBLE TO BOQ

1 Tendered Rates all Inclusive:

1.1.1 Unless otherwise provided in the Bill of Quantities, the rates tendered by the vendor for all items of the work shall be all inclusive and shall apply to all heights, lifts, leads and depths, in all positions of the building.

1.1.2 Rates/prices quoted in this tender shall be inclusive of cost of materials, labour, supervision, installation, testing and commissioning, materials erection, tools, plant appliances, scaffolding, sleeves, cutting, patching, excavation and backfilling, painting, storage of material, service connections, transport to site, taxes, duties, transit insurance, octroi and levies, all relevant insurance charges, breakage, wastage and all such expenses as may be necessary and required for the satisfactory completion of all the items of the work and final guarantee testing and to put there in working conditions and all other requirements as called for in all the parts of these tender documents.

1.1.3 All rates quoted must be for complete items inclusive of all such accessories, fixtures and fixing arrangements, supports, nuts, bolts, hangers as are a standard part of the particular item except where specially mentioned otherwise.

1.1.4 All rates quoted are inclusive of cutting holes and chases in walls and making good the same with cement mortar / concrete / water proofing of appropriate mix and strength. Rates are inclusive of holes, sleeves, recesses in the concrete and masonry work as the Work proceeds except foundation work.

1.1.5 All rates quoted shall include marking of grills/diffusers.

1.1.6 Nothing extra shall be payable to vendor on account of any of the above factors.

1.1.7 The client reserves the right to supply directly any of the items listed in the BOQ. For all such items, if desired by the BHEL, installation, testing and commissioning shall be the responsibility of the vendor.

1.1.8 All the equipment /material shall be only from one of the I-preference of approved makes as per tender documents.

1.1.9 Making and closing of all HVAC associated openings in walls shall form part of HVAC works. All quoted prices should be inclusive of this aspect.

1.1.10 Wooden frame work for mounting grills on walls shall be in the scope of HVAC works and nothing shall be paid extra for this. Frame work for mounting grills/diffusers on false ceiling shall be done by same vendor.

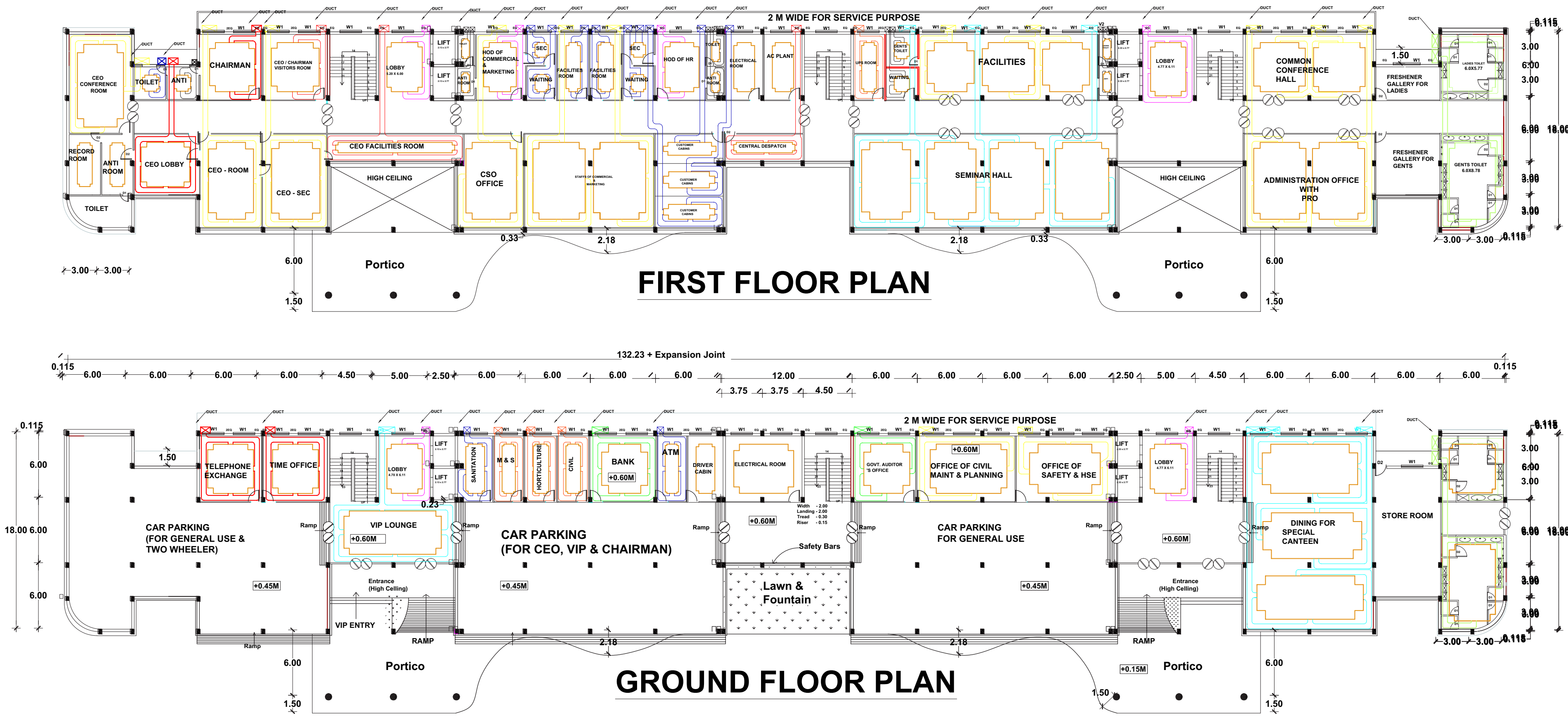
1.1.11 The bidder should quote all imported equipment with price breakup in Foreign exchange and Indian Rupees.

1.1.12 The bidder should quote as per the equipment/ materials given in BOQ. Any suggested deviations can only be given as an option with proper justification.

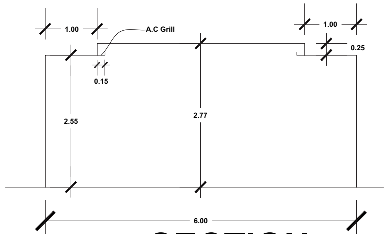
1.1.13 The quoted price shall include all labeling and identification of various equipment/piping as per relevant IS colour coding. In the absence of IS colour coding for any equipment, the labeling and identification shall be carried out as per good practice.

1.1.14 The water balancing is to be done using digital differential manometer. The data is to be accessed by online computer. Vendor must submit computerized printout of each valve indicating design flow, differential pressure, no. of turns and actual flow.

ALL DIMENSIONS ARE IN MILLIMETERS



No.	IDU TR	IDU TYPE	COLOUR	SPACE ALLOTTED
1	0.80	DUCT TYPE	Black	0.45 x 0.45 x 0.40
2	1.50	DUCT TYPE	DARK BULE	0.60 x 0.60 x 0.40
3	2.00	DUCT TYPE	ORANGE	0.75 x 0.60 x 0.40
4	2.50	DUCT TYPE	ROSE	0.75 x 0.60 x 0.40
5	3.00	DUCT TYPE	RED	0.90 x 0.60 x 0.40
6	3.50	DUCT TYPE	GREEN	1.00 x 0.60 x 0.40
7	4.00	DUCT TYPE	LIGHT GREEN	1.20 x 0.60 x 0.40
8	6.00	DUCT TYPE	YELLOW	1.35 x 0.60 x 0.40
9	8.00	DUCT TYPE	CYAN	1.50 x 0.60 x 0.40



SECTION

Note:-

1. Refer False ceiling design separately.
2. Indoor unit to be fixed in walls above lintel height and Pipes, Ducts taken in directly above false ceiling to all areas wherever necessary.
3. Outdoor unit to be fixed at floor level.
4. False ceiling to be fixed with acoustic Insulation.

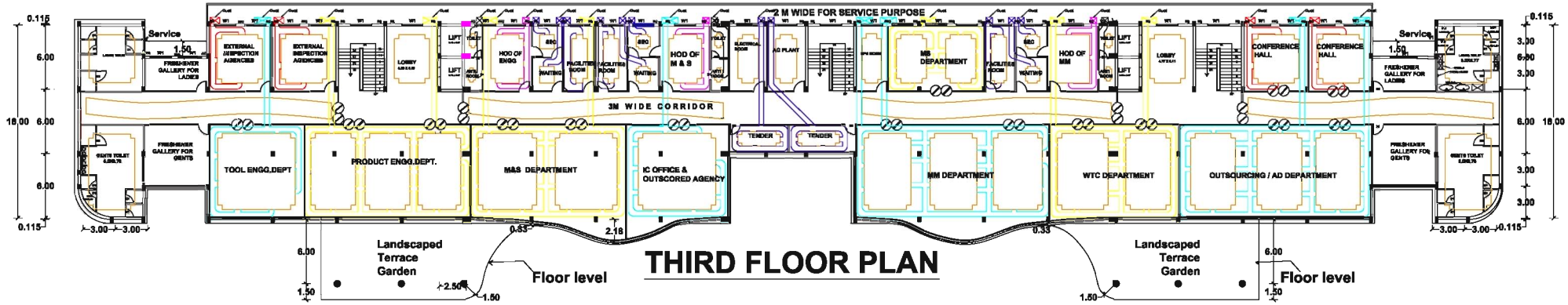
ADMINISTRATIVE BUILDING PPP UNIT/THIRUMAYAM

Bharat Heavy Electricals Ltd
UNIT: HIGH PRESSURE BOILER PLANT
TIRUCHIRAPALLI - 620014

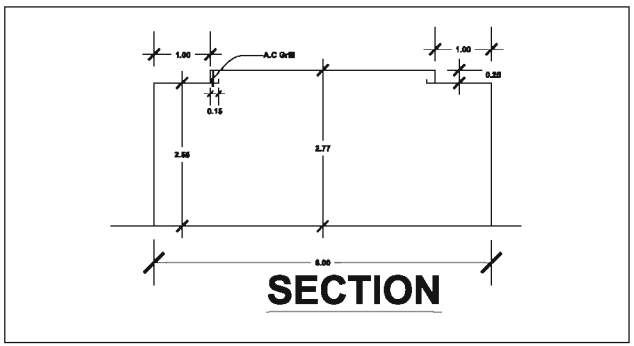
TITLE: AC INDOOR & OUTDOOR UNIT PIPES, DUCTS

DRAWING NO: 300/ /VY/GV/11

ALL DIMENSIONS ARE IN MILLIMETERS



No.	IDU TR	IDU TYPE	COLOUR	SPACE ALLOTTED
1	0.80	DUCT TYPE	Black	0.45 x 0.45 x 0.40
2	1.50	DUCT TYPE	BLUE	0.60 x 0.60 x 0.40
3	2.00	DUCT TYPE	ORANGE	0.75 x 0.60 x 0.40
4	2.50	DUCT TYPE	MAGENTA	0.75 x 0.60 x 0.40
5	3.00	DUCT TYPE	RED	0.90 x 0.60 x 0.40
6	3.50	DUCT TYPE	GREEN	1.00 x 0.60 x 0.40
7	4.00	DUCT TYPE	LIGHT GREEN	1.20 x 0.60 x 0.40
8	6.00	DUCT TYPE	YELLOW	1.35 x 0.60 x 0.40
9	8.00	DUCT TYPE	CYAN	1.50 x 0.60 x 0.40



Note:-

1. Refer False ceiling design separately.
2. Indoor unit to be fixed in walls above lintel height and Pipes, Ducts taken in directly above false ceiling to all areas wherever necessary.
3. Outdoor unit to be fixed at floor level.
4. False ceiling to be fixed with acoustic Insulation.

TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT: ADMINISTRATIVE BUILDING PPP UNIT/THIRUMAYAM

Bharat Heavy Electricals Ltd UNIT: HIGH PRESSURE BOILER PLANT TIRUCHIRAPALLI – 620014

AC INDOOR & OUTDOOR UNIT PIPING DUCTS

DRAWING NO : U 01