

TECHNICAL SPECIFICATIONPNS FOR MECHINCAL WORK

DRAINAGE

1. Scope

This Specification deals with the installation of the materials, fittings and equipment, the design and performance, the workmanship and the testing and commissioning of the below ground drainage.

This Specification is in addition to and will be read in conjunction with the Contract Drawings and relevant parts of the Contract Documents.

2. General

Works shall be constructed in accordance with BS CP 301: 1971 Building Drainage. The Contractor shall notify the Project Manager of discrepancies between BS CP 301 and the working drawings and specifications.

Pipes and fittings shall be jointed and laid in accordance with the manufacturer's recommendations. The Contractor shall notify the Project Manager of discrepancies between the manufacturer's recommendations and the design.

Unless otherwise stated, the provisions of the latest revised additions of relevant British Standards and Codes of Practice shall be held to be incorporated in the specification of materials and workmanship.

Drains shall be accurately laid, true to line and grade from point to point. Manholes shall be provided at changes of direction or gradient and at points of connection. Drain runs between manholes should be absolutely straight. Lines and falls shall be accurately set as shown on Drawings or as directed on Site.

Pipe work materials shall be as stated in the Particular Conditions or on the Drawings.

The Contractor shall perform all necessary excavation for drains, manholes, septic tanks, soak ways etc. , uphold sides , level or grade bottoms , return fill and ram and remove surplus spoil as directed .

The system shall be maintained in accordance with Clause 6 of CP 301.

3. Pipe work

Excavation of any section of the work shall not start until a complete set of the pipes and components for that section is available.

The trench shall be as narrow as practicable but not less than the pipe diameter plus 300mm from each side to permit adequate compaction of side fill. Adequate working space shall be left for pipe jointers and joint holes shall be formed where necessary.

The trench sides shall be kept vertical unless the approved use of a batter is unavoidable. In the latter case the sides of the trench shall be kept vertical up to 300mm above the top of the pipe. If over width excavation occurs at or below this level the trench shall be reformed using concrete to 300mm above the level of the top of the pipe or the Project Manager's approval shall be obtained for the proposed bedding for the wider trench condition.

Bedding material shall be

- (a) Local karkar
- (b) Sand to BS 882 Zones 1 - 4.

Pipes and fittings shall be inspected before fixing, and defective items shall be rejected.

Pipes shall be laid with the socket ends against the flow and shall rest on a solid and even bearing for the full length of the barrel .

Trenches shall be back-filled only after drains have been tested to the satisfaction of the Project Manager.

4. UPVC Pipes and Fittings

UPVC pipes and fittings shall comply with BS 4660.

All pipes and fittings on all soil waste and vent pipes shall be in un-plasticized Polyvinyl Chloride, with solvent weld cement joints, to pipes and fittings.

All branches waste and vent pipes from baseness and sinks to stacks, floor gullies, collection boxes and manholes shall be in modified UPVC with seal ring joints suitable to receive high temperature water discharge.

Fittings and coupling for use with UPVC pipes shall be jointed with solvent cement in accordance with manufacturer recommendations.

Fittings and coupling for use with UPVC pipes on movement joints shall be jointed with an incorporate synthetic rubber rings in accordance with the manufacturer recommendations.

Slip on cover plates shall be provided as a finish to pipe work, up to and including 50mm diameter, emerging from a wall in occupied areas other than service voids. Samples shall be first submitted to the Project Manager for approval.

On pipe work up to and including 50mm diameter union type fittings shall be provided to make up to outlets of basin, bath and sink wastes.

Access plates shall be fitted at the roof of each vertical stack at changes, to enable the complete disposal system to be internally cleaned.

Soil, waste and vent stacks above their highest branches shall be continued up words, at their full diameter, above roof level.

5. Safety

The Contractor shall provide, maintain and uphold safety measures adequate for the particular hazards of drainage works for all his employees. All safety measures taken by the Contractor should be approved by the Project Manager.

Such approval will not affect the full responsibility of the contractor toward the safety of all his employees, the supervision staff and any other third party existing on site.

The Contractor shall ensure that all timbering, shuttering, staging, strutting, ladders etc. , used in drain trenches and pits are adequate for the duty involved .

6. Manholes

Manhole dimensions shall be as shown on Drawings.

Manholes shall be constructed from approved pre cast concrete rings.

Manholes, chambers, Septic tanks, disintegration and settling tanks and percolating pits shall be constructed in the positions and to the dimensions shown on the Drawings or as directed by the Project Manager . The method of execution of all work in connection with these shall be as elsewhere described in the appropriate trades.

Manhole base slabs shall be according to drawings, and at least 150mm thick grade (A) concrete or as directed and approved by the Project Manager.

Manhole cover slabs shall be a minimum of 150mm thick suitably reinforced grade (A) concrete, where also approved pre cast covers can be used.

Pre cast concrete manholes shall comply with BS 556.

Manhole sections shall be jointed using a cement and sand mortar, 1 : 2 , proprietary bituminous or resin fillers . Where flexible fillers are used their shape, thickness and location in the joint shall be in

accordance with the manufacturer's recommendations. The remainder of the joint shall be filled with a cement and sand mortar 1: 2, to prevent settlement of the sections with possible point contact and subsequent spilling of the concrete joint.

7. Septic Tanks

Septic tanks shall be sized and constructed as shown on the Project Manager's Drawings and shall be constructed as stated in BS CP 302 unless otherwise stated.

Septic tanks shall be constructed with concrete floors and walls of block work or concrete.

External Walls of septic tanks shall be at least 300 mm thick.

Where indicated on the drawings the Contractor shall provide an intercepting trap with cleaning arm and lever-locking stopper to be set in cement mortar in the intercepting manhole adjacent to the septic tank or inside the site boundary in the case of main drainage. The normal drop from inlet to outlet of trap shall be preserved. A fresh air inlet shall be taken to the intercepting manhole with 100mm cast iron drain pipes with an easy bend to a point just below ground level.

Septic tanks shall meet the requirements of the local Authority.

8. Soak ways

Soak ways shall be constructed in one of the following ways:

- (a) Pre cast concrete rings to BS 556.
- (b) 200mm (min) cast in situ concrete.

Cover and base slabs shall be at least 150mm thick Grade (A) reinforced concrete, or pre-cast covers according to Specification.

Removable covers shall be as described for manhole covers.

Soak ways shall be of the sizes and in the positions shown on the Drawings or as directed on site by the Project Manager.

Soak ways constructed in cast in situ concrete shall have walls of at least 200mm thicknesses.

Soak ways shall meet the requirements of the Local Authority.

9. Connections to Existing Manholes and Drains

When work is being undertaken on existing drains and manholes including the construction of new manholes, building in pipes, cutting through manhole walls, cutting out and reforming benching, completing pipe entries and making good the Contractor shall keep existing drains open to flow and reasonably free from debris at all times during the progress of works.

On completion all work shall be in a watertight condition.

10. Cleaning, Protection and Testing Of Drains

The Contractor shall remove all silt and foreign matter from drains and manholes and leave the whole in a clean and workable condition.

In the event of delay between the laying of a drain and the placing of the first 300mm of back filling over the top of the pipe, precautions shall be taken to protect the pipes from damage arising from differential exposure to sun or wind.

Lengths of drain, manholes and inspection chambers shall be capable of withstanding the test. The test shall be applied after laying and before back filling or placing concrete surround and bedding concrete.

Leakage of the section under test, including sweating, which causes a drop in the test water level, shall be noted and the defective part of the work shall be rectified on the Contractor's own expenses.

The test shall be repeated after back filling and any faults in the bedding or support of the pipe, inadequacies in design or accidental damage during, or subsequent to, back filling, shall be noted and the defective part of the work shall be rectified on the Contractor's own expenses .

Whenever possible testing shall be carried out from manhole to manhole

Testing shall not be started until at least 48 hours after completion of the last joint.

Tests before back filling:

- (1) The section shall be filled with water and after about one hour test readings shall be taken.
- (2) A test pressure of 1.2m head of water shall be applied at the high end of the section (but not than 2.4m at the low end). Steeply graded mains shall be tested in sections.
- (3) The loss of water over a period of 30 minutes shall be measured by adding water from a measuring vessel at regular intervals of 10 minutes and noting the quantity required to maintain the original water level in the standpipe.
- (4) The average quantity of water added shall not exceed 0.06 liters per hour per 100 linear meters per Millimeter of nominal bore of the drain.
- (5) For sections of drain where the highest point is more than 1.2m below the water table the following infiltration test shall be undertaken.
- (6) Inlets to the system shall be closed. Visual inspection at manholes or inspection chambers will reveal any flow the cause of which shall be investigated and the faults rectified.
- (7) Tests for line, level and freedom from obstruction shall be applied by means of a mirror at one end of the drain and a lamp at the other.
- (8) Final test:

The water test shall be repeated in accordance with the requirements of the Local Authority or the Project Manager.

PLUMBING AND SANITARY INSTALLATIONS

General

1 *Layout*

The Layout of the fitting and pipe work is approximate and diagrammatic only. The Contractor shall be responsible for laying out the fittings and equipment together with the service pipe work to satisfaction of the Project Manager.

2 *Pipe work and Fittings for Services*

Each part of the piping systems shall be complete in all details and provided with all control valves and accessories necessary for satisfactory operation.

The drawings indicate generally the sizes of all main piping, and while the sizes are not to be decreased the Project Manager reserves the right to change the runs and sizing of piping to accommodate conditions arising during construction.

All pipe work, valves, fittings etc. are to be as detailed for various services in the Schedules.

All piping shall be grouped wherever practical and shall be erected to present a neat appearance. Pipes shall be parallel to each other and parallel or at right angles to structural members of the building and shall give maximum possible headroom .

Pipe work shall generally be set around all columns and shall follow the contour of the building. Piping shall not pass in front of doorways or windows, nor be installed passing through ductwork or directly under electric light outlets.

Unless otherwise shown on the drawings or instructed on the site, all pipes shall have a minimum clearance of 75mm from floors and ceilings and 25mm from the finished face of walls or other surfaces.

All pipe drops shall be truly vertical, drain piping shall pitch down in direction of flow, and all pipe work shall be installed with a continuous gradient to allow natural circulation, air venting and drainage . Levels are to be approved by the Project Manager.

Run outs shall be graded in such a manner as to prevent air traps being formed within them when the mains expand or contract.

Pipes erected in plant rooms, vertical shafts or false ceiling spaces shall be arranged to provide maximum access, and generally all pipe work installed in voids, shafts or false ceilings and in other places where subsequent access is likely to be difficult and where ease of dismantling is not required, shall have welded joints.

Sufficient space is to be allowed for accessibility for servicing. No joints shall be formed in the thickness of walls, floors or ceilings.

Where pipes are to pass through reinforced concrete this must be ascertained before the concrete is cast and approval must be obtained for size of hole to be formed.

The Contractor is responsible for ascertaining the thickness of plaster and other wall finishes, skirting heights, sill lengths and floor finishes and routing pipe work to suit.

Where pipe work is to be insulated , it shall be fitted in such a manner as to allow each pipe to be insulated the full circumference and also to allow the prescribed clearance, after insulation, between

the insulation and walls, floors, ceilings, other pipes or the insulation on other pipes , to any other surfaces .

Where pipes pass through or near walls, partitions or in chases, sufficient space must be left for the complete insulation treatment to be continued without interruption.

The Contractor shall be deemed to have included in his tender for work in setting pipes around all work and apparatus connected with other trades such as piers, wastes , drains , girders etc.

All reductions in sizes of horizontal piping shall be installed with eccentric fittings to maintain a level bottom.

Overflow and other warning pipes shall be fitted so that they discharge in obvious positions. Lightweight hinged weather flaps shall be provided which will close against wind pressure and open when discharging.

Pipe connections to equipment and valves shall be flanged for sizes 65 mm and above and with unions for other sizes, and shall be arranged for easy dismantling and removal.

All branches from mains shall be taken from the top of the main wherever practicable and shall be made in such a manner as to allow for expansion and contraction in both main and branch.

All sets, double sets and springs shall be formed on long lengths of tube with as large a radius as possible and shall be free from distortion.

The Contractor shall supply and install malleable iron unions for all pipes, up to and including 50 mm nominal bore to form removable joints at intervals of approximately 18 m and wherever difficulty in dismantling might occur.

All pipe work shall be free of corrosion and without any signs of scaling pitting or excessive weathering, to the satisfaction of the Project Manager.

Pipes stored on site shall be kept clean and off the ground and where possible stored under cover. Pipes corroded beyond normal "stock rust" conditions shall not be used.

The Contractor shall ensure that all tubes are free from internal obstructions. All burred and cut ends of pipes shall be well reamed and filed to ensure that the full bore of the pipes is maintained. The Contractor shall take special care to prevent dirt or rubbish entering the open ends of all pipe work during storage and erection. Screwed iron caps or plugs or plastic caps shall be used for this purpose.

Wood, rag, paper or other inadequate material will not be permitted. A valve fitted at an open pipe end shall not be considered adequate protection. Should any stoppage in the circulation occur after the various systems have been put into operation owing to non-compliance with these requirements the Contractor shall attend and rectify the matter at his own expense. Further information regarding flushing out of pipe work system is given elsewhere in the Specification.

The Contractor will ensure that at no part of any one system does he include, either in contact or at a distance, dissimilar metals which will promote chemical or electro - chemical action, causing a weakening or failure of the service. This applies not only to the internal surfaces but also the external surfaces of all pipes, fittings, valves, plant , vessels , pumps and any other item of equipment in the installation .

Where pipes are held in vices, as when screwing, care shall be taken to ensure that the pipe surface is not damaged. Any pipe work so damaged shall not be fitted.

The average depth of the inverts of mains below ground level shall be 60 cms minimum. The Contractor shall mark out and accept the entire responsibility for the correct positioning of the trenches required, both as regards line and level , and shall collaborate to the best of his ability with the Main Contractor in order to ensure adherence to the program , and to avoid lengths of trench

being opened up unnecessarily soon or remaining open unnecessarily long after the pipes have been satisfactorily tested. Depths of mains and branches must be approved by the Project Manager.

Where piping is buried underground it shall be wrapped with a double thickness of dense tape. All such wrapping shall be approved by the Project Manager before the trench is filled in.

Any pipe work which, in the opinion of the Project Manager, does not conform as to material and workmanship with this specification shall be removed and refixed at the expense of the Contractor.

Joints

Reduction in pipe diameters shall be made by using one fitting only, be it reducing elbow, tee or coupling.

Where standard fittings are not available in the configuration required reductions to the run and branch connections shall be made with reducing sockets. Bushes will not be permitted.

Branch connections to mains may be employed where the sizes of the branch is two or more smaller than the size of the main. Generally sweep branches shall be made except for tees on headers, or where a sweep fitting would cause air to be trapped.

Upon completion welded joints shall be thoroughly cleaned with a stiff wire brush and screwed joints shall have jointing compound removed.

Plastic Piping

Plastic pipes shall be used only if approved by the Project Manager (in all cases UPVC pipes must be used).

Cleaning fluids and solvent cements shall be suitable for use in the local ambient air conditions and operatives shall be fully trained in their use by attendance at an installation course organized by the manufacturers of the particular piping system.

Valves and Cocks

All valves and cocks for the services in which they are installed shall comply with the requirements of the appropriate Water Authority, and the Contractor shall include for any testing and stamping which the Authorities may require.

Valves are to be provided as indicated and at all places necessary for the proper working, regulation, control and maintenance of the installation.

Valves shall be either screwed or flanged in accordance with the Specification for the pipe work into which they are installed and as directed by the Project Manager.

Where flanged valves are specified, flanges are to correspond to appropriate BS specified in respect of the piping.

Gate valves shall be used for shut-off purposes and globe valves shall be used for balancing purposes. All valves shall be designed for packing under pressure when fully open. Gate valves shall comply with BS 5154 or 5150. All valves must be approved by the Project Manager.

Taps and stop cocks shall comply with BS 1010 and shall be marked with the manufacturer's name or trade mark and the nominal size. All taps and stop cocks must be approved by the Project Manager.

Valves shall be marked with the manufacturer's name or trade mark, the nominal size and the class number and must be approved by the Project Manager.

Mixing valves shall comply with BS 1415 and shall be marked with the manufacturer's name and trade mark and the nominal size, and must be approved by the Project Manager.

3 *Insulation*

All insulating materials required for general plumbing and equipment shall be furnished and installed according to this section of the specifications.

Insulation shall be installed in a smooth, clean, workmanlike manner and joints shall be tight and finished smooth.

All surfaces to be insulated shall be dry and free from loose scale, dirt, oil or water when insulation is applied.

Insulation shall be applied in such a manner that there will be no air circulation within the insulation or between the insulation and the surface to which it is applied.

Surface imperfections in the insulation such as clipped edges, small joints or cracks and small voids, or holes not over 25 sq.mm shall be filled with like insulating material or with insulating cement if approved by the Project Manager.

Insulation for all services shall be continued through sleeves. The insulation on exposed risers shall extend through the floor.

4 *Domestic Water Services*

Generally water shall be supplied from the City Main and will connect either to the roof storage tanks or to the low level suction tanks. From the suction tanks water shall be pumped up to the tanks at roof level. Connection can also be made directly to the water network in the building.

Where the rising main is installed in an open-to-sky void, it shall be in cast iron to BS 1211 with flanged joints or as directed by the Project Manager.

All hot and cold water services shall be in solid drawn copper tube, to BS 2871 Table X with capillary or compression fittings to BS 864.

The use of flexible connectors between services and sanitary fittings will NOT be permitted.

5 *Filter and Water Tanks*

All cold water storage tanks shall comply with the relevant British and local standards, and must be approved by the Project Manager.

Tanks shall be fitted with a suitably sized ball valve and overflow and shall include a metal cover.

Before all pumps and control equipment and on the outlet from all tanks, a strainer shall be fitted.

Large water storage tanks on roofs shall be sectional tanks to conform to BS 1564 and shall be type B (2) . The sizes of the tanks shall be as shown on the Drawings and noted on the schedules in the Particular Specification and the Contractor must allow in his rates for assembling, waterproofing, adequately bracing and providing holes, overflows and valves as required.

The tanks shall be supplied with one coat of black non-toxic paint and two further coats shall be applied on site to the approval of the Project Manager.

Alternatively the Contractor may provide fiberglass tanks subject to their suitability for the particular project and the approval of the Project Manager.

All tanks must be provided with strong covers and adequate access points for maintenance and cleaning.

6 *Tests at Site*

Pressure tests shall be applied to piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subject to pressures exceeding their rating.

Tests shall be completed and approved before any insulation is applied or pipes, valves and fittings have been concealed. Tests shall be performed in the presence of and to the satisfaction of the Project

Manager. Any leaks or defects uncovered by the tests shall be repaired and the system re-tested at no additional cost to the Employer.

When the installation has been completed to the satisfaction of the Project Manager, it shall be tested in the following manner:

- (a) The entire system shall be slowly filled with water, allowing any trapped air to escape.
- (b) When all outlets are closed the system shall be checked for water tightness.
- (c) Each outlet must be checked for rate of flow and correct operation.

7 *Cleaning*

The Contractor shall carefully clean out all cold water and hot water tanks, service pipes, sanitary fittings throughout, traps and wastes. The Contractor shall also overhaul and make good all flushing valves, check regulating valves, check taps including rewash ring as necessary and leave all works in perfectly clean and working condition to the satisfaction of the Project Manager.

8 *Sanitation and Rain Water Drainage*

The soil and waste system shall be installed in accordance with this Specification and bill of quantities and must be approved by the Project Manager.

Soil, waste and ventilation pipe work and fittings fixed in open-to-sky areas shall be in cast iron or UPVC as shown on the Drawings or directed and approved by the Project Manager.

Soil, waste and ventilation pipe work and fittings fixed in internal ducts shall be in un-plasticized P.V.C. and according to manufacturer's specification and as approved by the Project Manager.

Expansion joints and brackets shall be fixed in accordance with the manufacturer's recommendations where required.

Rain water pipes and fittings shall be as shown on the Drawings, Bill Of Quantities and as directed by the Project Manager.

Testing

Tests shall be carried out at the Project Manager's request during installation in accordance with manufacturer's specifications and to the approval of the Project Manager.

9 *Sanitary Fittings*

All sanitary fittings shall be of an approved quality obtained from an approved manufacturer. Sanitary fittings and their connections, services, wastes, overflows etc. shall be located as shown on the Drawings and shall be designed and installed to the satisfaction of the Project Manager.

Details of the fittings are as shown in the Particular Specification and Drawings or as directed by the Project Manager.

All sanitary fittings noted in the Particular Specification shall be properly assembled and the Contractor shall include for all waste fittings, traps, taps, plugs, chains, seats, handles, levers, fixings and brackets required to suit the installation.

All traps shall be of the correct size with a 3" deep seal and compression outlet connection.

Bath traps shall be provided with an integral overflow.

10 *Builders Work*

Normally pipes will be fixed on the surface of walls and the Contractor shall perform all cutting and pinning for holder bats or plugging and screwing for pipe clips.

Where pipes are required to be concealed in the walls etc., the contractor shall perform all cutting and subsequent making good. Pipes passing through walls and floors shall be sleeved with metal.

The expression 'Builders Work' shall mean work to be carried out by the Main Contractor under the direction of the Project Manager in connection with the plumbing installation.

The Contractor shall prepare accurate drawings giving details of all holes, fixings, bases, and other builders work requirements and shall be responsible for their accuracy. The cost of any unnecessary work due to failure to comply with this condition will be charged to the Contractor and deducted from his account when making payment. The cost of preparing builders work drawings shall be included in the tender price.

If, in order to progress the contract, the Project Manager has prepared certain details in connection with the builders work, the Contractor, when appointed, must immediately check these details against the architectural and structural drawings and if any additional work or alterations are required the Project Manager must be advised immediately.

The following is a summary of the work to be carried out by the Main Contractor:

- (a) Cutting and forming of holes for pipes or pipe fixings through walls, floors, ceilings, partitions, roofs etc., and making good after the work is sufficiently advanced.
- (b) Building of concrete and/or brick ducts in floors, walls...etc.
- (c) Formation of concrete bases , plinths etc. for plant and equipment .
- (d) Building of manholes pits etc.
- (e) Excavation, forming of trenches for services etc., and the filling in of same after the pipes are laid.
- (f) Cutting or forming of chases, recesses etc. in floors, walls...etc. for pipes and fittings, and making good.
- (g) Excavation for and laying of pipes and ducts.
- (h) The building in of brackets and supporting bars or other form of pipes after fixing unless specified to the contrary.
- (j) Painting of all pipes after fixing unless otherwise specified
- (k) Providing and building in of sleeves through slabs and walls

In general all holes through walls, floors and beams for pipes and ducts will be left out by the Main Contractor during the process of building.

Where pipes or fittings are fixed to concrete or woodwork by means of saddles or clips the Contractor shall himself execute the work necessary and shall include the cost of such work in the price given in the Form of Tender.

1. SCOPE OF SUPPLIES

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

- a. VRF Outdoor Units
- b. Indoor Units like, wall type and cassette 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. Automatic controls and instruments.
- h. Cutting holes, chases and the like through all types of nonstructural walls, and finishing's for all services crossings, including sealing, frame work, fire proofing, providing sleeves, and cover plates, making good structure and finishes to an approved standard.
- i. Balancing, testing and commissioning of the entire HVAC and mechanical ventilation installation.
- j. Test reports, list of recommended spares, as-installed drawings, operation and maintenance manual for the entire HVAC installation.
- k. Training of Owner's Staff.
- l. 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 in the indicated format according BOQ.

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 Manufacturer's 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 manufacturer's 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.

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. It 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.

➤ **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:

- Wall mounted Hi-Wall type.
- Cassette Ceiling mounted 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 outdoor 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.

➤ **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 wraparound type oil heater and discharge gas thermistor.

➤ **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.

➤ **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.

➤ **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.

➤ **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.

➤ **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.

➤ **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 Arm flex / 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 Aluminum Tape shall be used at joints of Piping with Bands for identification.

➤ **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.

➤ **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.

➤ **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.

➤ **MOUNTING:**

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

➤ **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 gauge G.I wire tied at 15 cm intervals.