A+ Engineers
MEP Consultants

NEW BOYS HOSTEL BLOCK B&C, IBA MAIN CAMPUS, KARACHI

VOLUME 4
HVAC & PLUMBING TENDER DOCUMENTS

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List of Approved Manufacturers

LIST OF APPROVED MANUFACTURERS

Equipment & Material shall be supplied only from the approved sources noted below. However in all cases the Contractor shall submit complete technical details of the equipment, material and obtain Consultants approval prior to delivery on site. Where option of "Approved Equivalent" is indicated, it shall be at the discretion of the Consultant to accept the alternate proposal submitted by the Contractor.

Section No.	Equipment/Material	Approved Manufacturers	Country of Origin
23 05 15	Paint	Berger	Pakistan
		ICI	Pakistan
23 05 23	Gate Valves, Globe Valves, Strainers, Check	Oventrop	Germany
	Valves, Ball Valves	Hattersley	UK
23 05 19	Thermometers Pressure Gages	Trerice, Weksler, Weiss	USA
23 05 29	Supports & Anchors	Fabricate as per approved sample	Pakistan
	Concrete Fasteners	Rawl plug Co.	UK.
		Fischer	Germany
		Hilti	UK/Germany
26 00 00	Motors	Siemens	Pakistan
		Imported	USA/Europe/Japan
23 34 19	Fans	Imported	USA/Europe/Japan
22 05 53	Piping		
	Polypropylene Random	Vesbo	Turkey
		Kelen	UK
		Approved equivallent	
	G.I. Pipe	IIL	Pakistan
	uPVC	Dadex	Pakistan
		Hepworth	UK
		Vesbo	Turkey
	Copper Piping for medical gases	Muller	USA
23 20 10	Fibreglass Pipe Insulation	Ductmate Inc.	USA
		Zahabiya	Pakistan
	Closed Cell Foam Insulation	Armaflex	USA
		Aeroflex	Thailand
		Approved equivalent	
		Zahabiya	Pakistan
23 31 00	Sheet Metal	Pakistan Steel	Pakistan
		Imported	As approved

		Approved equivalent	Imported
23 37 13	Air Devices	Thermec	Pakistan
		Shan Industries	Pakistan
		Mehran	Pakistan
		Steel Craft	Pakistan
26 06 20.6 & 26 00 00	Cables	Pakistan Cable	Pakistan
		Pioneer Cables	Pakistan
	Steel Conduits	Hilal Industries	Pakistan
		ILL	Pakistan
	Circuit Breakers/Switch Fuses	ABB	Europe
		Terasaki	Japan
		Telemecanique	France
		Siemens	Germany
	Contactors	ABB	Europe
		Telemecanique	France
		Siemens	Pakistan
	Control Panel (MCC) Manufacturers	Owner furnished	
	Cable Tray	Ezzy	Pakistan
		Approved equivalent	Pakistan
22 09 00	Pump controller and level indicator	Johnson	USA/ Europe
		Honeywell	USA/ Europe
		Schneider	USA/ Europe
22 06 30	pumps	KSB	Germany,
		Grundfos	Germany/ Denmark
		Lowara	Italy
22 33 34	Hot water storage heater	Grand Impex	Pakistan
		Approved equivallent	
22 40 00	Fixtures	Toto	Japan
	Fittings	Zilver	Germany

SECTION 23 05 10

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 – General

1.1 Related Documents:

Drawings and general provisions of Contract, including General and Special Conditions apply to this Section.

1.2 Summary:

a) This Section includes the following basic mechanical materials and methods to complement other Sections.

i) Piping materials and installation instructions common to most piping systems.
ii) No shrink grout for equipment installations.
iii) Field-fabricated metal and wood equipment supports.
iv) Installation requirements common to equipment specification sections.
v) Mechanical demolition
vi) Cutting and patching
vii) Touch-up painting and finishing
viii) Pipe and pipe fitting materials are specified in piping system Section.

1.3 Definitions:

a) Pipe, pipe fittings and piping include tube, tube fittings and tubing.

b) Finished spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, spaces above ceiling, crawl spaces and tunnels.

c) Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

d) Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

e) Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

1.4 Quality Assurance:

a) Qualify welding processes and operators for structural steel according to AWS D1.1 "Structural Welding Code – Steel."

b) Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications."

i) Comply with provisions of ASE B31 Series "Code for Pressure Piping."
ii) Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current.

c) ASME A13.1 for lettering size. Length of color field, colors and viewing angles of identification devices.

d) Equipment Selection: Equipment of greater or larger power, dimensions, capacities and ratings may be furnished, provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors bases and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

e) For products manufactured for 50 Hz use, that do not carry or qualify for UL labels, a manufacturer's certification is required that the product meets the minimum requirements of Internationally Recognized Testing Laboratories (IRTL) meeting the requirements of International Electro Commission (IEC), which are deemed equal to UL and other U.S. testing laboratories.

1.5 Delivery, Storage and Handling:

a) Deliver pipes and tubes with factory-applied end-caps. Maintain end-caps through shipping, storage, and handling to prevent pipe-and damage and prevent entrance of dirt, debris and moisture.

b) Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

c) Protect flanges, fittings and piping specialties from moisture and dirt.

1.6 Sequencing and Scheduling:

a) Coordinate mechanical equipment installation with other building components.

b) Arrange for chases, slots and openings in building structure during progress of construction, to allow for mechanical installations.

c) Coordinate the installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

d) Sequence, coordinate and integrate installations of mechanical materials and equipment for efficient flow of the work. Coordinate installation of large equipment requiring positioning prior to closing in the building.

e) Coordinate connection of mechanical systems with utilities and services. Comply with requirements of governing regulations, service companies, and consultants.

f) Coordinate requirements for access panels and doors where mechanical items requiring access are concealed behind finished surfaces.

g) Coordinate installation of identifying devices after completion of covering and painting, where devices are applied to surfaces. Install identifying devices prior to installation of acoustical ceilings and similar concealment.

1.7 Shop Drawings:

a) Shop drawing detailing fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

b) Coordination drawings for access panel and door locations.

c) Prepare coordination drawings to a 1:50 scale or larger. Detail major elements, components and systems of mechanical equipment and materials in relationship with other systems, installations and building components. Show space requirements for installation and access. Show where sequence and coordination of installations are important to the efficient flow of the work. Include the following:

d) Proposed locations of piping, ductwork, equipment and materials. Include the following:

i) Planned piping layout, including valve and specialty locations and valve stem movement.

ii) Planned duct systems layout, including elbows radii and duct accessories.

iii) Clearances for installing and maintaining insulation.

iv) Clearances for servicing and maintaining equipment, including space for equipment disassembly required for periodic maintenance.

v) Equipment services connections and support details.

vi) Wall penetrations.

vii) Fire-rated wall and floor penetrations.

viii) Sizes and location of required concrete pads and bases.

ix) Scheduling, sequencing, movement and positioning of large equipment into the building during construction.

x) Floor plans, elevations and details to indicate penetrations in floors, walls and ceilings and their relationship to other penetrations and installations.

e) Reflected ceiling plans to coordinate and integrate installations, air outlets, and inlets, light fixtures, communications systems components, sprinklers and other ceiling-mounted items.

PART 2 – Products

2.1 Pipe and Pipe Fittings

a) Refer to individual piping system specification Sections for pipe and fitting materials and jointing methods.

b) Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipefittings.

2.2 Joining Materials

a) Refer to individual piping systems specification Sections in Division 15 for special joining materials not listed below.

b) Pipe Flange Gasket Materials: Suitable for the chemical and thermal conditions of the piping system contents.

c) ASME B16.21, non-metallic, flat, asbestos-free, 3.2mm maximum thickness, except where thickness or specific material is indicated.

i) Full-Face Type: For flat-face, Class 125 cast-iron and cast-bronze flanges.

ii) Narrow-Face Type: For raised-face, Class 250 cast-iron and steel flanges.

d) ASME B16.20 for grooved, ring-joint, steel flanges.

e) AWWA C110, rubber, flat face, 3.2mm thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

f) Flange Bolts and Nuts: ASME B18.2.1 Carbon steel, galvanized, except where other material is indicated.

g) Solder Filler Metal: ASTM B 32.

h) Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent), and silver (approximately 5%), having 0.10-percent lead content.

i) Brazing Filler Metals: AWS A5.8.

j) Bag1: Silver alloy.

k) Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

l) Flanged, Ductile-Iron Pipe Gasket, Bolts and Nuts: AWWA C110, rubber gasket, carbon steel bolts and nuts.

PART 3 – Execution

3.1 Direction of Metal Supports and Anchorage

a) Cut, fit and place miscellaneous metal supports accurately in location, alignment and elevation to support and anchor mechanical materials and equipment.

b) Field Welding: Comply with AWS D1.1 “Structural Welding Code-Steel”.

3.2 Demolition

a) Disconnect, demolish and remove work specified under Division 15 and as indicated.

b) Where pipe, ductwork, insulation or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

c) Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

d) Removal: Remove all demolished materials and equipment from the project site.

e) Temporary Disconnection: Remove, store, clean, reinstall, reconnect and make operational equipment indicated for temporary or permanent relocation.

3.3 Cutting and Patching

a) Cut, channel, chase and drill floors, walls, partitions, ceilings and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved. Obtain prior approval of Consultant before performing work.

b) Repair cut surfaces to match adjacent surfaces.

3.4 Grouting

a) Install non-metallic, no shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates and anchors. Mix grout according to manufacturer's printed instructions.

b) Clean surfaces that will come into contact with grout.

c) Provide forms for placement of grout, as required.

d) Avoid air entrapment when placing grout.

e) Place grout, completely filling equipment bases.

f) Place grout on concrete bases to provide a smooth bearing surface for equipment.

g) Place grout around anchors.

h) Cure placed grout according to manufacturer's printed instructions.

3.5 Air Balancing

a) Unit shall be factory balanced for the specified air-flow rate however it shall also be capable to be field set at the desired air volume.

b) External scale shall be provided to accurately set the flow.

c) Radiated noise shall not exceed NC 35 in any case.

3.6 Installation

The installation shall be carried out complete in all respects as per manufacturers recommendations, all duct connections, electric connection and control connections etc., shall also be done by the contractor the unit shall be provided with proper hanging system.

3.7 Commissioning & Testing

The unit shall be factory tested for full and part load operation. The unit shall be commissioned and tested as per the manufacturer's recommendation. The contractor shall be required to carryout test, on forms to be supplied later by the Consultants, and obtain approval.

3.8 Control Dampers & Actuators

Dampers shall consist of: a 20 gauge galvanized steel channel frame with 5" depth; triple V type blades fabricated from 16 gauge galvanized steel; blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow in either direction or pressure on either side of the damper ½" dia plated steel axles turning in synthetic (acetal) sleeve bearings; extruded vinyl blade seals for 180F maximum temperature; jamb seals shall be flexible aluminum; and external (out of the airstreams) blade-to-blade linkage. Damper manufacturer's printed application and performance data including pressure, velocity and temperature limitations shall be submitted for approval showing damper suitable for pressure to 6" w.g., velocities to 4000 fpm and accordance with AMCA Standard 500. Dampers larger than 48" width and / or 74" height will be factory fabricated of multiple equal sections, jack shafted together.

Damper shall be provided with flanges for duct connection or mounting on wall.

Actuator shall be heavy duty floating type actuator of torque as required for the specified size of damper shall be able to directly mount to damper shaft.

3.9 Duct Work Insulation

3.9.1 Insulation

All supply air ducting and return air ducting shall be insulated with insulation indicated in Insulation Schedule. Panels shall be cut to size to fit duct being insulated, and shall be

fixed to the duct with approved adhesive. Adhesive shall cover at least 75% of duct area. Sheet metal hooks will not be allowed. The insulation is to be installed flush with the duct, but so as not to lessen the thickness of the insulation. Insulation shall be continuous, and no gaps, crevices, or other discontinuities shall be acceptable. The insulation shall be held in place additionally by using polyethylene packaging bands, 10mm wide.

3.9.2 Jacket

To provide mechanical protection to the insulation shall be provided in mechanical rooms, on ducts which are installed at or below 2m height. Jacket shall be as indicated under Insulation Schedule (Section-2), pasted to insulation using approved adhesive. All circumferential and longitudinal joints shall be over-lapped at least 40mm.

3.9.3 Cladding

All insulated ducting exposed to the atmosphere shall be provided with a cladding of 24 gage (0.70mm) GI sheet over the insulation. All joints shall be sealed with "Silicon Sealant", so that the cladding becomes completely water-proof. Cladding shall also be installed at all other locations shown on the drawings.

3.9.4 Insulation Tapes

At all insulation joints use 75mm wide self-adhesive tape consisting of reinforced aluminum foil and white Kraft paper.

3.9.5 Adhesive

Adhesive shall be rubber reinforced co-polymeric compound, equivalent in all respects to Zahabiya (Pakistan) ZGPA-7/223.

3.10 Duct Works & Accessories

3.10.1 Sheet Metal

Sheet metal duct work shall be constructed of galvanised sheet steel conforming to ASTM A527, lock-forming quality, uncoiled, regular spangle and having a minimum coating of 275 g/m².

3.10.2 Duct Construction and Installation Standards:

a) All duct construction and installation shall be carried out in accordance with current SMACNA HVAC Duct Construction Standards and SMACNA Accepted Industry Practice for Industrial Duct Construction, unless otherwise indicated herein.

b) Each duct system shall be constructed for the specific duct pressure requirements of the project as per the external static pressure.

- 1" WG pressure class shall be the minimum basis of compliance with the standards, regardless of the velocity in the duct, except when the system is variable volume. Measurement of duct velocity to be entirely the responsibility of the Contractor.

- All variable volume duct up-stream of VAV boxes shall have a 2" minimum basis of compliance. Measurement of duct velocity to be entirely the responsibility of the Contractor.

- 2" WG pressure class shall be the minimum basis of compliance for all ducts having velocity greater than 2000fpm and less than or equal to 2500fpm. Measurement of duct velocity to be entirely the responsibility of the Contractor.

- 3" WG pressure class shall be the minimum basis of compliance for all ducts having velocity greater than 2500fpm and less than or equal to 4000fpm. Measurement of duct velocity to be entirely the responsibility of the Contractor.

c) Minimum sheet thickness to be used shall be as follows, unless static pressure requirements dictate higher thickness as per SMACNA standards see TABLE-3 & 4 on pages 15670-6 & 15670-7 respectively.

3.10.3 Equipment Installation Responsibility

a) The Contractor shall ensure that the equipment is installed totally in accordance with the manufacturer's instructions (equipment installation manual must be obtained & read), and as directed by the Consultant. Correct alignment & leveling must be ensured.

b) Field assemble equipment (if required) in accordance with instructions in the manufacturer's installation bulletin.

c) Install the equipment on the foundation. Neoprene isolation pads or spring vibration isolators as specified for the equipment shall be placed under the equipment.

d) Insure that structure, piping or other equipment adjacent to this equipment do not restrict operation & maintenance requirements of the equipment.

e) Install all piping, cable, and other connections with all fittings, to the equipment. All material and labor required for a complete installation shall be supplied by the Contractor.

f) Connect equipment control panel to all operating external safety and auxiliary control devices.

g) Provide and install gauge cocks and thermometer wells for temperature and pressure readings at the inlet and outlet of all fluid flows.

h) Provide and install a flow switches on water circuits wherever necessary, and interlock it with the starting control circuit of the unit.

i) Install any control components provided by the manufacturer for installation external to the machine.

3.11 Flexible Duct

a) Supply and install pre-insulated flexible duct as and where shown on the drawings.

b) The duct shall be fabricated with extremely strong woven fibreglass fabric, with a flame resistant coating & permanently bounded to a coated spring steel wire helix, with a bi-directional metallic reinforced vapour barrier, with a stand-up beam. The duct shall be factory insulated with one inch fibreglass insulation with a vapour seal. Duct and insulation shall comply with NFPA-90A and be listed as Class-1 air duct under UL Standard 181. Also the duct shall be suitable for the temperature range from 20°F to 250°F

and velocity up to 5000 fpm. Positive pressure 10 inches and negative pressure 1 inch. Flexible duct shall be similar to model M-KC thermo flex Duct manufactured by Flexible Technologies, USA.

c) Limit length of the flexible duct to not more than 4 feet, unless otherwise shown on drawings.

d) Securely fasten the flexible duct run-outs to sheet metal collars. Slip the flexible duct over a matching sheet metal collars and clamp the flexible duct with a galvanised steel jubilee clamps.

e) Provide slack in duct @ 20% (twenty percents).

3.12 Louvers

3.12.1 General

a) Supply & install where indicated/shown on drawing or specified herein anodised aluminium exhaust/intake air louvers.

b) The blades and frames shall be of heavy gage extended aluminium sections provided with powder coating as approved by the Architect. The blades of louvers shall be set at 45°.

c) The louvers shall be provided with aluminium insect screen, so installed as to be removable for cleaning & replacement of screen.

d) Prior to order the Contractor shall submit shop drawing showing dimensions, free area available and sample to the Consultant for approval.

3.13 Mechanical Identification

3.13.1 General

The contractor shall install mechanical identification tags, shield, plates, etc., where specified below, shown on drawings, or directed by the Consultants. All components of the identification system shall be submitted to the Consultants for approval & approval obtained prior to installation.

3.13.2 Equipment Name Plates

All equipment shall be provided with metal nameplate with operational data engraved or stamped; permanently fastened to equipment at an accessible & visible location. Nameplate shall have name of manufacturer, product name, model number, serial

number, capacity, operating and power characteristics, labels of tested compliances and similar essential data.

a) Material shall be Fiberboard / Brass / Stainless steel / Laminated Plastic.

b) Stencil paint shall be black enamel, except as otherwise indicated.

c) Manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, conforming to ASME A13.1 shall also be accepted.

3.13.3 Equipment Data Plates

All equipment shall be provided with Equipment Data Plate to be permanently fastened at a suitable accessible and visible location of the equipment. Data plates shall be of min. 3mm thick laminated plastic of suitable size (min. 150mm x 100mm) fastened securely to the equipment. The plates shall generally display the following data:

a) Equipment identification symbol/number.
b) Fluid flow rates.
c) Pressure, pressure drops.
d) Cooling capacities or other capacities.
e) Motor data.

Any other matter required by the Consultants.

3.13.4 Labeling & Identifying

a) Piping Systems: install pipe markers as follows on each system, wherever piping is exposed in finished spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations. Include arrows showing normal direction of flow:

   i) Near each valve and control device.
   ii) Near each branch, excluding short take-offs for fixtures and terminal units.
   iii) Mark each pipe at branch, where flow pattern is not obvious.
   iv) Near locations where pipes pass through walls, floors, ceilings or enter non-accessible enclosures.
   v) At access doors, manholes and similar access points that permit view of concealed piping.
   vi) Near major equipment items and other points of origination and termination.
   vii) Spaced at a maximum of 15 meters intervals along each run. Reduce intervals to 8 meters in congested areas of piping and equipment.

viii) On piping above removable acoustical ceilings, except omit intermediately spaced markers.

b) Equipment: Install engraved plastic laminate sign or equipment marker on or near each major item of mechanical equipment.

i) Lettering Size: Minimum 6.5mm lettering for name of unit where viewing distance is less than 60mm, 12mm high for distances up to 180mm and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.

ii) Text of Signs: Provide text to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions and warn of hazards and improper operations, in addition to name of identified unit.

c) Duct Systems: Identify air supply, return, exhaust, intake and relief ducts with stencilled signs and arrows, showing duct system service and direction of flow.

i) Location: In each space where ducts are exposed or concealed by removable ceiling system, locate signs near points where ducts enter into space and at maximum intervals of 15 meters.

ii) Adjusting: Relocate identifying devices, which become visually blocked by work of this Division or other Divisions.

4. Equipment Lifting

The contractor shall be solely responsible for safe lifting of the equipments from place of storage to location of final installation and finally on the foundations.

Prior to lifting the equipments the following procedure shall be adopted:

a) Submit comprehensive insurance policy for the full value of the equipment to the Engineer/Employer from approved insurance company.

b) Submit complete information of specialist firm of lifters/riggers to the Engineer & obtain approval.

c) Submit complete procedure & equipment to be used for lifting the equipment in place. Identify on plans location of tripods, hoist, etc. that will transfer weight to the equipment, to the structure & obtain approval.

d) All the above to be completed with one month before the date of lifting of equipment.

5. Tests on Completion

a) The Contractor shall give to the Engineer/Consultant/Engineer in writing 15 days notice of the date after which he will be ready to make the "Tests on Completion". Unless otherwise agreed the tests shall take place within 10 days after the said date on such day or days as the Consultant/Engineer shall in writing notify the Contractor.

b) If the Consultant/Engineer fails to appoint a time after having been asked to do or to attend at any time or place duly appointed for making the said tests, the Contractor shall be entitled to proceed in his absence and the said tests shall be deemed to have been made in the presence of the Consultant/Engineer.

c) If in the opinion of the Consultant/Engineer the tests are being unduly delayed he may, by notice in writing, call upon the Contractor to make such tests within 10 days from the receipt of the said notice, and the Contractor shall make the said tests on such day within the said 10 days as the Contractor may fix and of which he shall give notice to the Consultant/Engineer. If the Contractor fails to make such tests within the time aforesaid, the Consultant/Engineer may himself proceed to make the tests. All tests so made by the Consultant/Engineer shall be at the risk and expense of the Contractor.

d) The Employer, except where otherwise specified, shall provide free of charge subject to the provisions of Sub-clause (e) of this clause; electricity, fuel and water, as may be reasonably demanded to carry out such tests efficiently.

e) If any portion of the works fail to pass the tests, tests of the said portion shall, if required by the Consultant/Engineer or by the Contractor, be repeated within a reasonable time upon the same terms and conditions, as aforesaid, save that all expenses to which the Employer may be put by the repetition of the tests shall be deducted from the Contract Price.

6. Inspection of Completed Works

a) The Contractor is required to give the Employer/Engineer/Consultant due notification when he expects the work to be completed, a report in triplicate of the measurements carried out with regard to pressure testing of pipes and leak testing of duct work and other specified tests shall be attached to this application. The final inspection should then be carried out, without unnecessary delay, and if possible within four weeks.

b) At the request of either party, inspection of such Sections of the work as will not be accessible after completion, or will be difficult to alter, which are to be taken into use by the Employer before the time of the final inspection, may be carried out in advance. (Advance Inspection).

c) An inspection is to be carried out immediately before the expiry of the guarantee period. (Guarantee Inspection).

d) Inspection of corrected faults or omissions noted in connection with advance, final, or guarantee inspection is also to be done (Supplementary Inspection).

e) Inspections are to be carried out by the Consultant/Engineer or any other suitable and competent person appointed by the Employer.

f) The costs of Advance Inspection, Final Inspection & Guarantee Inspection are to be met by the Employer, where the inspection has been carried out by a person appointed by him.

The costs of supplementary inspections and re-inspections are to be borne by the Contractor.

It is the responsibility of the Contractor to provide & pay for, any help or assistance necessary in connection with the inspection work.

g) The inspector's decision as to what faults or omissions may have occurred is binding on both sides.

h) The Contractor is required to carry out, without delay, any improvements, alterations or additions which may be considered necessary as the result of an inspection report.

i) When the final inspection has taken place, the work is to be handed over to the Employer in so far has been found to be in the state required by the Contract, and can suitably be put into use for this purpose for which it was intended.

j) The Employer has the right to put into use any Section of the work contracted for and not approved at the time of inspection, provided this can be done without jeopardising the progress of the work, and he may use it without special compensation even before the faults or omissions have been made good.

k) Where special dates are specified under the Contract for the completion of different Sections of the work, the provisions of this Clause are to apply to each part separately.

l) The inspection report required under this Clause is to be delivered in writing, and signed by the inspector, giving the date on which it is to be made available for the parties' inspection. The report should cover the following points:

- **i)** State whether the work has been approved or not.
- **ii)** State the reasons for failing to approve it, if it has not been approved.
- **iii)** State faults or omissions for which the Contractor is to be held responsible, together with the time within which they are to be made good.
- **iv)** Include notes on matters which do-not require immediate action, but ought to be finally settled in connection with the guarantee inspection.
- **v)** The sum to which the Employer is entitled.
- **vi)** Date on which the insurance taken out by the Contractor lapses.

vii) If the work has been approved at the final inspection, the date from which the guarantee/maintenance period is to run and the day after which it expires.

viii) Distribution of costs connected with the inspection.

7. Acceptance & Interim Operation

a) After the performance tests, if the equipment supplied by the Contractor is found to meet the guarantee and any other specified requirement, and if all other work called for hereunder has been completed, the Employer's acceptance will be forth-coming and final payment will become due as provided for under the terms of payment. This acceptance shall, however, not relieve the Contractor of his responsibility for the first inspection.

b) Should the equipment furnished by the Contractor fail to operate as required, or in case of failure to meet any of its guarantees, the Employer shall have the right to operate the equipment, using the Contractor's supervisory operating personnel, until such defects have been remedied and guarantees met with. In the event that defects necessitate the rejection of the equipment or any part thereof, the Employer shall have the right to operate the equipment until such time as new equipment is provided to replace the rejected equipment. Such operation shall not be deemed as an acceptance of any equipment.

END OF SECTION

SECTION 23 05 15

PAINTING, COLOUR COATING AND FINISHING

1.1 General

All parts of the work installed under this Specification shall be painted with approved first quality enamel paints, except those items specified as being painted by Builder or otherwise exempted from painting in this section of the Specification.

The requirement for painting of all pipe work and ductwork is in addition to the colour coding or banding specified in this Specification.

Paint shall be selected to withstand the temperature on the surface which it is applied, and shall be suitable in all respects for the environmental conditions in which it shall be located.

All metal work exposed to atmosphere e.g. roof mounted plant shall be epoxy coated to withstand the effects of chemical attack as experienced in areas close to cooling towers.

All paint used shall be of one approved manufacture, and finishes shall be full gloss unless otherwise specified.

Before ordering any primer, undercoat and finishing paint, the Contractor shall propose the color scheme to the satisfaction of the Engineer.

Before ordering any painting materials, the Contractor shall advise the Engineer of the type and manufacturer of all materials.

The Contractor shall select all finishing and painting materials from types suitable for the surfaces to which they are applied and for the environmental conditions in each area.

1.2 Plant, Machinery & Equipment

All items of plant, machinery and equipment supplied painted ex-factory shall be given one finishing coat of full gloss enamel, except where the manufacturer's standard finish is approved.

1.3 Exposed Metalwork

All exposed metalwork shall be wire-brushed and cleaned from rust, scale, dirt and grease, and shall then be given one priming coat, one undercoat and one finishing coat of full gloss enamel.

The priming coat for exposed galvanised iron shall be an approved galvanized iron primer.

The priming coat for exposed non-ferrous metalwork shall be approved as suitable for the metal to which it will be applied.

1.4 Concealed Metalwork

All galvanized iron surface concealed in roof spaces, false ceilings, building ducts etc. shall not be painted.

All black iron and steel surface shall be wire brushed and given one coat of zinc chromate or red primer.

Colour banding for identification shall be provided as described elsewhere in this Specification.

1.5 Ductwork & Pipework & Metal Sheathing

Uninsulated ductwork, internally insulated ductwork, uninsulated pipework and metal sheathing shall be painted as for exposed or concealed metalwork as applicable.

Turned parts of valves, controls etc., shall be cleaned and polished to approval.

1.6 Plastered Finish Insulation Surfaces

Plastered finish insulation surfaces shall be given one coat of size, one undercoat consisting of two parts of ordinary undercoat to one part of sealer, and one finishing coat of full gloss enamel.

1.7 Calico Finish Insulation

Exposed insulated surfaces finished in calico, scrim or canvas covering shall be painted with two (2) coats of polyvinyl acetate emulsion. Each coat shall be a different colour.

1.8 Pipework Identification

All pipes etc. shall be identified in accordance with BS 1710:1984.

Circumferential bands of standard ground colours shall be not less than 100mm wide on pipes up to 50mm nominal diameter, and not less than 150mm wide on pipes greater than 50mm nominal diameter.

Supplementary colours shall be displayed as bands not less than 25mm wide in the centre of the ground colour bands.

Where lettering is required it shall be painted in contrasting colours in accordance with the standard, in block letters not less than 15mm high for pipes up to 50mm nominal diameter, and in block letter not less than 40mm high for larger pipes.

Identification bands shall be located where they are clearly visible in each room or compartment through which the pipe runs, and shall be placed at centres not exceeding 6m.

Direction of flow shall be indicated by an arrow painted on the pipe adjacent to each colour band. Arrows shall be 75mm long on pipes up to 50mm nominal diameter, and 150mm long on larger pipes.

1.9 Colour Schemes

The whole of the installation shall be painted in accordance with the requirements indicated in Table 1.

Equipment shall be painted and colour coded to BS 381C:1980 as indicated in Table 1.

1.10 Labelling

All plant and equipment provided under this Specification is to be labelled in English. All warning signs shall be English as to duty or services, all such labelling to correspond to schedules, diagrams, etc. to be provided as part of the Record Drawings. Labels are of white Traffolyte with black engraved lettering not less than 20mm high or as otherwise required and approved. Labelling is also required for any Mimic Diagrams.

Manufacturers' nameplates shall generally be provided for all plant and equipment and shall show serial and model numbers and date of manufacture.

The following is an indication of specific items requiring labelling. (The list is by no means limited - all items shall be labelled to the intent of this section).

- All valves, motor starters, fans, distribution boards, gauges, contactors, cable terminals in switchboards, circuit breakers.

- Labels to be attached to valves (or pipe adjacent thereto) with a light gauge metal band or alternatively to be screwed to the insulated valve box where provided. These labels shall state the valve number.

- Distribution boards, starters etc. are to be labelled to indicate the circuit number, phase and item controlled.

Label shall be screwed or riveted to sheet metal. Adhesive fixing is not acceptable.

Details of exact lettering shall be agreed with the Architect prior to manufacture.

A complete valve schedule shall be incorporated in the as-built drawings and this schedule shall clearly indicate the valve numbers, duty, function, size, flow rate and any other relevant information necessary to allow the plant operators to safely operate each valve and to subsequently maintain or replace the valve as required.

The valve schedule shall clearly relate to the various system schematics to enable the entire operating sequence and circuitry to be followed.

1.11 Application of Painting

All paints shall be prepared and applied in accordance with the manufacturer's recommendations.

All galvanized metal surfaces shall be properly etch-primed to ensure correct adhesion of the paint to the surface. Materials for etch-priming shall be as recommended by the paint manufacturers. Subsequent painting of galvanized surfaces shall comply with this Specification.

Prior to painting, all metallic surfaces except galvanized surfaces shall be thoroughly scraped and wire brushed as necessary to remove scale, rust and swarf. Surfaces shall then be solvent cleaned to remove all oil, grease and dirt.

When the surfaces to be painted are clean and dry, one coat of an approved primer shall be evenly applied over the entire area. After surfaces have been primed, the Contractor shall notify the Architect so that an inspection of the primed surfaces can be made prior to the application of the undercoat and the finishing coats.

When the priming coat has been approved, one coat of an approved paint flat undercoat shall be applied. Before applying the finishing coats, the Contractor shall ensure that the undercoated surface is rubbed flat and smooth. Finally, an approved high gloss finishing paint shall be applied when all dust has been removed.

Each successive coating shall be completely dry prior to the application of the next coat. The minimum thickness of each layer of paint shall be 50 microns.

END OF SECTION

SEC- 23 05 29

HANGERS & SUPPORTS

1. General:

All pipe supports shall be approved supports locally manufactured as per specialist pipe supports manufacturers, such as Hilti, Sikla or Fisher. Pipe hangers, brackets, saddles, inserts, clamps and pipe rolls including rods, bolts, turn buckles, bases and protection shields.

Chain, wire, strap or other such devices will not be permitted as hangers or supports.

Pipe hangers shall be capable of supporting the pipe in all conditions of operations. Hangers shall be supported with beam-clamps, concrete inserts, Phillips concrete fasteners, or rawl-bolts. Concrete inserts when used shall be installed in the exact location prior to the pouring of the concrete.

2. Suspended Piping Supports:

a) Piping shall be supported by adjustable hangers or supports, which shall provide a means of vertical adjustment after erection. Unless otherwise indicated on drawings maximum spacing between pipe supports for straight runs of steel pipe shall be in accordance with recommended spacing shown in the table given below:

	Nominal Pipe Size, Ø mm											
	13	20	25	40	50	65	75	100	125	150	200	250
Maximum Span, m	1.5	1.8	2.1	2.7	3	3.3	3.6	4.2	4.8	5.1	5.2	6.7
Rod Size, Ø mm	10	10	10	10	10	13	13	16	16	19	22	22

Pipe hangers and supports shall be spaced not over 1.5m apart at heavy fittings and valves. A hanger shall be installed at not over 300mm from each change in direction of piping.

Vertical Piping shall be guided or supported in the centre of each riser but not over 4.5m on centres and shall be supported at the base of the riser on a base elbow or tee with a pipe stand only where required.

b) CI Piping shall be supported at not more than 2m for horizontal piping and 3m for vertical piping.

c) PVC Piping shall be supported so as not to cause any deflection and adequate support spacing shall be ensured but shall not exceed 2m.

d) Polyethylene piping shall be supported as per manufacturers recommendations.

3. Pipe Sleeves:

Pipes passing through concrete or masonry walls or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction or afterwards if necessary. Each sleeve shall extend through its respective wall, floor or roof and shall be cut flush with each surface. Sleeves shall be of such size as to provide a minimum of 6mm all around clearance between bare pipe and sleeve or between jacket over insulation and sleeve. Sleeves shall be of steel pipe or cast iron pipe.

Sleeves in exterior below ground, walls, pits and tanks shall be similar to 'Doyma' sleeves, consisting of a galvanised steel sleeve to be embedded in concrete, with the pipe passing through synthetic rubber rings that are compressed using galvanised steel pressure plates on both sides of the rubber ring as shown on drawings.

4. Other Supports:

Equipment, duct-work and any other plant component requiring supporting and anchoring shall be provided with properly engineered supports and anchors, as shown on the drawings, or as per manufacturer's recommendation or as directed by the Consultant/Engineer in all cases drawings & submittals for supports & anchor system shall be submitted to the consultant and approval obtained.

5. Payments:

Unless otherwise indicated in the BOQ, no separate payment shall be made for supports, hangers, sleeves, etc. and cost for these shall be part of the price quoted for the, supported piping, equipment, etc. Payment shall however be made for 'Doyma Sleeves' as indicated in the BOQ.

END OF SPECIFICATIONS

SECTION 23 08 00

TESTING, COMMISSIONING & HAND OVER

1.0 Testing, Commissioning & Hand Over

1.1 General

The Contractor shall carry out all commissioning and testing necessary for the safe, reliable and satisfactory operation of the system and equipment installed.

The Works shall be commissioned and tested in accordance with manufacturer's instructions, the appropriate CIBSE or ASHRAE commissioning codes, local Government requirements, applicable insurance company's and this Specification.

At least two month's prior to testing or commissioning any system, the Contractor shall furnish the following information for each system or process to the Engineer for review.

- Submission of testing procedure and details as well as the relevant report forms to the Engineer for approval.
- Type of instruments to be used
- Manufacturer of instruments
- Calibration methods for instruments
- Operating instructions for instruments
- Accuracy and tolerances of instruments
- Complete schedule and programme of all testing and commissioning activities

The Contractor shall employ thoroughly competent and experienced personnel to carry out all tests.

All instruments and labour necessary for testing and commissioning shall be provided by the Contractor.

In particular, the instruments as indicated in Schedule AA shall be provided and remain the property of the owner after testing and commissioning.

- One flow rate measurement set

- One hot wire anemometer with accessories for measuring static pressure
- One portable octave band sound meter
- One portable ^{o}C wb sling psychrometer.

All instruments shall have been recalibrated within six months of the start of commissioning or testing. Calibration of all instruments shall be certified by the instrument manufacturers or an approved calibration agency.

Should the results of any test show that any plant, system or equipment fails to perform to the efficiencies or duties as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performances be obtained.

Should it be necessary for the Contractor to modify or replace any item of plant as described above, he shall be responsible for the cost for making good of any damage or deterioration to the building or other services consequent on such modifications.

The Contractor shall allow in his cost for returning to site during the first year of operation from the date of Certificate of Completion at certified by the Engineer to test equipment and systems under maximum design conditions.

1.2 Factory Tests

The following items of equipment shall be tested at the manufacturer's works or elsewhere as appropriate prior to installation. In all cases, 'Type-test' certificates shall be submitted in triplicate to the Engineer. Cases where `Type-test' certificates will be accepted are as follows:

1.2.1 Fans

`Type-test' Certificates showing fan characteristic curves, (BS 848 Part 1, test method as appropriate) and Type Test Certificates for sound power levels (BS 848 Part 2).

1.2.2 Pumps

`Type-test' Certificates for head discharge, speed and power input (BS 599).

1.2.3 Electric Motors

`Type-test' Certificates in accordance with BS 5000. For motors of 40 kW output and above, routine individual test certificates in accordance with BS 5000.

1.2.4 Starters and Control Gear

`Type-test' Certificates (BS 587). For control panels as a whole, routine (individual) high voltage test in accordance with BS 587.

1.3 Site Testing and Commissioning

1.3.1 Execution of Tests

The plant will be inspected and tested during and after installation on site as set out below and approved for satisfactory design, workmanship and materials, for compliance with the provisions of the appropriate specifications and for performances, materials, dimensions and ratings as tendered.

All tests shall be witnessed by the Engineer or his appointed deputy with at least seven days' notice given prior to any test.

All tests shall be executed and, if not satisfactory, repeated to the satisfaction of the Engineer at no extra cost.

All DX/VRV system shall be commissioned and tested to the recommendation of the manufacturers.

1.3.2 Preliminary Commissioning Check

The Contractor shall ensure that all equipment included under this contract is thoroughly cleaned, lubricated and checked for serviceability immediately before setting to work. Particular attention is drawn to the removal of building debris from the air systems, motors, fan bearings and pipework.

All pipework shall be thoroughly flushed and chemically cleaned to ensure that all foreign matter is removed and internal surfaces are decreased. During all preliminary flushing, plant shall be isolated by means of bypasses to avoid dead legs, and the systems shall be completely isolated from any existing systems to ensure contamination cannot occur.

Further flushing and chemical treatment shall be carried out on isolated systems by connection of temporary diesel driven pumps to circulate water and dosing chemicals. The Contractor shall allow for cross-connection of flow and return pipework at the extremities.

All automatic controls and safety devices shall be inspected and checked for serviceability before the working fluid or electricity is applied to the system.

1.3.3 Air Handling Equipment & Ductwork

All the commissioning procedures shall comply with those set out in the current edition of the CIBSE Guide Commissioning Code Series A or SMACNA standards.

The Contractor shall allow for balancing all air diffusers and grilles by means of the regulating dampers provided. Air quantities shall be set to within +5% - 0% of the design value.

The following data shall be recorded on the commissioning sheets:

- Dry and wet bulb temperatures:
  - At ambient conditions
  - Within each occupied space, at various locations within same space as required
  - At each main supply and return air duct
  - Before and after coil
- Fresh air supply flow rate to each air handling unit
- Air flow and resistance across each main plant item, e.g. filter, cooling coil.
- Air flow at each supply and exhaust duct, and at each supply, return and exhaust air grille and diffuser.
- All fan and motor speeds.
- Starting and operating current for each motor.

All ductwork shall be tested for leakage rate in accordance with DW/143:1983. The floor where this test is to be carried out shall be as directed by the Engineer.

After leakage test for distribution metal ductwork, for VAV systems, all VAV terminals on ONE typical floor shall be connected to the distribution ductwork properly jointed and secured and outlets of the system shall then be pressure tested again to a pressure of 750 Pa. The total leakage rate in this test shall not exceed 5% of the total system design air flow rate.

The floor where this test is to be carried out shall be as directed by the Engineer.

Should result of the test turn out to be unsatisfactory, the Contractor shall carry out necessary remedial works and repeat the test thereafter until the specified requirement is fulfilled. In this case, the test shall also be carried out on one other floor chosen by the Engineer. Should the test on this new floor turn out not satisfactory this practice of re-test shall repeat until there is a floor where the test carried out is a satisfactory one without requiring any remedial work.

1.3.4 Pipe and Water Systems

All the commissioning procedures shall comply with those set out in the current edition of the CIBSE Guide commissioning Code Series W.

All water pipework, coils and other fittings shall be hydraulically tested to 1.5 times the working pressure but in no case less than 14 bar. The pressure shall be maintained for a period not less than 24 hours within ±2%.

Where any section of pipework or equipment of the plant is unable to withstand the maximum pipework test pressure, it shall be isolated during the pipework tests, then, that section of pipework or equipment shall be re-tested at the appropriate test pressure.

Before finally charging, the chilled and condenser water systems shall be thoroughly flushed and all strainers, filters, etc. cleaned.

All chilled and condenser water systems shall be adjusted and balanced for the correct duty by the regulation valves provided.

The following data shall be recorded on the commissioning sheets:

- Circulation pump motor speed
- Suction and discharge heads for all the pumps, and flow rates as checked against pump curves.
- Water flow rates in main branches and through major equipment
- Supply and return water temperatures of each water coil
- Starting and operating current of each pump motor
- Water pressure drop across each item of hydraulic equipment, e.g. cooling coils, control valves, strainers, etc.

1.3.5 Control System

The Contractor shall include all thermostatic and automatic controls to be commissioned and tested by the control manufacturers Engineer. Generally, the commissioning procedure shall comply with that set out in the current edition of the CIBSE Guide Commissioning Code Series C.

The Contractor shall calibrate all thermostats, humidistat and pressurestats, set the modulating range and set points on all automatic valves and dampers as required to ensure that operating conditions are correct. The time and control sequence shall also be tested and verified.

Interlocking circuit and safety devices shall be tested to ensure safety operation of the plant.

1.3.6 Electrical Test

The following tests shall be carried out in full compliance with the IEE Regulations by the Contractor in the presence of the Engineer.

- Insulation resistance test of all power and control cables
- Insulation resistance test of all motor windings
- Test of conductor continuity
- Test of effectiveness of earthing
- All thermal overload relays and starters
- Sequence of operation
- Flick test of motors

1.3.7 Miscellaneous Measurement and Testing

Room temperatures and humilities and noise levels (at each octave band mid-frequency from 63Hz to 8,000Hz) shall be measured to ensure design conditions are achieved. Measuring instruments hall be located 1500 above floor level at points away from the influence of draughts or hot or cold surfaces. Such measurements shall not be carried out when weather or other environmental conditions are likely to cause undue influence to the results.

Sound and vibration testing shall be carried out to ensure that equipments are operating with satisfactory sound and vibration levels and that there is no transmission of objectionable vibration or through the building structure. Sound levels shall be measured with and without the plant in operation.

All data relative to the performance tests shall be provided with 7 days of completion of the tests. Final retention moneys will not be released of completion of the tests. Final retention moneys will not be released until the performance test results have been received and approved.

1.4 Handing Over

The following procedure shall be adopted prior to handing over the installation:

(a) All preliminary testing, checking, adjusting and balancing of the installation shall be carried out before forwarding notification that the installation is considered to have reached the Completion.

(b) After inspection, and when the approving authority is satisfied and agrees that the installation is ready for handing over to the Purchaser, the plant shall be finally commissioned and Installation Manuals together with post contract drawings shall be provided as specified.

Certificate of Completion will be certified only after the plant has been inspected and approved and the above requirements fulfilled.

1.5 **Post Contract Drawings**

Supply prior to completion (which will not be granted until such have been supplied) six copies of all installation drawings which have been correctly brought up to date to reflect all field changes and are a true and accurate representation of the actual installations. Five copies of these drawings shall be folded and inserted in plastic envelopes in the installation manual and one copy shall be laminated into plastic. In addition supply two sets of microfilm aperture cards of all drawings. These drawings shall include the following:

(a) Complete ducting and layout drawings showing the actual sizes and locations of all ducts, dampers, supply outlets, return inlets, fresh air intakes, etc. and the final measured air flow rates at all relevant locations.

(b) Complete plant room and/or equipment layout drawings with full identification of each and every item of equipment.

(c) Complete piping layout drawings, showing the actual sizes and locations of all refrigerant, water, instrument air, steam, fuel oil, gas and any other lines applicable to the system.

(d) Complete schematic flow and control diagrams of all air, water, refrigerant, instrument air and any other systems incorporated in the installation.

(e) The drawings shall show all motorized automatic and hand-operated controls such as dampers, valves, relief valves, cut-outs, thermostats, expansion valves, solenoid valves, bleeds, vents, drains, strainers, gauges, thermo wells, by-passes, sight glasses, and all similar items pertinent to the functioning of the installation. Where applicable the drawings shall also include the settings and differential bands of all controls, cut-outs and other variable or adjustable items. All items must be clearly identified as to type and functioning of the installation.

(f) Complete control wiring diagrams showing all electrical controls, relays, cut-outs, timing devices, inter-locks, fuses, over-loads, contactors, solenoids, starters, etc. with all items clearly identified as to type and function, and "as installed" switchboard layout drawings.

If the quantity of drawings involved is too large to conveniently bind in the installation manual, then a separate matching cover shall be supplied for each of the three drawing sets.

END OF SECTION

SECTION **23 05 53**

Duct Work

1.1 General

a) This section of the Specification covers the general requirements for ductwork, ductwork accessories, and associated air control devices, unless the general requirements are abrogated by specific requirements elsewhere in the Specification or Drawings.

b) The Contractor shall supply and install all ductwork and accessories for the correct and satisfactory operation of the air systems covered by this Specification.

c) Where standards are referred to, the equivalent local standard shall be used if such exists. In all cases, the latest edition shall be followed.

d) All ductwork and fittings delivered to site shall be new and shall be clearly and indelibly stamped to identify different grades, materials and manufacturers.

e) All ductwork shall be manufactured as far as practicable to site dimensions taken by the Contractor. Where site dimensions cannot be taken in advance, dimensions shall be taken from architectural/structural detail dimensioned drawings to accommodate any discrepancies that may occur between interior decorator shall also be taken into consideration with regard to the requirements and interior finishes.

f) Prior to commencing work on site, the Contractor shall prepare complete working drawings for all ductwork systems included in the Contract to the satisfaction of the Architect. Working drawings shall include plans, sections, elevations, schematics, schedules and details of all systems and shall show locations and details of all dampers, splitters, hangers, supports, supply, return, intake and exhaust air fittings, joints, flexible connections, test points, insulation, linings, cladding, etc.

g) Prior to ordering any materials, the Contractor shall submit to the Architect for review manufacturer's data for all dampers, actuators, supply, return, intake and exhaust air fittings, proprietary brand jointing systems or materials, and for any other equipment as may be requested by the Architect.

h) In the case of supply, return, intake and exhaust air fittings, the submission shall include one finished sample in an approved colour and finish of each type of air fitting to be provided under the contract. No fittings may be ordered until the Architect has reviewed the sample in writing including the finish and colour. Samples shall include mounting frames, fixings, etc., so that the entire fitting assembly may be reviewed.

i) All ductwork, fittings, accessories, joints and jointing materials shall be suitable for the service and shall not deteriorate due to atmospheric action.

j) All fire dampers and casings shall be manufactured and installed in accordance with the Local Authorities' requirements and CP13 Fire Damper specification.

k) All ductwork and materials including linings, adhesives, flexible ducts, flexible connections, gaskets, sealants, fibreglass boards, etc., shall fully comply with all requirements of the Local Authorities and shall satisfy all local codes in respect of resistance to penetration of fire and spread of flame and smoke.

l) The materials, construction and installation of all sheet metal ductwork and fittings shall be in accordance with the Specification for sheet metal ductwork, DW/142 : latest edition (HVCA). Where any part of the installation is not covered by the HVCA Specifications, then the standard of the Sheet Metal and Air Conditioning Contractor's National Association of U.S.A. (SMACNA) latest edition shall apply for either high velocity or low velocity systems. Where any part of the installation shown on the drawings is not covered by either the HVCA or SMACNA Standard, then reference shall be made to the Architect for endorsement of materials and methods prior to installation.

m) The ductwork installation shall be leakage tested in accordance with Ductwork leakage testing, DW/143 : latest edition (HVCA). A complete record of the test shall be submitted to the Architect on approved forms for review. The Contractor shall provide all necessary equipment for the tests. Should any test indicate leakage rates in excess of that specified by DW/142, the section of ductwork shall be dismantled, joints cleaned down and re-assembled and test repeated.

n) The Drawings indicate the clear internal air passage dimensions of the ductwork and the manner in which the ductwork systems are to be installed. Due allowance shall be made for the thickness of internal or external linings when dimensioning ductwork and selecting fittings and accessories. The actual work involved in respect of transitions, offsets, etc., shall be ascertained by the Contractor, who shall co-ordinate the ductwork installation with the work of other trades and services.

    a. Aspect ratio, dimension and routing of duct work shall be adjusted to suit co-ordination of services and headroom requirement. The Contractor shall bear all costs associated with the adjustment.

1.2 **Sheet Metal Duct Materials**

a. Generally, all ductwork shall be of hot dipped galvanised steel sheet to BS 2989: latest edition, Grade Z2, coating type 'C' as specified in DW/142.

b. Galvanised steel ductwork shall be fabricated from new, best quality, full sized galvanised flat steel sheets.

c. The pressure class and air leakage limit shall be as defined in DW/142.

1.3 **Sheet Metal Duct Construction**

a. All sheet metal ductwork shall be constructed free of waves or buckles to the size shown on the plans. Rectangular ducts exceeding 300 mm longest side shall be cross broken between adjacent stiffeners, or alternatively shall be constructed of one size heavier material than scheduled. Internally insulated ducts shall not be cross broken.

b. Longitudinal joints shall be made with Pittsburg Lock or grooved seams, closed for tightness and appearance. Cliplock or Snaplock button punched joints may be used with tack soldering or self tapping screws at maximum 750 mm centres.

c. All flange and stiffener angles shall be solid rivetted at centres not exceeding 100 mm. Mating flanges shall be match drilled and bolted by 5 mm diameter cadmium plated nuts and bolts at 150 mm centres, using 4 mm thick rubber or equal approved insertion gaskets. Standing seams will not be permitted.

d. All joint exposed to weather, other than angle flanged joints, shall be soldered water tight.

e. All transverse duct joints shall be taped with approved duct tape.

Longest Side	Galvanised Steel (mm)	Intermediate Stiffening (mm)	Transverse Joint
1-300	0.5	None	Drive Slip at 2400 crs
301-450	0.6	None	Drive Slip at 2500 crs
451-750	0.6	25x25x3 angles at 1200mm crs on all sides over 450 mm	25mm standing seam
751-1050	0.8	25x25x3 angles at 1200mm crs on all sides over 450 mm	25mm standing seam
1050-1350	0.8	38x38x3 angles at 1200mm crs on all sides over 750 mm	38x38x3 angle flange
1351-1500	1.0	38x38x3 angles at 750 mm crs.	38x38x3 angle flange
1501-2100	1.0	38x38x3 angles at 750 mm crs.	38x38x3 angle flange
2101-2400	1.2	50x50x6 angles at 600mm crs.	50x50x6 angle flange
Over 2400	1.2	50x50x8 angles at 600mm crs.	50x50x8 angle flange

1.4 **Sheet Metal Duct Bends & Elbows**

a. Where possible, changes in direction shall be made with the internal throat radius of the air passage equal to the duct width. Where space does not permit this throat radius, bends of smaller radius may be used with approved stream splitters in accordance with the following schedule:

Throat Radius (mm)	Duct Width (mm)	No of Stream Splitters
100 - 200	200 - 700	2
	701-1300	3
Over 200	300 - 600	1
	601 - 1500	2
	Over 1500	3

b. The radius of each splitter shall be approved by the Engineer.

c. Stream splitters shall be constructed of 1.2 mm galvanised steel or 1.6 mm aluminium secured both edges by folding, and shall be solid rivetted or pop rivetted and soldered to the duct at centres not exceeding 100 mm. The entering and leaving edges of stream splitters will be folded to form a hem not less than 15mm long, which will be supported by approved stays at intervals not exceeding 600 mm for galvanised steel or 400 mm for aluminium

d. Where radius bends are impractical and where shown on the drawings, square throat elbows shall be employed, which shall be fitted with approved aerofoil section air turns at maximum 30 mm centres, fixed in runners and secured tot the duct as for stream splitters.

1.5 **Sheet Metal Duct Transitions & Fittings**

a. Duct surfaces which diverge from the centres line of the air flow shall not diverge at a ration greater than 1:7, and converging surfaces shall do so at a ratio not greater than 1:4. Where space prohibits such ratios, stream splitters shall be provided so that the required ratios are maintained relative to the centre line between adjacent surfaces.

b. Where it is impossible to offset ductwork around obstructions, the obstruction within the duct shall enclosed in a fairing which shall be semi-circular on the entering air slide and which shall converge equally on the leaving air side to form an angle not greater than 60 degrees. The duct dimensions shall be increased around the obstruction to maintain the same net free area.

c. Branch take-offs from main ducts shall be made with an inside radius 0.75 x branch duct width, and shall be provided with an adjustable splitter damper the length of which shall be 1.5 x the internal take-off width. Where air diffusers take-off directly from a duct, they shall be provided

with stream splitters 80 mm long at 50 mm crs. in the take-off adjacent to the duct and with a full size adjustable damper. Stream splitters may be omitted if the length of straight take-off duct attached to the diffuser exceeds 4 times the take-off diameter or 4 times the longest duct side.

1.6 **Round Flexible Ducts**

a. All flexible ductwork shall be of the patent pre-insulated type and shall be by suitable for the duties and pressures as required for the particular system.

b. All bends made in flexible ducting shall be formed to manufacturer's recommendations and shall have a centre-line radius of not less than 1.5 time the diameter of the ducts. Bends shall remain at full diameter throughout the length of the bend.

c. All joints between lengths of flexible ductwork shall be made with short spigots of galvanised sheet metal circular duct to form a slip joint. Similarly all connections to fittings and terminal boxes etc. shall be of the spigotted slip joint type.

d. Duct connections shall be taped and provided with bands as follows.

e. All joints shall be sealed with shrink-on type duct bands. These shall be continuous screw type metal or PVC bands similar to "Jubilee" hose clips or approved equivalent may be used. Self tapping metal screws and rivets shall not be used.

f. All flexible ducts shall be adequately supported with hanger straps located, at a minimum of 2000 centres, to prevent undue sagging and strictly in accordance with the manufacturer's recommendations.

g. Circular flexible acoustic ductwork shall be of the metal helix type incorporating perforated acoustic reinforced aluminium internal liner 25mm thick flexible fibreglass insulation as specified and reinforced external vapour barrier.

h. The ductwork shall have the following minimum acoustic performance:

Octave Band Mid Frequency

Frequency Hz	63	125	250	500	1K	2K	4K	8K
Insertion Loss dB	22	24	33	31	31	35	34	24

i. The completed ductworks shall have Class 1 surface spread of flame and Class 0 ratings when tested to BS 476.

1.7 **Kitchen Exhaust Ductwork**

a. Dishwasher exhaust ducts shall be constructed of stainless steel 304 to BS 1449 Part 1 latest edition or other local code. Metal thickness and construction details of the stainless steel ducts shall be same as for galvanised sheet steel. All duct seams and joints shall be air tight with heat resistant and waterproof sealant and low points shall have a drained sump. Ducts wider than 600mm shall be jointed by stainless steel flanges.

b. Unless otherwise specified, kitchen exhaust ducts shall be constructed of minimum 1mm thick SS316 stainless steel including sealing air tight all seams and points with heat resistant and waterproof sealant. Provide all low points with a drained sump.

c. Air-tight access doors shall be provided every 6000mm, and shall have minimum size 600 x 600mm. Access doors shall have equivalent thermal resistance as the main exhaust ductwork.

d. Where shown on the Drawings, kitchen exhaust hoods shall be of the double skinned balance type provided over all main cooking equipment. The clear height from the floor to the underside of the hood shall be as stated in local codes. Where no measurement is given, locate hoods 800mm above the surface to be exhausted. Bottom edge of hood shall be at least 1.85m above floor level but not exceeding 2m. The hood shall in plan overlap all equipment by 100mm.

e. Hoods shall be manufactured from 1mm thick SS316 stainless steel and all stiffening and supports shall be hidden by the double skin. The hood shall include all necessary grease filters and lighting. Provide allowance for sprinklers where shown on the drawings. Lighting shall be of vapour proof type and constructed of die cast aluminium alloy with clear prismatic glass. Lighting shall be sealed against oil laden fumes at temperature of 150^{o}C.

f. Individual removable drip trays with sufficient length, width and depth shall be attached to the entire length of the filter with handles to permit quick removal.

g. Grease filters shall be provided, sized such that the face velocity over the filters shall be between 0.75 m/s and 1.25 m/s. Grease filter shall be of rugged, heavy duty, washable metal construction with stainless steel frame. Filter media shall be 50mm thick non-combustible material

consisting of alternate layers of flat and herring-bone crimp zinc electroplated steel screen wire. Filters shall be tight fitting and firmly held in place. They shall be installed at an angle between 45^{o} to 60^{o} and easily removable for cleaning.

1.8 **FITTING**

1.8.1 Joints And Fittings

i) All cross joints, longitudinal joints, take-offs, bends, transitions and other fittings shall be in accordance with DW/142 : latest edition for the appropriate class.

ii) All flanges and steel works for jointing and supporting members shall be hot-dipped galvanised to BS729:1971, Part 1 or BS2989 G275 whichever is applicable.

1.8.2 Ductwork Jointing Sealant

Jointing for flanged cross joints shall be formed from a lead impregnated gasket or other approved material to thickness not less than 4mm. Sealant shall be suitable for the type of fluid and temperature encountered.

1.8.3 Vanes and Deflectors

Vanes or deflectors shall be provided inside ducts where required. In particular, such vanes or deflectors shall be provided at all bends having an internal radius less than the width of the duct and also where the included angle exceeds 30° at changes of section. Vanes and deflectors shall be of special profile to ensure complete change of direction of flow at the point, with extended leading and trailing edges, and with radii and spacing selected to achieve uniform velocity at the bend.

1.8.4 Flexible Joints

i) All flexible connections for use at temperatures up to a maximum of $90^{o}C$ shall be of neoprene coated glass fabric having a density of not less than 1 kg/m^2.

ii) All flexible connections fur use with temperatures in excess of $90^{o}C$ and in carpark, smoke exhaust and other high temperature applications shall be

of non-combustible woven glass fabric type capable of withstanding 250°C under continuous operation for at least 2 hours.

iii) All flexible connections exposed to the weather shall be cover with prime quality galvanised sheet steel or fibreglass weather shields arranged to form a complete weatherproof jacket.

iv) All flexible connections shall be fixed over mild steel angle flanges at both ends and secured to same with not less than 2.5mm thick x 25mm wide mild steel bands. For circular ducts flexible connections shall be of the split semi-circular type drawn up tight with bolts at the split points. Flat bars for rectangular ducts shall be fixed with bolts or screws at not more than 150mm centres. The flanges to take the connections shall be not less than that specified for the ducts and the "free" space between flanges shall not be less than 50mm. The flexible connections shall be installed with not less than 25mm additional slack length between the flanges to prevent transmission of vibration.

v) Flexible connections shall not be used to correct misalignment of fan and duct.

1.8.5 Fire Dampers

a) Fire dampers shall comply fully with the up-to-date requirements of the Local Services Department and any other Local Authorities having jurisdiction regarding rating, construction, installation and testing.

b) The fire dampers shall be constructed generally to the same standards of air-tightness as the rest of the system.

c) Fire dampers are to be provided where ducts enter shafts, pass through masonry or concrete walls, floors, fire partitions, and wherever required by authorities having jurisdiction over the work. All rectangular fire dampers shall be constructed to provide a fire rating the same as the wall or floor penetrated.

d) In locations where the fusible link is of the electro-thermal type, the Contractor shall leave the bare wire link connections adjacent to the damper (unless otherwise indicated) for connection to electrical circuits by another Contractor. This Contractor shall be responsible to inform when connection can be effected.

e) Fire dampers shall be of multi-leaf type or shutter type (100% out of the air stream) as indicated on the Drawings and constructed from corrosion resistant material or otherwise protected to inhibit corrosion. All fire dampers shall be operated by fusible links designed to function at 68^{o}C unless otherwise specified or shown on the Drawings.

f) Fire damper assemblies shall incorporate provision to permit free expansion in case of fire, and the integrity of the fire damper shall be maintained by fire resistant packing around the casing and duct through the fire partition. Access openings shall be provided adjacent to fire dampers to permit access to and replacement of links.

1.8.6 Access Panels

a. Access panels shall be provided at every point in the ductwork systems where access for checking, servicing and cleaning of equipment is required. Such equipment shall include all fire dampers, plenums, motorised dampers, fan chambers, air chambers, etc. Where additional access panels are required for checking, servicing and cleaning of equipment not mentioned above, these shall be provided by this Contractor.

b. Submit required location and sizes of any access panel in finished building surfaces and exposed areas for approval in time to enable them to be incorporated into the construction. Access panels in building surfaces will be supplied by other trades Contractors. The exact location shall be shown on shop drawings.

c. Access panels in ductwork, casings, or sheet metal partitions shall be of G.I. double construction with insulation of the same general character as adjacent sections of ductwork of not less than 0.8 mm sheet metal and shall have gaskets around their entire perimeter to ensure a seal conforming to DW/142 leakage class specification as required by the system. For rectangular or square duct, minimum size shall be 450 mm x 450 mm or 50 mm narrower than the duct whichever is smaller. For circular duct, access panels shall be "ductmate" or approved equivalent, minimum size 250 x 150mm for duct up to 450mm diameter, 400 x 300mm for ducts up to 1200mm dia. and 600 x 450mm for ducts up to 2000mm dia. Access panels shall be fully removable but secured with sufficient steel cable to ensure panels are not lost but can be removed to provide adequate room for proper access.

1.8.7 Volume Dampers

a. The Contractor shall provide and install hand operated dampers where required for the proper regulation of the ventilating and air conditioning systems. In general, dampers shall be provided as follows:

i) In all main supply and exhaust air ducts, branches, outside air connections to fan coil units and all outside air supply outlets.
ii) Behind all supply and exhaust air diffusers/grilles/linear diffusers or supply connection to grilles.

b. All volume dampers shall comply with DW/142 and shall be provided in separate purpose-made flanged casings of rigid construction conforming to the same standards of air-tightness.

c. Materials for dampers in all cases are to be mild steel galvanised or aluminium.

d. The damper spindles shall be provided with suitable seals when passing through the casing and penetrations shall be limited by the use of internal linkages.

e. Dampers up to width of 300mm in the plane of rotation shall be of butterfly type having blades of double construction fitted round a square mild steel spindle and the edges of blades folded and left smooth. Sides of blades shall be folded, left smooth, and in all cases shall be felt lined to give a good fit against sides of duct. The spindle shall be turned down at each end and be carried in substantial bronze bosses fixed to the sides of duct, with substantial cast quadrant piece in an accessible position and with means of clamping after adjustment. Spindles shall be of sufficient length to ensure easy access to the quadrant after installation of insulation.

f. Dampers larger than 300mm shall be of multi-leaf opposite blade type, mounted in built-up frames inserted in the ductwork and bolted thereto. Individual blades shall be as specified for butterfly dampers, each shall be carried on solid spindle with ends housed in bronze or nylon bushes. The group of blades forming the damper shall be linked to a hand-operated mechanism, which shall be controlled by a quadrant in cases where the damper is accessible from ordinary working level and in all other cases, shall be provided with screw-operate remote-control gear with the winder at an accessible point. In all cases, the adjusting gear shall be accessible after installation of insulation. Dampers in circular ducts up to 250mm in diameter shall be of butterfly type as for dampers up to width of 300mm specified above, except that edges of blades are not required to be folded.

g. After final testing and adjustment, all dampers are to be clamped in their correct positions which are to be marked on the quadrant in a permanent manner and stops fitted. All damper quadrants are to be covered with wooden or steel boxes with hinge lid for access.

h. Where fitted directly behind supply and exhaust air diffusers or grilles, dampers shall be adjustable through the face, without the need to remove the diffuser or grille face.

i. Dampers required to control areas larger than 1.6m² shall be divided into multiple sections each of 1.6m² maximum area with individual drive motors for each section.

j. Take off's or spigots for connection of circular flexible ductwork to main ducts which are 200mm diameter or smaller shall be aluminium spun cone type complete with volume control damper as specified above. For larger sizes take off's shall be of sheet metal to the same thickness as the main duct. In all cases, the take off's shall provide at least 25mm overlap surface for proper connection of the flexible duct.

1.8.8 Motorised Dampers

a. Motorised damper actuators shall be of the electric type and sized to provide smooth modulating control under design temperature and pressure conditions. Actuators shall be site interchangeable for direct or reverse action and be suitable for on/off or modulating operation. Dampers shall be suitable for both vertical and horizontal installation. Damper actuator shall be installed outside the air stream.

b. Each motorised air damper assembly shall be fitted with an adjustable crank arm and ball joint, through which it will be connected to the damper actuator by an aluminium rod of not less than 6mm diameter.

c. Positive positioning devices shall be furnished where required. Positioners shall be furnished for all sequencing applications.

d. All damper actuators shall be externally mounted to the damper frame via a single linkage.

e. All electric operated dampers shall be of the low leakage type averaging approximately 100 litres/sec. per m^2 of opening when a pressure difference of 1000 Pa is applied across them.

f. Dampers shall consist of a formed channel section frame containing linked aerofoil section blades. The units shall be of the opposed blade type operated by electric regulating motors where damper assemblies of area greater than $2m^2$ are required, they shall be made up of individual damper units fitted to a suitably braced steel sub-frame.

g. Damper, frames and supports shall be able to withstand a differential pressure of 2000 Pa in fully closed position.

h. Motorised fire damper shall be of a design and construction that will provide the required fire resisting rating of 2 hours or more tested and certified by PSB or other local authority. Installation shall comply with CP13 requirements and other local authority requirement.

i. Damper blade and frame seals shall be of flexible material suitable for the type of fluid handled and have the required high temperature resistant at

250^{o}C or more for continuous operation to handle high temperature application such as carpark and smoke exhaust.

j. Spring return shall be provided to drive the damper into failsafe open or close position as required during power failure.

k. Circuit switches for remote monitoring of damper position shall be provided as specified and installed outside the air steam.

1.8.9 Self-Closing (Non-Return) Dampers

Self-closing dampers shall present a minimum resistance to air flow under running conditions and take up a stable position in operation. Maximum resistance shall be presented under reverse air flow conditions such that they will be forced to close and remain so. Resilient strips or other purpose made devices shall be provided to prevent the damper rattling and as an aid to air sealing under reverse flow conditions.

1.8.10 Hangers

a. The Contractor shall be responsible for building in all support etc. and shall allow for using Philips Redhead bolts for concrete, and cutting away and building in of brackets in brickwork, etc.

b. No vibration whatsoever shall be transmitted from the ductwork of plant to the structure. The Contractor shall provide where necessary resilient mountings to achieve this.

c. The construction of hangers shall be in accordance with DW/142. All such hangers shall be provided with screw lengths or turnbuckles for adjustment of ducting runs to level; welding of hanger to bearers will not be permitted. All nuts shall be provided with washers and lock-nuts. Projecting ends of bolts shall be cut-off and ground smooth.

d. On no account shall supports be riveted or bolted to the air ducts.

e. All vertical ductwork shall be supported by angle iron bearers under flange joints.

f. All support and hangers shall be of hot-dipped galvanised mild steel construction to BS 729 : latest edition Part 1 with minimum coating thickness of 85 and 210 for indoor and outdoor installation respectively.

g. All bolts and nuts shall be electroplated with zinc or cadmium to BS 3382:Parts 1 and 2 with minimum plating thickness of 25.

h. The Contractor shall note that ducts must be tightened to underside of slabs/beams and after the projecting ends of bolts are cut off, no other part of the support shall project below the bottom angle iron bearer, thus maintaining maximum height throughout.

1.9 GRILLES AND DIFFUSERS

1.9.1 General

a. All air diffusers, air registers, louvres, exhaust air grilles, door relief grilles, light troffers, linear grilles and all other such fittings shall be of an approved type and as scheduled in the following clause of this section of the specification and as shown on the drawings.

b. Provide approved certified performance data for all air diffusion equipment to be installed.

c. All outlets shall be selected for efficient air distribution and low noise levels and responsibility shall be accepted for selecting and checking neck velocities, horizontal and vertical flow patterns and noise levels. Outlets with poor distribution and excessive noise levels shall not be used.

d. All outlets selected for variable volume systems shall be suitable for the system and shall be capable of providing adequate distribution without causing draughts at high volume or "dumping" at low volume and shall only be used if manufacturer's have specifically tested them for variable volume systems.

e. As selected below all outlet air flow rates shall be controlled by means of dampers in branches, opposed blade dampers in necks, behind grilles or distribution slots, dampers in cushion heads or satellite units or stream splitter dampers as appropriate. All dampers shall be of an approved type and shall be readily accessible without moving diffuser escutcheons or registers.

f. All slot diffusers, linear grilles and light air saddle diffusers shall have provision for air pattern adjustments such that air can be deflected in a vertical or horizontal direction.

g. All internal parts of outlets, such as straightening vanes and volume controllers shall be finished matt black. External finishes shall be coloured to match adjacent surfaces. Unless otherwise specified aluminium outlets shall be colour anodised and steel outlets shall be finished in baked enamel.

h. Internal duct surfaces visible through any air outlet shall be painted matt black.

i. Outlets shall be installed with trim gaskets where applicable and in accordance with the manufacturer's recommendation.

j. Diffuser shall be tested in the factory or approved testing laboratory to provide the following certified performance data:

i) Face velocity
ii) Pressure drop
iii) Throw for terminal velocity of 0.75, 0.25 m/s and room air velocity.
iv) Sound power level tested in reverberant room to ASHRAE Standard 36.

1.9.2 Linear Slot Diffusers

a. Linear slot supply air diffusers shall be supplied and installed complete with plenums, transitional spigots for air connections, and caps or jointing bars for each module and "secret" fasteners where necessary for jointing of all modules and mitred corners.

b. Where shown on the drawings the slot type diffusers shall be extended without plenum boxes as required to maintain a continuous slot. Where the linear slot diffuser has been so extended and is not used for return air or fitted with a plenum box, a blanking plate shall be fitted on the top of the diffuser securely fixed in position.

c. When viewed from the conditioned spaces the appearance of the slot diffusers shall be that of a continuous diffuser. Where the ends of each module butt together, "secret" guides and/or fasteners shall be used so that the joint in each and every case is perceptible as a very thin line. Any misalignment will be rejected.

d. The deflectors of the diffuser shall be such that it would allow the air to flow across the surface of the diffuser evenly to eliminate the condensation problem.

1.9.3 Ceiling Diffusers

Ceiling diffusers shall be of all aluminium construction and shall be mounted to suit the ceiling grid type. Each diffuser shall include an insulated cushion (plenum) head box. Unless otherwise stated, diffusers shall be all 4 way blow and fitted with blank off plates to adjust the neck size and the direction of throw. The blank off plates shall be made of canite or similar material painted black.

1.9.4 Sidewall Registers And Grilles

Unless otherwise specified, grilles shall be of the double deflection type with the horizontal blades mounted at the front of the grille. All grilles shall be capable of 0-45^{o} adjustable deflections in both the vertical and horizontal planes at 12mm centres. Grilles shall be held in position with "secret" fasteners.

1.9.5 Egg Crate Grilles

a. Unless otherwise shown the core shall comprise 13mm x 13mm aluminium egg crate held in position with springs or "secret" fasteners.

b. Where the grille size does not conform to the ceiling grid size the grille shall be located centrally within the ceiling tile if the tile is of the type suitable for cutting. Alternatively, the grille shall be mounted in an insulated mounting plate of standard grid size and finish painted to match the ceiling.

1.9.6 External Louvres

a. Louvres shall be fabricated from galvanised steel or "window grade" aluminium.

b. Galvanised or aluminium mesh to suit the material of the louvres shall be fitted across the inside surface of the louvres. Mesh shall be 13mm x 13mm x 1.2mm.

c. Blades shall incorporate a return fold and weather bar on the high side, a vertical stiffener on the lower edge and shall be fitted at 45^{o}.

1.9.7 Door Grilles

a. Door grilles where indicated on the drawings shall be supplied by this Contractor for installation by builder.

b. Grilles shall be of the telescopic, flanged frame type with inverted chevron, sight proof blades. The free area of the opening in the grilles shall not be less than 60%.

c. Grilles shall comprise fixed, horizontal blades, concealed vertical bracing bars where necessary and shall be of aluminium construction anodised to the approved colour unless otherwise specified in the "Schedule of Air Outlets".

1.10 THERMAL AND ACOUSTIC INSULATION

1.10.1 General

a. This section of the specification covers the supply and installation of the thermal and acoustic insulation required for ductwork.

b. Preparation of the equipment and application of all insulating materials shall be carried out only by skilled tradesmen, experienced and competent in this type of work.

c. In general, insulating materials shall be of best quality in their respective types, and shall have the following properties:

i) High thermal efficiency and low moisture absorption combined with adequate strength to prevent deterioration under normal operating conditions.
ii) Resistance to fibre and attack of algae, bacteria, Vermin and the growth of mould and fungi.
iii) Free from objectionable smells when dry or wet and shall not cause or promote corrosion or deterioration when in contact with galvanised metal, steel, iron, copper, bronze, brass, aluminium or PVC.

d. All insulating materials shall be delivered to the site in a dry condition and shall be housed in a dry store until drawn up for use.

e. Prior to the application of insulation, all surfaces shall be thoroughly cleaned of scale, rust, grease, oil and dirt. The application of the insulating materials to any part of the installation shall not be commenced until all pressure tests on the relevant part have been completed and approved.

f. All insulation materials, regardless of the methods of fixing, shall be in close contact with the surfaces to which they are applied. Edges and ends of insulating sections shall be arranged to butt up close to one another over the whole insulating surface. Joints of insulation shall be properly sealed. Pressure sensitive tapes shall not be accepted as joints having mechanical strength.

g. Allowance for thermal movement shall be provided for in the application of insulation.

1.10.2 Thermal Insulation

a. Thermal insulation shall be of rigid fibreglass of 48kg/m^3 with thermal conductivity of not greater than 0.038 W/mK at 20^{o}C mean temperature.

b. The insulation shall be wrapped with fibre reinforced double sided aluminium foil vapour barrier. The fibre reinforcing grid shall not be greater than 10mm x 10mm. All joints in the aluminium foil shall be vapour sealed.

c. Ductwork shall be insulated from hangers and supports generally as indicated in DW/142 : latest revision (HVAC).

d. Fibreglass shall be adhered to duct with fire resistant and non water based adhesive. Adhesive shall be applied so that insulation conforms to duct surfaces uniformly and firmly.

e. For ducts up to 450mm wide, the insulation shall be wrapped around the duct. For horizontal ducts with any side over 450mm, metal pins or nylon pins shall be stud welded using the capacitor discharge method without damaging the galvanising on the bottom surface at 400mm maximum centres. Then insulation shall be wrapped around. For vertical ducts with any side over 450mm, the pins shall be located on all sides of the duct at approximately 300mm centres. Protruding ends of pins shall be cut off flush after clips have been applied. The vapour barrier facing shall be thoroughly sealed with a vapour-barrier mastic or tape where the pins have pierced through.

f. All joints shall be sealed with at least 75mm wide vapour barrier tape to provide a continuous external vapour seal. Prior to the application of tape all contact surfaces of vapour barrier foil shall be wiped clean of dust and grease using cloth and suitable solvent all in accordance with the manufacturer's recommendation.

g. All ductwork insulation shall extend over external flanges and stiffening.

h. Insulation shall be applied so as to form a continuous heat barrier without gaps, cavities and openings. Care shall be exercised to ensure that the minimum thickness specified is maintained at corners, protrusions, etc.

i. At the point of support, specially prepared blocks of hardwood or styrofoam material must be positioned to ensure integrity of vapour barrier by bonding the supports to the insulation.

j. All externally insulated ductwork exposed in plant rooms, corridors and other areas subject to normal usage traffic shall be sheathed externally by

means of 0.5 mm galvanised steel with all joints lapped and secured by self tapping screws at 100 mm centres.

k. All insulation shall be applied so as to give a smooth, homogeneous and lineable surface. All rigid sections shall be concentric, and accurately matched for thickness. Steps and undulations in the surfaces shall not be acceptable. Any sections or slabs having damaged ends or edges shall be rejected.

l. All insulation shall fit tight to surfaces to be covered, and all slabs and sections shall be built up close, butting edges being mitred, chamfered or shaped as necessary. Any minor interstices left in insulation shall be filled and sealed.

m. The vapour barrier shall be sealed around all hangers or other projections through the insulation.

n. Continuous insulation shall be provided through all sleeves and insulation joins shall be staggered with respect to joints on the associated ductwork system.

o. Where ducts pass through walls and slabs, suitable fire stop system shall be provided for the duct including the fire damper. The continuity of the insulation shall be maintained throughout.

1.10.3 Acoustic Lining Ductwork

a. All acoustic lining shall comply with Class 1 surface spread of flame and Class 0 rating when tested to BS 476.

b. All acoustic lining shall have a thermal conductivity rating of not more than 0.036 W/m K at a mean temperature of 24°C and shall be of the semi rigid type manufactured from minimum 50mm thick mineral wool or fibre glass, having a density of not less than 48 kg/m^3.

c. Insulation shall be faced with perforated galvanised sheet. Insulation shall be adhered to the ducts with an approved type adhesive and fastened with welded pins and speed clips located at not more than 400mm centres.

d. All joins between insulation butts shall have the surface layer lapped and adhered together or pop riveted as appropriate in the direction of the air flow.

e. All end pieces shall be complete with sheet metal nosing and all corners shall be held firm with angles formed from galvanised sheet steel.

f. Acoustic lining shall have sound absorption coefficients of not less than following:

	Frequency (hertz)				
Thickness (mm)	125	250	5000	1000	2000
25 (foil laminate)	.01	.19	.43	.71	.73
50 (foil (laminate)	.22	.52	.73	.94	.94

g. Acoustic lining in masonry ducts shall be as for sheet metal ducts as previously specified except that pressed 1 mm thick galvanised steel "Z" sections shall be located at approximately 1000mm centres to support the full weight of the butts in a horizontal direction.

h. The galvanised steel "Z" sections shall be firmly attached to the masonry wall with expanding type masonry anchors or at not more than 450mm centres.

i. Pins and speed clips shall be used as for ductwork except that approved cement type fixings shall be used for direct and firm attachment of pins to the masonry wall in lieu of welded type.

The thickness of insulation shall be as follows:

Duty	Location	Insulation Thickness	
		Thermal	Acoustic
Conditioned air duct (Supply & Return)	In false ceiling void of air conditioned space with no roof above	25mm	
	In false ceiling void of air conditioned space with roof above	50mm	
	In air handling unit room	-	50mm
	In air handling unit room where using AHU room as return plenum	-	50mm
	In concrete shaft	25mm	
	In non air-conditioned space	50mm	
Outside and ventilation air duct	In air-conditioned space In return air space	25mm 25mm	

Plantrooms		50mm lined with perforated sheet metal with 23% free area

1.11 Plenum Box

a. The plenum boxes shall generally be designed to meet the requirements as specified in the Noise and Vibration Control section of this Specification.

b. The boxes shall be so designed as to provide an efficient, quiet and maintenance free air distribution system.

1.12 Test Points

a. Test holes for measuring air flow shall be provided at the following locations:

i) At all fans (in the straightest section of duct near to the outlet).
ii) At main branches after regulating dampers.
iii) At cooling coils, heater batteries (both before and after the coil or battery).
iv) Any other position indicated on the Drawings.

b. The location of these holes shall be confirmed by the Architect.

c. On insulated ductwork, these holes shall be boxed out for the thickness of the insulation.

d. Test holes shall be 25mm diameter and fitted with an effective removable seal.

e. For circular ducts up to 1200mm diameter, provide two holes on perpendicular centreline. For circular ducts above 1200mm diameter, provide four holes on two perpendicular centrelines at 45 degrees to each other.

f. For rectangular ducts, provide the following:

i) Four ducts having diagonal dimensions up to 450mm provide six (6) openings, located on two perpendicular sides, three per side. Openings to be located at 1/6, 1/2 and 5/6 locations on both duct faces.
ii) For ducts having diagonal dimensions up to 900mm provide eight (8) openings located on two perpendicular sides, four per side.

Openings to be located at 1/8, 3/8, 5/8 and 7/8 locations on both duct faces.

iii) For ducts having diagonal dimensions up to 2300mm provide ten (10) openings, located on two perpendicular sides, five per side. Openings to be located at 1/10, 3/10, 5/10, 7/10 and 9/10 locations on both duct faces.

iv) For ducts having diagonal dimensions exceeding 2300mm provide twelve (12) openings, located on two perpendicular sides, six per side. Openings to be located 1/12, 1/4, 5/12, 7/12, 3/4 and 11/12 locations on both duct faces.

1.13 Leak Testing

a. All low pressure supply and exhaust systems shall be tested by hand feel and audio checking of all joints and sealing all obvious leaks with a synthetic rubber sealing compound to approval.

b. All medium and high pressure systems shall be pressure tested to not less than 2000 Pa static pressure or 1.25 times the maximum operating pressure of the system whichever is greater.

c. Ductwork carrying air at less than 10 m/s and pressures less than 500 Pa is low pressure. For velocities above 10 m/s and pressures greater than 500 Pa but less than 1500 Pa, ductwork is medium pressure. For velocities over 10 m/s and pressures greater than 1,500 Pa but up to 2,500 Pa, ductwork is high pressure.

d. Regardless of the actual air velocity and pressure, the following systems shall be tested in accordance with medium pressure ductwork :

i) All VAV systems
ii) Smoke control/purging system
iii) Kitchen exhaust system
iv) Underground carpark ventilation

e. The test apparatus, test procedure, detection and repairs of leaks shall comply with the Sheet Metal and Air-Conditioning Contractors National Association Inc. of America (SMACNA) Manual for the Balancing and Adjustment of Air Distribution Systems AIA File No. 30-D-4 Chapter 8 (Latest Edition) or other approved standard, except where the following requirements supervene.

f. Testing shall be done in short convenient lengths and shall include all branch ducts, riser ducts, flexible connections and fittings from the fan discharge up to the terminal equipment and shall be completed prior to the insulation being applied.

g. Each section tested individually shall have a leakage rate not exceeding 5% per minute of the total volume of the section. Thus, a section having a total volume of $12m^3$ shall have a leakage rate not exceeding $0.6m^3$/min. or 10 ℓ/s.

h. Notwithstanding the above, the cumulative total of the leakages from all sections shall not exceed 0.5% of the maximum total air flow rate for the system.

i. Where the cumulative total of the leakage from individually tested sections exceeds 0.5% of the maximum total air flow rate for the system, the individual sections shall be retested and repaired as necessary to reduce the cumulative total leakage to less than 0.5% of the maximum total air flow rate for the system.

j. On completion of the installation of all medium and high pressure ductwork, all joints between the pre-tested sections shall be tested by the brush and soap bubble method at the maximum available system pressure and all leakage made good.

k. Notifications of tests shall be given at least 48 hours prior to testing of each section so that a representative may observe the test.

l. The method of testing, sections of ducts and the test procedure shall be clearly indicated on shop drawings so that site personnel involved in the testing are fully aware of testing criteria.

m. Alternative methods and procedures of testing may be used provided that full approval has been obtained prior to proceeding.

3.14 AIR BOOTS/PLENUM BOXES

1.14.1 General

a. The air flow and acoustics performance of the air boot shall be tested in accordance to ADC Standard or other approved international standard.

b. The boot shall be provided with suitable support points independent of the suspended ceiling.

c. The Contractor shall co-ordinate with the Ceiling Contractor for installation of the air boot and diffuser.

1.14.2 Light Troffer Air Boot

a. The Contractor shall supply and install single and double air boots above light troffers and blank off the slots of the light troffers which are not used for supplying air as indicated on Drawings. The Contractor shall co-ordinate with the light troffer supplier to ensure matching of sizes.

b. The air boot shall be constructed of 0.8mm galvanised sheet metal and internally lined with minimum 25mm thick 24kg/m^3 matt faced fibreglass. An inlet spigot of size as indicated on Drawings shall be provided for connecting flexible duct. At the outlet, the slot width shall be as nominated in the drawings and at each outlet there shall be an adjustable aerodynamically curved extruded aluminium blade for adjustments at the site for projection of air in a horizontal or vertical pattern.

c. The air boot must be capable of handling the air flow quantity per metre per slot as indicated on Drawings. The sound power level at such rated capacity must comply with the specified noise criteria.

d. The blank-off plate shall be of 0.8mm galvanised sheet metal painted matt black. The plate shall be securely fixed by means of spring clips to prevent any movement. The plate shall be easily detachable so that air boots can be installed for air supply. All plates shall be of standard sizes and interchangeable. Fixing details shall be proposed to the satisfaction of the Architect prior to manufacture.

1.14.3 Air Boot For Supply Air Diffusers

a. The air boot shall be robustly constructed in 0.8mm galvanised sheet metal and internally lined with minimum 24 kg/m^3 fibreglass liner 25mm thick. All internal components shall be painted matt black.

b. Spigot diameter to the air boot shall be of 200mm diameter unless specified or shown otherwise.

1.15 Fire Resistant Ductwork/Enclosures

a. Fire resistant ductwork or enclosures shall be fabricated from material such as "Durasteel" or "Promat" or approved equal.

b. The materials shall have adequate thickness and the same fire rating properties as the structure in which they are installed.

c. Fire resistant enclosures shall be provided to all protected lobbies and fire escape routes where services pass through, and/or other areas as indicated on the drawings.

d. Fire resisting ductwork shall be constructed as per standard galvanised steel ductwork to DW142 and encased in 19mm thick fire resisting board using self tapping screws. Provide galvanised steel support channels at 600mm centres. The space between the fire resisting board and metal duct shall be packed with mineral wood.

e. The complete assembly shall be non-combustible to BS 476:Part 4:1970.

f. Fire resisting enclosures shall be similarly constructed as for fire resisting ductwork but without the mineral wool. As many layers of fire resisting board shall be used as required to provide the required fire rating. Provide adequate supports to suit the weight of the enclosure.

g. Fire resisting board shall have zero indices for ignitability, spread of flame and smoke developed, in accordance with BS 476 and as approved by the FSB. The Contractor shall provide Certificate of Supervision with endorsement by supplier's PE upon completion of the installation.

1.16 VARIABLE AND FAN ASSISTED AIR VOLUME BOXES

1.16.1 General

a. The Contractor shall select all boxes, electric reheaters suitable for the scheduled duties, and space available.

b. VAV equipment including the electric reheaters as applicable and octopus shall be packed, factory assembled type of imported origin mounted as shown on the Drawings.

c. The boxes shall be supplied to meet the specified noise criteria.

d. All VAV boxes shall be of the highest commercial standard and shall be designed, constructed, rated and tested (including acoustic performance) in accordance with an approved authority such as Air Diffusion Council (ADC) or approved international standard.

e. Materials shall comply with the relevant British Standards or other approved international standards.

f. All factories applied acoustical and thermal insulation, including facing and adhesive is to be fire resistant and is to conform to the requirements of the Local Authorities.

g. Power supply for VAV/CAV terminals shall be taken from the respective AHU motor control panel with all necessary wirings. Maximum 5 VAV/CAV terminals shall be connected to one MCB circuit.

1.16.2 Variable Air Volume Box

a. All boxes shall have pressure independent control type.

b. Each box shall have a matching thermostat. The finishing shall be required to match with the interior design. Confirmation of exact location and finishing must be obtained from the Architect before installation.

c. All boxes shall be self-contained and fabricated from galvanised steel of minimum 22 gauges.

d. The casing shall be sealed to limit to the leakage of air to not more than the specified percentage of the air volume handled at the corresponding working pressure as shown in the equipment schedule. The data must be submitted at the time of tendering.

e. The casings shall be lined internally to provide thermal and acoustic insulation, the insulation should have an index number below 12 as defined in the 'Fire Propagation Tests', BS 476:Part 6 and be protected against erosion.

f. All acoustic tests shall be carried out in an approved Testing Laboratory. Sound power level tests results for both air discharge and casing radiation noise shall be tabulated for all wave bands from 63 Hz to 4000 Hz for 100 Pa and 250 Pa, and submitted for approval prior to ordering.

g. Under no circumstances shall the sound power levels exceed the maximum permissible levels indicated in the "Equipment Schedule".

h. Each box shall have an access door(s) which must be air tight and positioned to enable ease of maintenance (from below) on the working parts within the box.

i. Where boxes comprising a number of components are offered, each component shall be constructed in sheet metal and to a similar specification as indicated above and shall be provided with connecting flanges and complete in all respects.

j. VAV boxes shall be normally open and fitted with a thermostatically controlled electric or pneumatic actuator as specified to vary the supply volume between the limits scheduled and pressure independent.

k. Control shall be ±5% at any point in the range, for inlet static pressure between 50 Pa and 500 Pa.

l. A facility shall be provided to modify the operating volume by simple adjustment (within the catalogue range). A calibration scale in m^3/s shall be fitted.

m. The volume control devices shall be robustly constructed from aluminium or other corrosion resistant materials and have a proven record of accurate and maintenance free operation. Unit shall be designed for field conversion from normally open to normally closed, or vice versa, without relocating the actuator, changing parts or adding relays. The dampers\ shall have built-in stop to prevent overstriking and shall seal against an approved gasket to limit close-off leakages lower than that specified. The leakage data shall be submitted at the time of tendering.

1.16.3 Fan Assisted Variable Air Volume Box

a. Variable volume fan assisted terminal units shall comprise an acoustic insulated casing, primary supply air inlet damper and damper control, secondary air fan with back draught damper complete with speed controller, mixing chamber and inlet and outlet connections.

b. All aspects of fan assisted VAV boxes shall match those for VAV boxes as appropriate and as specified elsewhere in this specification.

c. Secondary air fan and motor assemblies shall be centrifugal, aluminium scroll and stainless steel shaft statically and dynamically balanced. Fan assembly shall be fitted with vibration isolators to prevent noise transmission. Fans shall be suitable for variable speed operation. Fans shall be selected to operate at an external static pressure as scheduled.

d. Primary air dampers shall be arranged to be normally closed wit the control system fitted to the terminal units.

1.16.4 Constant Air Volume Boxes

a. Constant volume boxes shall be pressure independent and shall be constructed similar to VAV boxes.

b. The Contractor shall supply and install the constant volume boxes including the velocity sensor and actuator are compatible with the control system to be used.

1.16.5 Electrical Reheater

a. Reheater elements (where specified) shall be mounted in supply air ductwork adjacent to unit discharge and shall comply with all relevant local codes. Reheater capacities, voltages and steps of control are scheduled.

b. Each box reheater shall be provided with a manual reset high limit safety thermostat mounted downstream of the elements. Thermostats shall have concealed screwdriver set point adjustment in the range 0 to 100 C with a high limit dial stop factory adjusted to 52 C but capable of being adjusted in the field.

c. Switch contact action shall be single pole double throw. Thermostats shall have a rod and tube sensing element.

d. A sheet steel enclosure with a removable cover shall be provided over the reheater element terminals. Under no circumstances shall any other equipment be mounted under this cover. Heater elements shall be connected with high temperature cable, with terminations made strictly in accordance with the element manufacturer's requirements, such that deterioration and burning of the cable at the termination point is avoided throughout the lift of the building.

e. An earth strap shall be connected to the removable reheater element plate from the main earth connection to the unit. Reheater elements shall be fully withdrawable without damage to high temperature protection sensing elements.

f. Any control equipment required on the box shall be mounted in a separate enclosure located a minimum of 500mm clear of the terminal enclosure, measured edge to edge. Cabling to the reheater elements shall be provided with the unit, from approved tunnel type indirect pressure terminals mounted in the controls enclosure, such that all on-site connections are made in the controls enclosure.

g. A clearly labelled isolating switch shall be mounted on the side of the controls enclosure.

h. Reheaters shall be installed in a galvanised steel plenum insulated with insulation meeting NFPA 90A requirements and VL 181 erosion requirements.

1.17 RE-INSULATED DUCT WORK

1.17.1 Materials

a. The pre-insulated duct work panel manufacturer shall European origin.
b. The duct work shall be made of pre-insulated aluminium sandwich panels with aluminium foil both sides of the sandwich panel filled with expanded polyurethane rigid foam insulation.
c. Both sides of the aluminium foils shall be lacquered with a 3 g/sq.m weatherproof and ultraviolet rays protection polyster lacquer.
d. All the panels shall be embossed with the name of the manufacturer and production date.
e. Minimum thermal insulation characteristics shall be as follows:
    - Insulating material: Close cell rigid expanded polyurethane foam, CFC, HCFC and HFC free.
    - Density 45-48 kg/cu.m,
    - Thermal Conductivity
      - Initial 0.0206 W/mK
      - After aging 0.0226 W/mK
    - Fire Reaction – Class B European Standard
    - Pressure: 2000 Pa – operating
    - Pressure: 5000 Pa – 1 Hr.
    - Air Tightness - Compliance with EN 1507, EN 14239 Class B and C
    - Water vapour Transmission: > 2000 sq.m.hPa/mg
    - Max. Velocity: 35 m/s
    - Working Temperature: -35deg C. to +110 deg.C
    -

Description	Duct Work (Indoor Installation)	Duct Work (Outdoor / Exposed Installation)	Duct Work (Mech./ Plant Rooms/ Large Sections)	Remarks
Panel Thickness	21 mm	30 mm	30 mm	Otherwise as per Manufacturer's Recommendations
Outer Foil Thickness	80 Microns (Embossed)	200 Microns (Embossed)	200 Microns (Embossed)	Otherwise as per Manufacturer's Recommendations
Inner Foil Thickness	80 Microns	80 Microns	80 Microns	Otherwise as per Manufacturer's Recommendations

1.17.2 Installations

a. To be generally in accordance with manufacturer's guidelines, under the supervision. Certified professional/manufacturer's local agent.
b. Duct shall site delivered ready to install, and fabricated in the local agents workshop.
c. The pre-insulated duct work supplier shall be the sole authorized dealer/agent by the manufacturer.
d. The local agent must have his own fabrication workshop completely equipped with all necessary manufacturer's recommended tools and instruments.
e. The ducts shall be fabricated completely in accordance with the manufacturer's guidelines/recommendations.
f. Duct shall be joining using manufacturer's recommended flange/slide-in-channels. And connected to the duct panels using self-extinguishing adhesive composed of special resin provided by the manufacturer.
g. Application of gasket in Teflon between the joining system to provide proper air tightness, both on negative or positive, complying to EN 13403 Class b and C.
h. Duct section and the internal pressure the duct work must be provided with stiffening devices composed of aluminium stiffening rods (approx. min. 14 mm dia) connected with a cross fixing device, applied to the duct by means of PVC plates approx. 120 mm dia. for indoor application and steel plates (approx. min. 170mm dia. for outdoor/heavy application.
i. All the duct s shall be as per approved shop drawings prepared by the Contractor.
j. Flanging: Anti-condensation polymer flange profile, invisible/flush type, external corners of the ducts shall be provided with aluminium self adhesive tape of same finish as of the duct.
k. Tee Connection: large branches exceeding 900 W x 450 H (any direction), using dedicated Tee-connector profile.
l. Damper shall be of same material as of pre-insulated duct, with mild steel/aluminium blades.
m. Damper Connection: Special flanged connector shall be used.
n. Flexible Duct Connection: Use spin collars/special bands arrangements.

1.17.3 Warranty

a. Manufacturer/agent shall warrant the system against manufacturing defects and/ deterioration for 10 years from the date of commissioning.

b. Contractor's installation shall be deemed as acceptable by the Engineer/Employer, after manufacturer/agent certified that it is in conform to standards and has been inspected in course of execution.

END OF SECTION

SECTION 23 20 10

PIPING INSULATION
(HVAC)

1. Piping Insulation:

a) Insulation Installation:

No insulation shall be applied to any system of piping until all foreign matter has been removed from the surface to be insulated, and until the piping has been tested, cleaned out and made tight and painted. All insulation shall be applied in a manner consistent with good practice and methods. All longitudinal joints of pipe shall be top and bottom. Insulation shall be continuous through walls, floors, ceiling and partitions etc.

b) Insulation:

All cold & hot water piping shall be insulated as indicated under INSULATION SCHEDULE in EQUIPMENT & MATERIAL SCHEDULE (Section 2). Insulation shall be in preformed sections with tongue and groove attachment. All insulation shall be fixed to the pipe with approved adhesive. Insulation shall be continuous and gaps if any, shall be filled up. Circumferential and longitudinal joints of vapour barrier and jacket shall be over-lapped at least 50mm.

c) Vapour Barrier:

Shall be as specified under INSULATION SCHEDULE in EQUIPMENT & MATERIAL SCHEDULE (Section-2). Vapour barrier shall be fixed to the insulation with approved adhesive covering at-least 75% area. All circumferential and longitudinal joints shall be over-lapped at least 40mm. Vapour barrier shall be completely continuous. All scratches, tears, etc., shall be made good by pasting fresh layers of the vapour barrier on the discontinuity.

d) Jacket:

Shall be as specified under INSULATION SCHEDULE in EQUIPMENT & MATERIAL SCHEDULE (Section-2). All circumferential and longitudinal joints shall be overlapped at least 40mm. The jacket shall be stretched tight over the insulation using adhesive which shall cover 100% area. Cut edges shall not be visible. All longitudinal joints shall be on top for horizontal piping and hidden from view for vertical piping. Circumferential joints shall be equally distant and equal to the width of the jacket roll. Patches shall not be permitted.

e) **Vapour Barrier Coating:**

shall be as specified under INSULATION SCHEDULE, in EQUIPMENT & MATERIAL SCHEDULE (Section-2).

f) **Cladding:**

All chilled and hot water piping shall be provided with cladding as specified below.

2. **Valves, Fittings & Other Specialities:**

shall be insulated with preformed adjoining insulation, cut to suitable shapes and sections, to closely fit around valves and fittings. Insulation thickness shall not be less than the adjoining straight pipe insulation thickness. The adjoining insulation near these fittings shall be mitred and trimmed into suitable sections to fit closely around the valves, flanges and fittings. All trimmed sections shall be secured by wrapping of approved type of self-adhesive tape to form a complete vapour seal. There shall be a clear break between adjoining pipe insulation & valve/specialities insulation, so that when valve/specialities insulation is opened for maintenance the adjoining pre insulation is not affected.

3. **Condensate Drains:**

shall be insulated as specified under INSULATION SCHEDULE in EQUIPMENT & MATERIAL SCHEDULE (Section-2).

4. **Cladding:**

All insulated pipes shall be provided with a cladding of 26 gauge 0.55mm G.I. sheet. At all flanges and valves the cladding shall be openable type. Valves shall be provided with valve boxes with quick opening clamps. Large valve boxes may be held together using "Jubilee Clamps".

5. **Buried Steel Piping:**

The bare steel piping, or the steel cladding of an insulated pipeline shall be externally painted with one coat of Asphalt primer 2000 (National Petrocarbon Pvt. Ltd.) followed by two coats of Hykote Enamel (National Petrocarbon) reinforced with one layer of galss fibre wrap. The primer and enamel shall be applied strictly in accordance with manufacturer's recommendations.

6. **Adhesive:**

shall be "MOWLITH" as manufactured by HOEST, Pakistan.

7. Insulation Tapes:

At all insulation joints use 75mm wide self-adhesive tape consisting of reinforced aluminium foil and white Kraft paper.

8. Reference Specification

The following specifications shall be construed to be part of these specifications.

- 15010 - Basic Mechanical Requirement
- 15015 - Basic Mechanical Materials and Methods

END OF SPECIFICATIONS

SEC - 23 34 16

CENTRIFUGAL FAN

(CABINET TYPE)

1. General:

The Contractor shall supply fans of the type specified below, and conforming to the data given in the EQUIPMENT & MATERIAL SCHEDULE (Section 2). The Contractor shall be responsible for the proper selection of the fans so that the specified operating conditions are obtained. Motors shall conform to specification under MOTOR (Section 15024) and shall be sized to provide the required BHP for meeting the specified conditions without overloading.

2. Centrifugal Fans:

Shall be single width, single inlet or double width double inlet, class I, II or III as required or indicated in the EQUIPMENT & MATERIAL SCHEDULE (Section 2) for the design system pressure.

Fan Housing: Housings shall be of heavy gauge steel, continuously welded construction with rigid reinforcement. In class I & II construction size 12 inches through 27 inches shall have 12 gauge sides and 14 gauge scrolls, while sizes 30 inch through 66 inches shall have 10 gauge sides and 12 gauge scrolls. All fan housings shall be equipped with flanged discharge, and removable spun inlet cones designed for smooth airflow.

Single-inlet, single-width fans shall be provided with extended inlet collars for slip-on type duct connections. Inlet collars shall be of heavy gauge round design.

Fan Wheels: shall be rigidly constructed, accurately balanced both statically & dynamically on precision electronic balancers, and shall be free from objectionable noise and vibration.

Each wheel shall be designed for critical speed of at least 1.25 times the maximum class speed. Upto 27 inches fan blades may be forward curved, backward curved or airfoil design. Fan blades over 27 inches shall have backward curved or airfoil design, unless otherwise specified under EQUIPMENT & MATERIAL SCHEDULE (Section-2). Forward or backward curved wheel shall be of steel plate, while aerofoil wheels shall be of cast-aluminium, or formed steel with cavity filled.

Fan Shaft: Fans shall have shafts of solid hot rolled steel, accurately turned, ground, polished & ring gauged for accuracy. Close tolerances must be maintained where the shaft makes contact with the bearings. Shaft diameter, must have first critical speed at least 1.35 times the maximum class speed of the fan.

Bearings: Fans shall have heavy duty, grease lubricated, precision anti-friction ball or roller, self-aligning, pillow block type bearings, selected for minimum average bearing

life of 125,000 hours when operating at maximum catalogued class conditions. Bearings shall be provided with suitable arrangements for re-lubrication.

Mounting & Drive: The fan and motor drive shall be mounted on heavy steel framing. Motor shall be mounted on slide rails. Drive arrangement shall be as specified, or as recommended by AMCA for the condition of operation. Drive shall be selected for minimum 1.2 BHP. Fans upto & including 50HP shall be with variable pulley & suitable for adjustment within ±10% of specified RPM. Provide complete belt guard on fan and motor pulley, constructed of heavy steel framing and expanded metal mesh screening.

Painting & Coating: Each fan component shall be thoroughly degreased, phosphatised and provided with two coats of special anti-rust primer and two coats of stove enamelled paint.

3. Installation:

Fans shall be rigidly secured so that they operate without vibration and transmission of vibration to structure, shall be isolated. Connection to ducting shall be through flexible connectors. Ducting connection to fan shall ensure lowest turbulence and smooth transition of sides. All supporting arrangement of the fans shall be drawn up by this contractor and submitted to the consultant for approval.

Floor mounted fan shall be installed as a 100mm high concrete foundation with edges provided with 25×25×3mm angle iron.

4. Commissioning and Testing:

The fans shall be commissioned and tested by this contractor. Test forms, supplied by the consultants shall be filled in and the consultant's approval obtained.

5. Reference Specification

The following specifications shall be construed to be part of these specifications.

- 15010 - Basic Mechanical Requirement
- 15015 - Basic Mechanical Materials and Methods
- 15020 - Painting & Coating
- 15023 - Supports & Anchors
- 15024 – Motors
- 15025 - Mechanical Identification
- 15027 - Vibration Isolation Control
- 15030 - Equipment Installation

END OF SPECIFICATIONS

SEC - 23 34 19

PROPELLER FAN

1. General

The Contractor shall supply fan of the type specified below, and conforming to the data given in the EQUIPMENT & MATERIAL SCHEDULE (Section-2). The Contractor shall be responsible for the proper selection of the fan so that the specified operating conditions are obtained. Motor shall confirm to specification under MOTOR (Section-15024) and shall be sized to provide the required BHP for meeting the specified conditions without overloading.

2. Propeller Fans (Non-metallic Construction):

shall be manufactured out of special plastic. Fan shall be propeller type and shall be directly mounted on the motor, and shall operate without disturbing noise & vibration. The discharge side of the fan shall be provided with self-closing shutters. Fan shall be suitable for continuous operation.

Fan installed on glass shall be through glass type, for which purpose the contractor shall cut a hole in the glass of the right diameter.

Fan installed in wall shall be provided with "deodar" wooden frame 20mm thick and spanning full width of the wall. The discharge end of the wall opening shall be provided with an aluminium louver with bird screen.

3. Propeller Fan (Metallic):

Propeller fan blades shall be of aluminium, mounted on a hub directly attached to an electric motor. Fan shall operate without abnormal noise and vibration, and shall be statically and dynamically balanced.

Fan shall be mounted on the wall with approved anchors, and shall be provided with "deodar" wooden frame 20mm thick and spanning full width of the wall. The discharge end of the wall opening shall be provided with an aluminium louver with bird screen.

4. Installation:

Fan shall be rigidly secured so that they operate without vibration and transmission of vibration to structure, connection to ducting shall be through flexible connectors. Ducting connection to fan shall ensure lowest turbulence and smooth transition of sides. All supporting arrangement of the fans shall be drawn up by the contractor and submitted to the consultant for approval.

5. Commissioning and Testing:

The fan shall be commissioned and tested by the contractor. Test forms, supplied by the consultant shall be filled in and the consultant's approval obtained.

END OF SPECIFICATIONS

SECTION - 23 37 13

DIFFUSERS, REGISTERS & GRILLS

1. General:

These shall be factory-fabricated of powder coated or anodised aluminium and of colour as approved and shall distribute the specified quantity of air evenly over the space intended, without causing noticeable drafts, or dead spots anywhere in the conditioned area. The Contractor shall be responsible for diffusion, spread, drop and throw. If, according to the certified data of the manufacturer of the proposed units, the sizes indicated on the drawings will not perform satisfactorily, the units shall be re-selected to perform quietly and effectively in accordance with the manufacturer's recommendations as approved by the Consultant. A schedule of all air inlets and outlets shall be submitted to the Consultant, indicating location, types, specified air quantity, neck or face velocity, sound power level values, pressure drop, throw and drop for registers and maximum and minimum diffusion range, prior to ordering.

2. Diffusers:

shall be round, half round, square, rectangular, slot, strip shaped or perforated type with fixed or adjustable air discharge pattern, as indicated on the drawings. Ceiling mounted units shall be furnished with anti-smudge device, unless the diffuser unit minimises ceiling smudging through design features. Diffusers shall be provided with air deflectors specified herein. Ceiling mounted units shall be installed with trims tight against ceiling whether flush, recessed or surface mounted. Rubber gasket shall be provided between ceiling and surface mounted diffusers, when necessary for air leakage-control. Suitable trim shall be provided for flush mounted diffusers. Duct collar connecting the duct to diffuser shall be airtight and will not interfere with the volume controller. Return or exhaust units, when indicated, shall be similar to supply diffusers. Diffusers shall be provided with opposed blade volume controller with accessible key operator.

3. Registers:

shall be of the type and size shown on the drawings approved. Registers shall be provided with rubber gaskets between flanges and walls or ceilings. Wall supply registers shall be installed at least 6 inch (150mm) below the ceiling unless otherwise indicated. Registers shall be provided with opposed blade volume controllers with accessible key operator.

4. Self Closing Gravity Louvers:

These shall be of aluminium construction, and shall consist of self closing gravity louvers at one end and fixed louvers at the other end.

5. Grills:

shall be of sizes and type shown on the drawings. All grills shall be provided with control dampers unless otherwise indicated on drawings.

6. Swirl Diffusers:

fixed blade type shall be similar to TROX Model RFD and shall be supplied & installed where shown on the drawings. Diffusers shall be provided with plenum & top entry spigot & shall be provided with stove enamelling of approved colour. Dampers shall be provided.

7. Jet Nozzles:

Adjustable construction type shall be similar to Trox model DUK-V and shall be supplied and installed where shown on the drawings. The spherical discharge nozzle shall be mounted in a housing and shall be provided with a front mounting flange and circular spigot for direct connection to a circular duct. The nozzle shall be capable of upward and downward manual adjustment.

Discharge nozzle and installation flanges shall be of aluminium. Duct connection element shall be rolled galvanised sheet steel.

8. Disc Valve:

Circular disc valves shall be suitable for supply and extract air, comprising valve ring with peripheral seal, central disc with threaded spindle and lock nut and installation subframe.

Face sections and installation subframe shall be aluminium with no additional treatment; threaded spindle and lock nut shall be galvanised steel.

Disc valve shall be similar in construction to Trox LVS model. Locking nut shall be able to lock from bottom / outside the disc valve through a locking key.

9. DAMPA Sq. 600 Diffuser:

Shall be as manufactured by Thermec, & designed to integrate with the DAMPA ceiling system. Finish shall be powder coated/stove enamelled of approved colour. Diffuser shall be provided with damper & field constructed inlet plenum, which shall be lined with
1-inch (25mm) thick acoustic liner.

10. Plenum for Linear Diffusers:

Plenums for linear diffusers shall be factory fabricated by the manufacturer of the linear diffuser, using 20 gage (1.01mm) galvanised sheet steel, of size shown on the drawings. Plenums shall be provided with hanging holes at every 1200mm centres, intake round spigots at 1200mm centres unless otherwise indicated on drawings; arrangement for alignment of plenum sections; arrangement for fixing of diffuser to plenum with out visible screws and assuring leak-proof fitting into the plenum.

11. Installation:

shall ensure that all lines are perpendicular and parallel to the building walls and other surfaces, flush with the ceiling and properly centred so that complete symmetry is obtained.

All diffusers shall be installed directly to the supply air ducting, so that the weight of the diffusers is not transferred to the false ceiling. Diffuser shall be so installed that the collar is flush with the ceiling. Gaskets shall be used to prevent leakage.

Registers and grills on side walls shall be fixed on deodar wooden frames provided with anti-termite Solignum treatment. Frame thickness shall be 6mm less than the register/grill collar and shall cover the full depth of the wall. Perfect alignment & symmetry shall be maintained.

After the system is in operation, if drafts, dead spots, or excessive noise are noticeable in the conditioned areas due to improper selection or construction of the air outlet, the air-outlet shall be changed to the proper type to remove the defect, without additional cost to the Employer.

12. Reference Specification

The following specifications shall be construed to be part of these specifications.

- 15010 - Basic Mechanical Requirement
- 15015 - Basic Mechanical Materials and Methods
- 15020 - Painting & Coating
- 15023 - Supports & Anchors
- 15030 - Equipment Installation

END OF SPECIFICATIONS

SEC - 23 41 00

AIR FILTERS

1. General:

Each air system shall have its own air filters, and shall be of capacities and sizes as given in specifications herein, or in the EQUIPMENT & MATERIAL SCHEDULE.

The air-handling unit filter shall be mounted in an air-tight flat or angular filter box of galvanised steel or aluminium sheet so that they can be removed from either end for replacement and cleaning. In an air handling unit the filter section shall be a standard module from the AHU manufacturer.

In selecting the sizes of the air filters, the space available in the Plant Room and air handling units etc., should be kept in view.

The Contractor shall provide the following information for each of the air filters proposed to be supplied by them.

a) Capacities in CFM and media air velocity.

b) Initial and Recommended Final air pressure drop in inch of WG (Pa) for each type of filters.

c) Manufacturer's performance guarantee certificate and technical bulletins.

The Contractor shall install a multi-blade damper in the plenums of air handling unit having high efficiency filters to balance the air system when the filtering media is new with low initial resistance.

2. Viscous Impingement Filters (Filter Class G2 to EN 779):

Filters shall conform to filter Class G2 to CEN Standard EN 779, & provide a Dust Arrestance Efficiency of 65% to 80%.

Filters shall be 2-inch (50mm) thick, permanent viscous impingement, washable, all metal, panel type. Media shall be corrugated strips of aluminium screen enclosed in an 18-gauge aluminium frame with flush mitred corners. The corrugation shall be tapered to form a series of pyramid shaped pockets to prevent dust-laden air from drifting through the filters. Expanded metal shall be placed on both sides of the filtering media to add strength and for mechanical protection.

Resistance to airflow of a clean filter shall not exceed 0.1inch WG. Pressure drop across the filter and final pressure drop shall not exceed 0.5 inch of WG. The filters shall be selected for face velocities not exceeding 500 fpm (2.5 m/s).

Provide filter adhesive in suitable containers in sufficient quantity for three month's requirement, based on operating the system for 10 hours a day. Provide a filter-washing tank suitable for washing of the particular size of filter.

3. Replaceable Panel Filter (Filter Class G2 to EN 779):

Filters shall conform to filter Class G2 to CEN Standard EN 779, & provide Dust Arrestance Efficiency of 65% to 80%.

This filter shall consist of 2-inch (50mm) thick glass fibre mat coated with dust binding adhesive (Viscosine) as the filtering media. The filtering media shall be fixed into a U-shaped metal frame and a metal grid shall be provided for additional support.

The filter shall be supplied with a 50mm deep galvanised steel cell (holding) frame with quick release clamps or hinge type spring clips for positive airtight clamping of the filter.

The filter shall have a rated face velocity of 500 FPM (2.5 m/s) with maximum initial resistance of 0.24 inch of WG (60 Pa) and final pressure drop of 0.72 inch of WG (180 Pa).

4. Throwaway Disposable Synthetic Media Panel Filters (Filter Class G4 to EN 779):

Filters shall conform to filter Class G4 to CEN Standard EN 779, & provide Dust Arrestance Efficiency of greater than 90%.

This filter shall be a pleated disposable filter utilizing synthetic media securely sealed in a die-cur beverage board frame. The filter shall be 2-inch (50mm) thick.

The filter shall be supplied with a 50mm deep galvanised steel cell (holding) frame with quick release clamps or hinge type spring clips for positive airtight clamping of the filter.

The filter shall have a rated face velocity of 500 FPM (2.5 m/s) with maximum initial resistance of 0.30 inch of WG (75 Pa) and final pressure drop of 0.72 inch of WG (200 Pa).

5. Medium Efficiency Bag Filters (Filter Class F6 to EN 779):

Filters shall conform to filter Class F6 to CEN Standard EN 779, & provide Average Atmospheric Dust Spot Efficiency of 60% to 80%.

These filters shall be extended surface air filters, pocket type having a minimum of 8 pockets; with either a retainer device designed to give full top, bottom and side support to each pleat, or with the pleats so designed as not to require a supporting retainer. Retainer device, if used, shall be of galvanised wire with PVC coating.

Filter media shall be ultra-fine fibreglass specifically manufactured for filtration.

Filters shall be provided with holding frames lined with sealing gasket with quick-release clamps, for side access application, designed to ensure a positive seal against leakage of

unfiltered air. The filters shall have a rated filter face velocity of 500 FPM (2.5 m/s), providing a maximum Initial Resistance of 0.24 inch of WG (60 Pa) and a recommended final resistance of 1 inch WG (250 Pa). Filter depth shall be 22 inches (560mm).

6. Medium Efficiency Bag Filters (Filter Class F7 to EN 779):

Filters shall conform to filter Class F7 to CEN Standard EN 779, & provide Average Atmospheric Dust Spot Efficiency of 80% to 90%.

These shall be similar to Class F6 Bag Filters as specified above. The filter shall have a rated filter face velocity of 500 FPM (2.5m/s), providing a minimum initial resistance of 0.3 inch of WC (75 Pa), and a recommended final resistance of 1 inch WG (250 Pa).

7. High Efficiency Bag Filters: (Filter Class F8 to EN 779):

Filters shall conform to filter Class F8 to CEN Standard EN 779, & provide Average Atmospheric Dust Spot Efficiency of 90% to 95%.

These shall be similar to Class F6 Bag Filters specified above, except that the filters shall have a minimum of eight pockets and shall have a rated filter face velocity of 500 FPM (2.5 m/s), providing a maximum Initial Resistance of 0.35 inch of WG. (88 Pa), and a recommended final resistance of 1 inch WG (250 Pa). Filter depth shall be 22 inches (560mm).

8. High Efficiency Pleat Filters (Filter Class F9 to EN 779):

Filters shall conform to filter Class F9 to CEN Standard EN 779, & provide Average Atmospheric Dust Spot Efficiency of greater than or equal to 95%. These shall be of high efficiency extended surface rigid type, consisting of galvanised steel holding frame and replaceable filter.

The holding frame shall be of 16-gauge galvanised steel, minimum 70mm in depth, and designed to provide positive seal against leakage of unfiltered air. The frames shall be provided with integral spring type latches to firmly hold the filter against neoprene rubber gaskets.

The filters shall be made from water-resistant ultra-fine glass fibres. The media shall be pleated and shall have crimped aluminium separators to maintain uniform spacing between pleats. The filter casing shall be of galvanised steel.

The rated filter velocity shall be 500 FPM (2.5 m/s) providing a maximum Initial Resistance of 0.60 inch of WG (150 Pa) and a Recommended Final Resistance of 1.2 inch WG (300Pa). Filter depth shall be 292mm.

9. Activated Carbon Filters:

These filters shall consist of activated carbon filter cells for removal of odour and harmful vapours by adsorption process.

Filter housing shall be constructed of 16 gauge galvanised steel sheet with internal stiffener bars. Top and bottom slide track inserts shall be one-piece moulded corrosion resistant plastic.

Filter cell frame shall consist of moisture resistant chipboard with neoprene seals. The activated carbon cells shall be of wedge formation securely fixed to the frames. The activated carbon used shall have cylindrical shaped granules. Filter shall be minimum 1 inch (25mm) thick. Carbon trays shall be rechargeable and manufactured of high impact plastic with internal separators to prevent settling of the carbon beds. Two beads of caulking, one on either side of the mounting holes and around the framework to allow the filters to seal against each other shall be provided.

The filters shall have a rated filter velocity of 500 fpm (2.5m/s), providing a maximum initial resistance of 0.5 inch of WG (125 Pa). Minimum service life shall be one year.

10. Reference Specification:

The following specifications shall be construed to be part of these specifications.

- 15010 - Basic Mechanical Requirement
- 15015 - Basic Mechanical Materials and Methods

END OF SPECIFICATIONS

SECTION NO: 23 62 00

AIR COOLED CONDENSING UNIT

1. General:

The contractor shall supply & install air cooled condensing unit matching with AHU DX coil elsewhere mention in this section of the required capacity and rating as shown on the HVAC SCHEDULE.

Cabinet: Cabinet shall be weather-proofed for outdoor use and shall be assembled on a heavy angle iron frame. Cabinet shall have sheet steel panels coated with two coats of baked enamel.

Condenser: shall be air cooled type. Condensing coil shall be of copper tubing mechanically bonded to aluminium fins. Coils shall be factory pressure tested. Back seating service valves in liquid & suction lines shall be provided.

Condenser Fan: Fans shall be vertical discharge, direct drive aluminium propeller fans, statically and dynamically balanced. Motors shall be of 3-phase, heavy duty with permanently lubricated bearings and rain protection shall be provided to the motor by either providing waterproof motors or weather tight slingers over the motors. Motors shall have built-in thermal overload protection. Fans shall have safety guards.

Compressors: shall be hermetic or semi-hermetic, pressure lubricated with overheat protection for the motor. Compressors shall be mounted on vibration isolators.

2. Refrigerant Circuit:

General: Refrigerant control shall be through expansion valves. All refrigerant circuits shall be through copper tubing with brazed joints. Units shall have an operating charge of Refrigerant-22, factory-provided after a pressure test to 450 psig. Circuits shall be provided with suction and liquid line service valves.

Single Circuit: Units below 15 nominal tons capacity shall have a single refrigerant circuit with one condenser coil, one evaporator coil, one or two compressors, one expansion valve and one receiver.

Dual Circuit: Units above 15 nominal tons capacity shall have two independent refrigerant circuits which could operate independently even if one circuit is inoperative because of defective components. Each circuit to have one evaporator coil, one condenser coil, one compressor, one expansion valve and one receiver.

3. Electrical Controls:

Unit shall be factory provided with complete electrical control circuitry. Unit shall be provided with starter plus overload protection for all motors, internal high pressure cut-out & over-load protection for the compressors.

Unit shall be provided with return air temperature controller and three position (Fan-Off-Cool) switch completely wired and unit-mounted. Controls shall be reset by means of three-position switch or thermostat but prevented from repeated cycling by reset relay control circuit. On dual compressor units a compressor sequence switch shall be provided to alternate lead-lag compressor operation.

4. Refrigerant Controls:

Unit shall be factory provided with a thermal expansion valve. On units with two refrigerant circuits, each circuit shall have its own expansion valve.

5. Spares:

Spares shall be provided as indicated under HVAC SCHEDULE.

END OF SPECIFICATIONS

SEC- 23 81 27
SMALL SPLIT AIR CONDITIONER
(DECORATIVE MODEL)

1. General:

This Contractor shall supply & install air-cooled split type air conditioners with condensing units of the type and capacity rating as shown in SCHEDULE.

2. Evaporator Unit:

Unit shall be supported by a rugged frame and enclosed by sheet steel panels. Panels should be coated with two coats of baked enamel paint and insulated on the inside by ½inch (12mm) thick insulation. The insulated drain pan shall have connections on both sides. The Evaporator coils shall be of ♎inch (10mm) diameter seamless copper tubes, mechanically bonded to aluminium fins. Coils shall be factory tested and dehydrated and provided with quick connect couplings. Evaporator blower fans shall be centrifugal, forward curved type, statically and dynamically balanced, direct-coupled to the motor. The fan motor shall be multispeed type with built-in thermal overload protection. Filters shall be cleanable and easily accessible.

3. Condensing Unit:

Unit shall be weather-proofed for outdoor use and shall be assembled on a rugged frame. The Cabinet shall have sheet steel panels coated with two coats of baked enamel paint. Internal protection devices on the compressor shall include a thermal overload relay and a pressure relief valve. The compressor shall have internal spring mounts and external vibration isolation mounts to minimise noise and vibration. Condenser coils shall be ♎inch (10mm) diameter seamless copper mechanically bonded to aluminium fins. Coils shall be factory tested and provided with quick-connect couplings.

4. Controls:

Refrigerant control shall be provided by capillary tube. Unit control shall be through a control box which has the unit on-off switch, fan speed selector switch and room thermostat, all installed in it.

5. Installation of Split Units:

a) Supply and install the air-conditioning units where shown on drawings.

b) Provision of space clearance required for units (indoor & outdoor) shall be strictly followed as per manufacturer's recommendations.

c) Indoor & outdoor units shall be installed properly levelled & aligned.

d) Indoor & outdoor units will be fixed with appropriate size Anchor.

e) In case of front discharge condensing unit, the air discharge direction will be the same as the wind direction but symmetry will be maintained according to building orientation.

f) Outdoor unit and floor mounted indoor unit will be installed on 4 inch high concrete pad, & provided with cement plaster finish or steel structure as shown on drawings.

g) On unit 5 HP and larger, install rubber-in-shear vibration isolators below out-door unit. On floor- mounted indoor unit use 1 inch thick neoprene pad. On ceiling suspended indoor units use rubber-in-shear isolators.

6. Refrigerant Piping:

a) Refrigerant piping shall be copper tubing conforming to standards and source given in SCHEDULE

b) Use copper phosphorus filler metal for brazing rods.

c) Perform pipe brazing by flowing nitrogen gas through it.

d) Prevent ingress of foreign material and water vapor into refrigerant pipes. Keep pipe ends plugged.

e) All pipe passages thru walls/roof shall be thru a suitably sized G.I. pipe to act as a sleeve. (Refer DETAIL DRAWING).

f) Install closed cell foam insulation 3/8 inch thick on liquid and suction lines. Wrap all joints with self-adhesive aluminium tape.

g) Insulated pipes exposed to the atmosphere shall be installed in a rectangular 22 gage (US) G.I. sheet race-way, similar to a cable tray, with removable top cover, as per approved sample.

h) Install pipe supports at every meter distance and at every change of direction. (See DETAIL DRAWING).

i) On units of 5HP & higher, install refrigerant drier on liquid line with shut off valve on both sides of the drier and a bypass line with shut-off valve.

j) When brazing work is finished, check for leaks at the joints. For this purpose pressurise piping by charging with nitrogen to a pressure of 250 psig along with a

small amount of refrigerant. Use Freon leak detector to check for leaks. As refrigerant gas is heavier than air, apply Freon sensor to the bottom of the joint.

k) After refrigerant-piping work is finished, evacuate the installed pipes along with indoor unit evaporator coil upto 1mm Hg vacuum or by Freon sweep method by vacuum pump.

7. Condensate Drain Piping:

a) Install drainpipes as and where shown on drawings.

b) Drainpipes shall be G.I. pipe sized in accordance with schedule as given in TABLE at the end of this section, unless otherwise shown on drawings.

c) Provide support at every 1 meter and at every change in direction. (Refer DETAIL SKETCH OF SUPPORT).

d) Drainpipe shall be installed with proper slope.

e) Trap shall not be installed on small split units upto 2 TR capacity.

f) Do-not connect drain piping to drainage system. Use in-direct connection.

g) Insulate drainpipe with closed cell foam insulation 3/8 inch thick and seal insulation joints with self-adhesive aluminium tape.

h) All pipe passage thru walls shall be thru a suitably sized G.I. pipe to act as a sleeve.

8. Electric Wiring:

a) Provide and install electric wiring and earthing from electric supply point provided by others either near outdoor unit or indoor unit as required. Provide all control wiring between indoor and outdoor unit. Size of wires shall be as per schedule noted at TABLE 15182-1, or otherwise shown on drawings.

b) All electric wiring exposed to the atmosphere shall be installed in G.I. Pipe (KPM, Light Quality), and all indoor wiring shall be installed in metallic conduit, sized in accordance with Schedule given in TABLE 15182-1.

c) After completion of wiring, check all wiring with Meggar Tester to ensure no damages to wire insulation during pulling of wire into conduit.

9. Commissioning & Testing:

The contractor shall be responsible for commission the air conditioning unit in accordance with manufacturer's recommendations.

The split units will have a guarantee/warranty period of 12 months from the date of commissioning the units, and should any defects arise during this period which can be

attributed to poor workmanship, improper material, or defective manufacture of the air conditioning units, for which the Consultant shall be the sole judge, the Contractor shall be required to replace or repair all defective parts, except compressors (burnt or otherwise) which shall be replaced with new compressors. All repairs and replacement shall be as directed by the Consultant.

Schedule of Sizes for Piping & Wiring Small Split Air Conditioners
(Decorative Model)

Item	Units	12,000 (Btu/Hr)	18,000 (Btu/Hr)	24,000 (Btu/Hr)	30,000 (Btu/Hr)	36,000 (Btu/Hr)	48,000 (Btu/Hr)
Liquid Line Ø	Inch	3/8	3/8	3/8	3/8	3/8	½
Suction Line Ø	Inch	5/8	5/8	5/8	5/8	3/4	3/4
Drain Line Ø	Inch	1	1	1	1	1 ¼	1 ¼
Power Input (Cooling)	kW	1.40	2.10	2.80	3.50	4.2 TP	5.6 TP
Power Wire Size *	mm Sq.	2 × 4	2 × 4	2 × 6	2 × 6	3 × 2.5	3 × 4
Control Wire Size	mm Sq.	5(1.5)	5(1.5)	5(1.5)	5(1.5)	5(1.5)	5(1.5)
Earthing Wire Size	mm Sq.	2.5	2.5	2.5	2.5	2.5	2.5
Power Conduit Ø	mm	20	20	20	20	20	20
Control Conduit Ø	mm	20	20	20	20	20	20

** For Lengths Exceeding 100 Feet, Cable Size May Have To Be Increased*

END OF SPECIFICATIONS

SEC- 22 33 34

HOT WATER HEATER/GEYSER (GAS OPERATED)

Storage types Gas Fired Water Heater of capacity as given in the EQUIPMENT & MATERIAL SCHEDULE (Section 2), and shall be installed where shown on the drawings.

The storage tank shall be constructed of galvanised sheet steel. Thickness of sheet steel shall be a minimum of 14 US gage for system pressure upto 30 psig and 10 US gage for higher pressures.

The heater shall be provided with the following accessories.

a) Two magnesium anodes to inhibit corrosion of the tank. These shall be easily removable & replaceable from the top.

b) 50mm thick fibreglass insulation.

c) Jacket of mild steel provided with two coat of stove enamelled paint over primer.

d) Dial type insertion thermometer, Ø 75.

e) Imported thermostat.

f) Safety relief valve.

Heater shall be installed & the following work carried out.

- Install heater on 12" concrete foundation, of size to suit heater dimension.
- Clamp/supply heater
- Connect cold & hot water line with gate valves.
- Connect gas line with gas cock.
- Install flue duct using 20 gauge GI sheet & terminate as shown on plans.

All heaters, after installation, shall be subjected to an operation test to determine the efficient working of the recovery side, thermostat, etc., to the satisfaction of the Consultant. Heaters shall be inspected by the Consultant prior to supply & installation.

Payments shall be made for unit item price quoted in the Bill of Quantities which shall include the supply and installation of water and gas piping connections, relief valve, thermostats, exhaust ducting, etc., as specified and/or directed by the Consultant, complete in all respects.

END OF SPECIFICATIONS

SEC- 22 47 00

ELECTRIC WATER COOLER

(DISPOSABLE BOTTLE TYPE)

1. General:

   Provide and install where shown on the drawings vertical free standing refrigerated water coolers with self-filling 5 gallon (19 litres) bottle on top. The unit shall be supplied with integral sediment & activated carbon filtration system.

2. Cabinet:

   Housing shall be made of high density polyethylene saturated with U.V. protection and antistatic material in one piece blow moulding part. The material surface shall be textured to help conceal scratches. Drip tray shall be of rugged moulded high impact polystyrene, easily removable for cleaning. Faucets shall be durable polypropylene self-closing type.

3. Cold Water Reservoir:

   Cold water reservoir shall be constructed of ASTM 304 stainless steel with removable reservoir insulation consisting of two piece polystyrene insulation jacket.

4. Thermostat:

   Temperature shall be controlled by an adjustable high quality thermostat easily accessible, and adjustable from 9°C to 12°C (48°F to 54°F).

5. Refrigeration Unit:

   The refrigeration unit shall consist of a hermetically sealed compressor with automatic overload protection. No lubrication shall needed. The water reservoir shall be provided with external copper refrigerant coil using ozone friendly refrigerant. Refrigerant shall be controlled by an accurately calibrated capillary tube. Condenser shall be convection cooled.

   Unit shall operate on 230V/1 phase/50 hertz, electric power.

6. Spares:

   Provide 6 sets of sediment & carbon filters.

END OF SPECIFICATIONS

SECTION 23 05 19

METERS & GAUGES

1.0 Thermometers:

The ranges of thermometers shall comply with the system parameters ensuring normal indication in the mid-region. Ranges much under or above the required readings shall not be acceptable, unless specifically approved by the Consultant.

a) Pipe Thermometers: These shall be adjustable angle type, with brass separable socket. Case shall be smooth die cast aluminium with metallic blue-black finish. Window shall be clear acrylic plastic or double strength glass, held in place with removable stainless steel caps. Tube shall have lens front with red appearing mercury tubing. Scale shall be on white background with jet black embossed figures and markings, of specified or suitable scale, in combination of °F-°C.

- Scale size:

  175mm

- Stem length:

  90mm up to 150mm diameter pipes

  150mm above 150mm diameter pipes

- Insertion length:

  65mm for 90mm stem length

  125mm for 150mm stem length

b) Duct Thermometers: These shall be adjustable angle type and shall conform to specifications given above for pipe thermometers, except that the duct thermometer shall be supplied with 75mm OD reversible aluminium flange and perforated aluminium bulb guard. Stem insertion length shall be 300mm.

c) Thermometer Wells: These shall be of brass suitable for pipeline mounting. Wells for insulated piping shall be provided with extension necks compatible to insulation thickness, to allow thermometer to clear the insulation.

d) Installation: Thermometers shall be installed wherever shown on the drawings. Installation on both ducts and piping shall conform to the manufacturer's recommendations. On thermally insulated ducts, casing, equipment or piping, stand off mounting brackets, bases, adopters or extended tubes shall be provided. These items shall provide clearance not less than the thickness of the insulation. Thermometers shall have ranges suitable for the fluid being served.

2.0 Pressure Gauges

Pressure gauges shall be of scale range as required, for service condition, graduated in both Psi and Kg/cm². On open circuit pump suction line and wherever necessary install compound gauges.

a) Case: shall be of cast aluminium, black finished. Ring shall be close type, chrome plated. Window shall be clear acrylic. Dial shall be white with jet black embossed figures and graduations. Pointer shall be micrometer type, black finished and red tipped. Movement shall be stainless steel, rotary type. Bourdon tube shall be phosphor bronze. Socket shall be forged brass. Accuracy shall be 1% of the scale range. Connection shall be 6mm NPT. Dial size shall be Ø 4.5 inches.

b) Installation: Pressure gauges shall be installed where shown on drawings. These shall be installed with ball valves to serve as gauge cocks. For pressure gauges installed on steam line, a coil siphon shall be installed. Gauges shall be screwed in so that no leakage exists, and shall be installed in a neat and workmanlike manner and the dials aligned for convenient reading.

2.1 Magnahelic Gauges:

a) **General:** Magnahelic differential pressure gauge shall be of scale range as required for the application.

b) **Construction:** Housing shall be of die cast aluminium. Test case and aluminium parts irradiate dipped to withstand 168 hours (minimum) salt spray test. Exterior finish shall be baked dry grey hammerloid. Pointer shall be red tipped of heat treated aluminium. Diaphragm shall be silicon rubber diaphragm with integrally moulded "O" ring shall be supported by front and rear plates. It shall be locked and sealed in a position with a sealing plate and retaining ring. Diaphragm motion shall be restricted to prevent damage due to over pressure. Accuracy shall be ± 2% of full scale connection shall be 3mm NPT, dial size shall be minimum Ø 100mm.

c) **Installation:** Magnehalic gauges shall be flush or surface mounted with standard hardware supplied and shall be installed as follows:

i) At Filters: Each bank of high efficiency filter and HEPA filter shall be provided with an appropriate station to determine pressure drop, consisting of magnahelic gauge, probes, flexible tubes and mounting arrangement.

ii) At Positive or Negative Pressurised Areas: At the outside of each positive or negative pressure areas, install a magnahelic gauge to read room pressure with respect to adjoining space pressure. For this purpose probes shall be installed in the room and in the adjoining corridor/space, and connected with flexible tubing to the magnahelic gauge.

iii) As shown on drawings or as required.

END OF SPECIFICATIONS

SECTION NO:23 05 23

GENERAL DUTY VALVES

1. Butterfly Valves:

Butterfly valves shall be used in applications requiring 50mm or larger diameter valves, and shall have a rating suitable for the service intended, but a minimum of 10 bars. Butterfly valves shall be wafer type with modular cast iron body, suitable for mounting between ANSI 150 lb flanges. Two flanges plus required nuts and bolts shall be provided with the valves.

The center disc shall be of stainless steel, with extended shaft for accommodating insulation depth.

The liner shall be replaceable, of Nitrile or EPDM rubber. Each valve shall be provided with one replaceable liner as spare.

Actuator shall be worm gear type of aluminium or cast iron, weather proof to IP65, complete with hand wheel, position indicator, and with adjustable stops at both fully open and fully closed positions. The actuator shall be self-locking, lubricated for life and free of maintenance.

2. Gate Valves:

a) Ø 50mm (2 inch) & Smaller: 125 psi (860 kPa) SWP, 250°F (120°C), threaded ends, bronze body, union bonnet, non-rising stem, wedge disc. Hand wheel nut, packing nut, gland, stuffing box, bonnet, bonnet ring, disc and body shall be of bronze. Hand wheel shall be of malleable iron. Packing shall be suitable for specified usage but shall not use asbestos. Stem shall be manganese bronze.

b) Ø 65mm (2 1/2 inch) & Larger: 125 psi (860 kPa) SWP, 250°F (120°C), cast iron body bronze mounted with flanged ends. These shall be of solid wedge disc type, with outside screw and yoke (rising stem). Body and bonnet shall be of cast iron. Wedge shall be of cast iron with bronze disc. Seat rings shall be bronze. Packing shall be suitable for specified usage but shall not use asbestos. Packing gland shall be cast iron. Yoke shall be of cast iron and yoke nuts shall be of bronze. Hand wheel shall be of cast iron.

3. Globe Valves:

a) Ø 50mm (2 inch) & Smaller: 125 psi (860 kPa) SWP, 250°F (120°C), bronze, threaded ends. Body, bonnet, disc holder, stem lock nut, packing nut and disc lock nut shall be of bronze. Hand wheel shall be of malleable iron with stem of manganese bronze. Renewable composition

disc shall be provided suitable for water & steam. Packing shall be suitable for specified usage, but shall not use asbestos.

b) Ø 65mm (2 1/2 inch) & Larger: 125 psi (860 kPa) SWP, 250°F (120°C), cast iron body, bronze mounted with bronze faced disc and yoke bonnet, and shall be flanged. Hand wheel, gland, bonnet and body shall be of cast iron. Stem shall be of manganese bronze. Packing shall be suitable for specified usage but shall not

use asbestos. Stem lock nut, disc and seat ring shall be of bronze. Disc shall be renewable composition type.

4. Ball Valves:

a) Ø 50mm (2 inch) & Smaller:

125 (860 kPa) SWP, Screwed; two-piece cast bronze body, chrome plated brass ball, teflon ball and flange seals, rods silicon brass stem, teflon and Viton “O” ring stem seals, zinc plated carbon steel handle with vinyl grip and brass handle nut.

5. Swing Check Valves:

a) Ø 50mm (2 inch) & Smaller: 125 psi (860 kPa) SWP; 250°F (120°C), threaded ends. Cap, hinge pin, body, hinge, disc nut and disc shall be of bronze.

b) Ø 65mm (2 1/2 inch) & Larger: 125 psi (860 kPa) SWP; 250°F (120°C), cast iron body, including valve cap and disc. Hinge pin, seat ring and disc ring shall be of bronze. Ends shall be flanged.

6. Y-Strainers:

a) Ø 50mm (2 inch) & Smaller:

125 psi (860 kPa) SWP; 250°F (120°C), “Y” type, with bronze body and threaded

ends. Screen shall be of 20 mesh monel.

b) Ø 65mm (2 1/2 inch) & Larger: 125 psi (860 kPa) SWP; 250°F (120°C), cast iron body with flanged ends. Screen cover shall be provided with blow off taping. Screen shall be of perforated stainless steel, (33 holes per sq.cm.), with 1.1mm diameter and 0.41mm thickness.

7. Float Valve:

Shall be best quality heavy duty type provided with Ø 150mm copper ball and heavy duty bronze float arm. Valve shall provide tight shut off at full closed position.

8. Foot Valve for Pump Suction Line:

Shall be installed where required or indicated on the drawing. Foot valve shall be of brass, and shall be provided with integral strainer. Foot valve shall be provided with a spring loaded vertical check disc with gasket for tight shut-off.

9. Gaskets:

General: non-asbestos, compressed gasket material with high-strength aramid fibres bonded with high grade nitrite NBR synthetic rubber, suitable for 750°F (400°C) and 1450 psi (10000 kPa).

10. Thread Lubricant:

General: non-hardening, non-poisonous as approved.

11. Dielectric Couplings:

General: provide sweat-to-screw dielectric couplings at junction of copper pipe to steel pipe and insulation bushings for flanged connections to steel or cast iron valves and fittings.

12. Installation of Valves and Strainers:

All gate valves, globe valves, check valves, control valves, butterfly valves, drain cocks, etc. necessary for satisfactory operation of the system shall be provided whether indicated or not. All valves having stem over 2m height shall be provided with galvanised chain operators. Valves in horizontal lines shall be installed with stem horizontal or above. Isolation gate valves shall be installed on each side of each piece of equipment as pumps, coils and other similar items; at the midpoint of all looped mains; and at any other points indicated or as required for draining, isolation or sectionalising purposes. Each valve shall be identified with not less than 35mm round or square black over white laminated plastic tags secured to valve with a suitable brass chain. Tags shall be engraved to identify valve by number and valve function. Strainers shall be installed wherever necessary to protect equipment and control valve, where proper functioning would be affected by dirt on the seat or scoring of the seat. Strainers shall be arranged not to clog piping and allow easy disconnection for change. All strainers 50mm and above shall be provided with Ø 20mm ball valves for blow-off. Strainers shall allow removal of accumulated dirt and screen replacement without disconnecting main piping.

END OF SPECIFICATIONS

SEC – 23 11 23

HORIZONTAL, END SUCTION Centrifugal Pump

1. Scope:

These specifications cover vertical split case end suction centrifugal pumps for hydronic applications. Pump curves certifying pump operation, BHP & NPSH curves shall be submitted to the Consultant for approval.

2. Service Condition:

Pumps shall be designed and constructed to operate satisfactorily in a typical hydronic application, and shall be the product of a manufacturer regularly engaged in the production and marketing of these pumps.

3. Operating Conditions:

The flow rate, pump head & other required data are indicated in the Equipment Selection Data and the pumps supplied shall conform to these requirements. The Contractor is required to ensure non-overloading selection of motor for parallel pumping operation.

NPSH required by the pump shall be stated & the NPSH as available checked by the Contractor for the specific application. The pump RPM shall be as specified in the Equipment Selection Data. Pump casing shall be designed to withstand the discharge pressure specified on the Schedule Sheet plus the static head on the system, plus 50% of the total head, but not less than 125 psi (8.5 bars).

1 **Pump Construction:**

2 **Details of pump construction shall be as follows: a) Casing** shall be vertical split with centreline discharge, foot-supported and made

of cast iron. Casings shall be provided with tapped & plugged holes for priming, vent & drain.

b) Casing Connections: shall be ANSI B16.1, 125PSI (8.5 bars), ASA Standard flat face flanges.

c) Casing Wearing Rings: Easily replaceable casing wearing rings of suitable material for service shall be provided in front and rear of impeller.

d) Casing Joint Gasket: An O-ring shall be provided at the casing joint to prevent leakage.

e) Impeller: shall be the single section enclosed type of bronze. Impeller shall be statically and hydraulically balanced. Drilled holes shall be provided through the impeller hub to balance axial thrust loads and keep positive pressure on the stuffing box. Impeller shall be keyed & locked to the shaft with a hexagonal head impeller nut and shall be easily removable without the use of special tools.

f) Shaft: Pump shaft shall be high strength stainless steel sized to provide a minimum amount of deflection. Shaft shall be protected in the stuffing box area by a replaceable shaft sleeve.

g) Seal: Pumps shall be provided with gland packing seal or mechanical seal as indicated in the Equipment Selection Data.

h) Bearing Frame: shall be rigid, one piece cast iron construction. Frame shall be provided with catch basin reservoir with tapped drain hole to collect and pipe away stuffing box leakage.

i) Bearings: shall be ball type on both ends of the frame. Both bearings shall be locked in place and be sized to provide long life under thrust loads encountered. Both bearings shall be enclosed by replaceable box.

j) Bearing Lubrication: Ball bearings shall be grease lubricated with provisions for the addition & relief of grease.

k) Deflector: A replaceable shaft deflector of non corrosive material shall be provided to prevent the entrance of contaminants into the pump bearings at the inboard end of the bearing frame.

6. **Baseplate & Coupling**: **a) Baseplate:** shall be of heavy duty, fabricated steel or cast iron, sufficiently rigid to support the pump and the driving motor with tap hole to pipe away leakage and condensation.

b)Coupling: shall be spacer type.

c) Coupling Guard: shall be metallic and fastened to baseplate and conform to the requirements of ANSI B.15.1.

7. Rotation:

Pump shall have clockwise rotation viewed from its driven end.

8. Motor:

Motor shall be manufactured by Siemens Pakistan. It shall be selected in accordance with the pumps non-overloading performance characteristics. Motors shall be mounted with pump on base plate in manufacturer's plant and shipped as one unit.

9. Foundation:

Foundation for the pump shall be 1:2:4 concrete.. Edges of the foundation shall be provided with 25×25×3mm angle iron frame work and painted with two coats of oil paint. When shown on drawings, or with pumps mounted on upper floors, the pump's concrete foundation shall be supported on four suitably sized spring isolators.

10. Installation:

During installation, the pump shall be properly levelled, grouted in and realigned before operation in accordance with the manufacturer's recommendations. Suction & discharge connections shall be installed through flexible connectors, and electrical wiring shall be done. Drain lines from pump base plate at drip pocket shall be installed equal to the size of the opening.

11. Commissioning and Testing:

The pump shall be commissioned and tested by the Contractor, in accordance with the manufacturer's recommendations. The pump operational curve shall be identified by taking no-flow reading and shall be charted on the pump curve. Operational point at full flow shall be identified and submitted to the Consultant. Tests shall be conducted and test reports submitted to the Consultants and approval obtained.

END OF SPECIFICATIONS

SECTION 23 20 10

PIPING INSULATION (HVAC)

1. Piping Insulation:

a) Insulation Installation:

No insulation shall be applied to any system of piping until all foreign matter has been removed from the surface to be insulated, and until the piping has been tested, cleaned out and made tight and painted. All insulation shall be applied in a manner consistent with good practice and methods. All longitudinal joints of pipe shall be top and bottom. Insulation shall be continuous through walls, floors, ceiling and partitions etc.

b) Insulation:

All cold & hot water piping shall be insulated as indicated under INSULATION SCHEDULE. Insulation shall be in preformed sections with tongue and groove attachment. All insulation shall be fixed to the pipe with approved adhesive. Insulation shall be continuous and gaps if any, shall be filled up. Circumferential and longitudinal joints of vapour barrier and jacket shall be over-lapped at least 50mm.

c) Vapour Barrier:

Shall be as specified under INSULATION SCHEDULE Vapour barrier shall be fixed to the insulation with approved adhesive covering at-least 75% area. All circumferential and longitudinal joints shall be over-lapped at least 40mm. Vapour barrier shall be completely continuous. All scratches, tears, etc., shall be made good by pasting fresh layers of the vapour barrier on the discontinuity.

d) Jacket:

Shall be as specified under INSULATION SCHEDULE. All circumferential and longitudinal joints shall be overlapped at least 40mm. The jacket shall be stretched tight over the insulation using adhesive which shall cover 100% area. Cut edges shall not be visible. All longitudinal joints shall be on top for horizontal piping and hidden from view for vertical piping. Circumferential joints shall be equally distant and equal to the width of the jacket roll. Patches shall not be permitted.

e) Vapour Barrier Coating:

shall be as specified under INSULATION SCHEDULE

f) Cladding:

All chilled and hot water piping shall be provided with cladding as specified below.

2. Valves, Fittings & Other Specialities:

shall be insulated with preformed adjoining insulation, cut to suitable shapes and sections, to closely fit around valves and fittings. Insulation thickness shall not be less than the adjoining straight pipe insulation thickness. The adjoining insulation near these fittings shall be mitred and trimmed into suitable sections to fit closely around the valves, flanges and fittings. All trimmed sections shall be secured by wrapping of approved type of self-adhesive tape to form a complete vapour seal. There shall be a clear break between adjoining pipe insulation & valve/specialities insulation, so that when valve/specialities insulation is opened for maintenance the adjoining pre insulation is not affected.

3. Condensate Drains:

shall be insulated as specified under INSULATION SCHEDULE.).

4. Cladding:

All insulated pipes shall be provided with a cladding of 26 gauge 0.55mm G.I. sheet. At all flanges and valves the cladding shall be openable type. Valves shall be provided with valve boxes with quick opening clamps. Large valve boxes may be held together using "Jubilee Clamps".

5. Buried Steel Piping:

The bare steel piping, or the steel cladding of an insulated pipeline shall be externally painted with one coat of Asphalt primer 2000 (National Petrocarbon Pvt. Ltd.) followed by two coats of Hykote Enamel (National Petrocarbon) reinforced with one layer of galss fibre wrap. The primer and enamel shall be applied strictly in accordance with manufacturer's recommendations.

6. Adhesive:

shall be "MOWLITH" as manufactured by HOEST, Pakistan.

7. Insulation Tapes:

At all insulation joints use 75mm wide self-adhesive tape consisting of reinforced aluminium foil and white Kraft paper.

END OF SPECIFICATIONS

SEC- 22 05 10

EXCAVATION & BACKFILLING

1. Excavation:

   a) Excavate in such a manner that buried items can be laid to the alignment and depth indicated; excavate only so far in advance of pipe laying as approved.

   b) Width of trenches shall be such that buried items can be laid to the alignment and depth indicated; excavate only so far in advance of pipe laying as approved. Width at the top of the trench shall not be more than 600mm plus outside diameter of pipe.

2. Back-filling:

   a) For back-filling use builders sand, or excavated material, if of a sandy nature, but duly screened to remove all rocks & stones which are greater than ¾ inch (20mm) dia approximately.

   b) In filling around pipe, deposit backfill material in successive horizontal layers not exceeding 150mm thickness before compaction. Compact each layer thoroughly by means of approved mechanical tampers. Take special care to obtain compaction under pipe haunches. Deposit backfill adjacent to pipes on both sides to approximately same elevation at the same time. Continue this method of filling and compacting until backfill is at least 450mm above top of pipe.

   c) Backfilling for the remainder of pipe trenches to sub-grades of paved or landscaped areas: Perform by mechanical tamping and rolling equipment, except that use of such equipment is prohibited when said use may result in damage to pipe lines or structures.

   d) Moisten backfill as necessary for proper compaction. Water setting of fill will not be permitted.

   e) Complete backfilling of pipe trenches as soon as possible after the pipe is laid and tested.

   f) Restore to original condition existing pavements, roadways, walkways, curbs and landscaped areas disturbed during the progress of the excavation and backfill work.

   g) Compaction: Minimum of 90% of modified AASHTO maximum density as defined by ASTM D-1557.

   h) Fill not compacted to the required density: re-compact until the specified density is achieved or remove the layer and replace with new material.

3. Payment:

No separate payment shall be made for excavation or back-filling, and the cost of all excavation & back-filling required to lay pipes or carryout any other works requiring excavation & back-filling, shall be considered to be part of the cost of that work.

END OF SPECIFICATIONS

SECTION NO : 22 05 11

DISINFECTION OF WATER DISTRIBUTION SYSTEM

1. PIPELINE DISINFECTION:

a) General:

The Contractor shall furnish all equipment, labour and material for the proper disinfection of the pipeline. Disinfection shall be accomplished by chlorination after the lines have been tested for leakage but before they have been connected to the main system. Disinfection of the pipelines shall be done in the presence of the Engineer's representative with equipment approved by him.

b) Chlorination:

A chlorine and water mixture shall be supplied by means of a solution feed chlorination device. The chlorine solution shall be applied at one end of the pipeline through a trap, in such a manner that as the pipeline is filled with water, the dosage applied to the water entering the pipe shall be at-least (25 ppm) or enough to meet the requirements given hereinafter.

c) Retention Period:

Chlorinated water shall be retained in the pipeline for a period of at least 24 hours. After the chlorine treated water has been retained for the required time, the chlorine residual at the pipe extremities and at such other representative points shall be at least 10 parts per million. The procedure shall be repeated until the required residual chlorine concentration is obtained.

d) Chlorination of Valve:

During the process of chlorination of the pipe lines, all valves or other appurtenances shall be operated while the pipeline is filled with the heavily chlorinated water.

e) Final Flushing:

Following complete disinfection of the pipeline, all treated water shall be thoroughly flushed from the pipeline at its extremities. Treated water and water used for flushing the pipelines shall be disposed of in a manner instructed by the Engineer. Fresh treated water shall be filled in the line and water tested for presence of coliform. The test result should indicate negative coliform presence. If the test indicates any positive coliform, the entire process of disinfection shall be repeated or improved upon until coliform free samples are obtained.

f) Sampling and Testing:

Disinfection of the pipeline and appurtenances shall be the responsibility of the Contractor. The first set of samples will be collected for analysis by the Engineer. Should the sample reveal presence of coliform the Contractor shall again disinfect the pipeline and appurtenance and shall pay the Employer for sampling and testing for subsequent retest until coliform free samples are obtained.

g) Clean-Up:

Upon completion of the installation of the water supply lines, distribution system and appurtenances, all debris and surplus materials resulting from the work will be removed and disposed off in a manner satisfactory to the Engineer.

h) Measurement and Payment:

Payment of this work will be made at the lump sum cost quoted in the BOQ, after satisfactory completion of this work as certified by the Consultant.

END OF SPECIFICATIONS

SEC- 22 05 53

IDENTIFICATION FOR PIPING & EQUIPMENT

1. General:

The contractor shall install mechanical identification tags, shield, plates, etc., where specified below, shown on drawings, or directed by the Consultants. All components of the identification system shall be submitted to the Consultants for approval & approval obtained prior to installation.

2. Equipment Name Plates:

All equipment shall be provided with metal nameplate with operational data engraved or stamped; permanently fastened to equipment at an accessible & visible location. Nameplate shall have name of manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances and similar essential data.

a) Material shall be Fiberboard / Brass / Stainless steel / Laminated Plastic.

b) Stencil paint shall be black enamel, except as otherwise indicated.

c) Manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, conforming to ASME A13.1 shall also be accepted.

3. Equipment Data Plates:

All equipment shall be provided with Equipment Data Plate to be permanently fastened at a suitable accessible and visible location of the equipment. Data plates shall be of min. 3mm thick laminated plastic of suitable size (min. 150mm x 100mm) fastened securely to the equipment. The plates shall generally display the following data:

i) Equipment identification symbol/number.

ii) Fluid flow rates.

iii) Pressure, pressure drops.

iv) Capacity.

v) Motor data.

vi) Any other matter required by the Consultants.

4. Stencilling on Piping:

The Contractor shall attach a stencil near each valve on the pipe, indicating the name of the fluid. Also an arrow should be painted next to the legend indicating the direction of flow in pipe. The legend shall be placed in a location so that it can be easily read from the floor. The legend shall conform in size of letters and colour to ASA A-13.1 of 1975, "Scheme for the Identification of Piping System", but shall not be less than

32mm letters for duct work, and not less than 19mm letters for access door sign & similar operational instructions.

5. Identification Tags on Valves

Identification Tags shall be installed on all valves, controls and other parts of the system where necessary. Tags shall be either of engraved laminated plastic or brass as directed by Consultant, 3mm thick (black in front and white behind) 1.6 inches (40mm) round or square with letters or numbers 0.5 inches (12mm) high and fastened securely with brass "S" hooks or chains.

The Contractor shall further provide charts, diagrams, of size and type as approved designating numbers, service or function and location of each tagged item.

END OF SPECIFICATIONS

SECTION NO : 22 05 73

DRAINAGE & WATER SUPPLY SPECIALITIES

1. **Trapped Floor Gully:**

   Shall be of uPVC similar to Terrain model 279/281 with inlet model 282/283. The drain shall be provided with a trap having a minimum water seal of 50mm. The drain grating and all visible parts shall be of CP brass with level adjusting arrangement.

2. **Vent Cowls:**

   All vent-lines terminating above the building shall be provided with best quality uPVC vent cowls similar to Terrain model 150.

3. **Clean-out for Finished Floor Areas:**

   Shall be similar to ZURN Model No. Z 1323. These shall be of cast iron, designed to provide an air tight seal. The clean-out shall be provided with a threaded brass plug that shall fit into the hub and provide an airtight seal. A key to unscrew the plug shall be provided. A brass ferrule shall be provided, that shall screw into the hub with the capacity of level adjustment. The ferrule shall be provided with a round scoriated brass top and a long brass screw threaded into the plug below, shall hold down the top cover. All visible parts shall be chrome plated.

4. **Roof Drain: (Cast iron)**

   Shall be similar to Zurn Model Z 100, cast-iron body with combination membrane flashing clamp/gravel guard and low silhouette dome.

5. **Roof Drain (PVC)**

   These shall be similar to the cast-iron roof drain specified above, except manufactured in uPVC. It shall have a membrane flashing arrangement and gravel guard with a low silhouette dome.

6. **Drain Gratings: (Mild Steel)**

   Drain gratings shall be installed on open channel drains where shown on the drawings. These shall be fabricated out of mild steel formed members & hot dipped galvanised after fabrication, in accordance with details shown on the drawings. Edge support angle iron member shall be grouted into the concrete edge of the channel, and the drain gratings laid loose on top. Grating length shall not exceed 4ft, & each grating shall fit level & smoothly on the support member.

7. **Manhole:**

   Manhole chambers shall conform to BS 556: Part 2 (Concrete Manholes for Drainage purposes),

Top and bottom of manholes shall be constructed of 150mm thick 1:2:4 RCC with nominal reinforcement or as shown on drawings. The depth of the manhole shall be upto the invert level shown on the drawings. The civil construction shall conform to the specs of the Civil Works. The internal surface of the manhole shall be provided with 15mm thick Pudlo plaster.

Manhole shall be provided with cast iron frames and covers as shown on the drawings & specified below. The invert channels shall be smooth and accurately shaped to a semicircular bottom conforming to the adjacent sewer section. Inverts shall be formed directly in the concrete of the manhole base. Steep slopes outside the invert channels shall be avoided. Changes in size and grade shall be made gradually and evenly. Changes in direction of the sewer and entering branches shall have true curves of a radius as large as the size of the manhole will permit. Manhole shall be provided with built-in steps of Galvanized iron. The rungs shall be not less than 250mm in width and spaced at intervals of approximately 300mm and alternative rungs shall be staggered or off-set 150mm. Bars or rods for steps shall not be less than 20mm in diameter.

The manhole frame shall be carefully embedded in the top slab of the manhole as neatly as possible.

Types of manholes shall be as follows:

Type 'A' Manholes – for use in Residential applications, with 600mm x 600mm clear opening inside manhole, constructed of 200mm thick block or 225mm brick masonry, & provided with cast-iron frame & cover conforming to grade C (BS 497) as given below.

Type 'B' Manholes – for use on commercial, industrial or institutional projects, for non-traffic areas up to a maximum depth of 2 meters. These shall be provided with walls constructed of 200mm thick block or 225mm brick masonry with cast-iron frame & cover conforming to Grade B, Class 2 (BS 497) given below.

Type 'C' Manholes – for use on commercial, industrial or institutional projects, for traffic areas up to a maximum depth of 2 meters. These shall be provided with walls constructed of 150mm thick RCC, with cast-iron frame & cover conforming to Grade A & Grade B, Class 1 (BS 497) given below.

Type 'D' Manholes – for use on commercial, industrial or institutional projects, for traffic & non-traffic areas, depth from 2m to 6m. These shall be provided with walls constructed of 200mm thick RCC of with cast-iron frame & cover conforming to Grade B, Class 2 (BS 497) given below.

8. Intercepting Manhole:

Intercepting manhole shall conform to specification given above except that it shall be provided with an uPVC RCC intercepting trap of the same diameter as the main pipeline.

9. Storm Water Drainage Manhole:

These shall be constructed to conform to specifications given for Manhole at Clause 1, except that the manhole cover shall be replaced with double grating to allow the water to flow into the manhole. The grating shall be manufactured of cast iron and provided with 25mm square holes on 25mm centres in both directions.

10. Manhole Frame & Covers:

Manhole Frame & Covers shall be of water tight quality manufactured from good quality cast iron conforming to BS 497, & shall be of types as noted below:

Grade A - Manhole covers & frames capable of bearing wheel loads upto 11.5 tonnes for use in carriage ways

Grade B Class 1 Manhole covers & frames capable of bearing wheel loads upto 5.0 tonnes for use in carriage ways carrying relatively slow moving normal commercial vehicles.

Grade B Class 2 - Sealed manhole covers and frames capable of bearing wheel loads upto5.0 tonnes for use in areas to which vehicles would have only occasional access.

Grade C - Sealed inspection covers and frames for use in situation in-accessible to motor vehicles.

11. Gully Trap:

Gully trap chamber shall be constructed of 100mm thick masonry walls with 15mm thick pudlo plaster. Bottom of gully trap shall be 100mm thick 1:2:4 RCC pad with nominal reinforcement. Trap shall be of cast iron/uPVC 100mm dia with 50mm water seal. Frames and cover shall be of cast iron of watertight quality. Size 300mm x 300mm, weight 10 kg.

END OF SPECIFICATIONS

SEC– 22 09 00

PUMP CONTROLLER

1. Pump Controller:

   The automatic pump control system shall be of the solid–state type, with low– voltage electrodes in the UG tanks, and an electronic controller.

   The level sensors shall be adjustable for high and low water levels, and shall be installed in weather–proof boxes (IP 54) above each tank, with electrodes installed in PVC pipe into the tanks or as shown on drawings.

   The pump controller shall start pump at a adjustable low level, stop pump at an adjustable high level and provide alarm at an adjustable low–low level, and switch off the pump.

2. Level Indicator:

   The liquid level indicators system shall be of the solid–state type, showing the levels in the UG tanks through LEDs, and have the provisions for low and high level alarm with a 90 dBA hooter and alarm cancel button Suitable low–voltage electrodes shall be mounted on each tank, and the indicator in the pump–room.

END OF SPECIFICATIONS

SECTION NO : 22 11 16

BUILDING WATER PIPING

1. Scope of Work:

The work includes in general the following:

a) Internal cold & hot water piping.

b) Internal Potable Water Piping.

c) Internal Fire Protection Piping.

d) All specials shown specified or needed.

e) Services & Connection to site piping.

f) Other items specified or shown on drawings.

2. Piping Material:

a) Galvanised Iron Pipes: G.I pipes shall conform to BS 1387 of 1957 (medium series); fittings shall be screwed of galvanised malleable iron.

b) Mild Steel Pipe conforming to BS 1387 (medium series), screwed upto 50mm (2 inch) & welded above ø 50mm (2 inch).

c) Mild Steel Pipe conforming to ASTM A53, Schedule 40, screwed upto 50mm (2 inch) & welded above Ø 50mm (2 inch).

d) Polyethylene Pipes: high-density, cross-linked, polyethylene piping, conforming to DIN 16892, DIN 16893 and DVGW Code of Practice W531.

Fittings & pipe shall be suitable to work on normal operating pressure of 10 bars and 79°C. Fittings shall be "Dezincification resistance brass" compression sleeves with copper content of approximately 62%, and shall be manufactured from profiled and dieforged parts.

All supports channels, hangers and fasteners shall be as per manufacturers recommendations. Special tools as recommended by the manufacturer shall be used for installation.

e) PVC Piping shall conform to ASTM D1785 or BS 3505 of 1968, Class 'E' upto Ø 25mm (1" inch) Class 'D' upto Ø 40mm (1 ½ inch), Class 'C' upto Ø 65mm (2 ½ inch) and Class 'B', for Ø 75mm (3 inch) & above. Jointing shall be solvent welded. Fittings shall be injection moulded of high density & shall be imported.

f) Polypropylene Piping: Type III: PP-R (Polypropylene random copolymer) piping conforming to DIN 8077-8078, with a service life of 50 years @ 60°C & 10 bars operating pressure.

Joints shall be made by electrofusion welding upto dia 110mm, & butt welding above dia 110mm. Fittings shall conform to DIN 16962. Fittings with threaded metallic inserts shall be of dezincification resistance brass.

3. Installation of Piping, Valves and Fittings:

a) General: Pipes shall be cut accurately to measurements established at the job site and worked into place without springing or forcing, properly clearing all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Shop drawings by Contractor shall show locations of all supports, typical details for special anchorages for suspended piping, valves, tank, pumps, converters, and other mechanical equipment. Where supports are required between structural framing members, suitable intermediate metal framing shall be provided and detailed. Pipe shall have burrs removed by reaming and shall be installed to permit free expansion and contraction without damage to joints and hangers. Changes in direction shall be made with fittings, except that bending of pipe 4 inches (100mm) and smaller will be permitted provided a pipe bender is used and wide-sweep bends are formed. The center line radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening or other malformations will not be accepted. All piping shall be installed with sufficient pitch to ensure adequate drainage and venting. Piping connections to equipment shall be provided with unions or flanges. Open ends of pipelines or equipment shall be properly capped or plugged during installation to keep dirt and other foreign matter out of the system.

b) Screwed joints shall be used on metallic pipes of diameter 50mm and below. Screwed joints shall be made with tapered threads properly cut. Joints shall be made tight with polytetrafluoroethylene (Teflon) Tape or other approved thread joint compound applied to the male thread only. Not more than three threads shall show after the joint is made up. For galvanized pipe threaded flanges shall be used for 100mm dia pipe and above.

c) Flanges and Unions shall be faced true. Flanges shall be provided with 1.6mm asbestos-free gasket, and made square and tight. Except where copper tubing is used, union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment such as coils, pumps, control valves & other similar items.

d) The run and arrangement of all pipes shall be approximately as shown on the drawings and as directed during installation and shall be as straight and direct as possible, forming right angles or parallel lines with building walls and other pipes, and shall be neatly spaced. Offsets will be permitted only where required to permit the pipes to follow wall, standard fittings shall be used for offsets. All risers shall be erected plumb

and true, and shall be parallel with walls and other pipes and shall be neatly spaced. This Contractor shall at all times work in connection with other contractors in order to avoid interference of pipes and unnecessary cutting of floors and walls. All pipes running underground or concealed in floors or wall construction shall be installed before the construction is closed up.

e) All horizontal runs of piping, except where concealed in partitions, shall be kept as high up as possible and close to walls. Consult with other trades so that grouped lines will not interfere with each other. Where plans call for offsets, same shall be kept close to underside of beams and slabs, and run along side of beams, girders of partition.

f) The arrangement, positions and connections of pipes, fixtures, drains, valves, etc., as shown on the drawings shall be taken as a close approximation and while they shall be followed as closely as possible the right is reserved by the Engineer to change the location etc., to accommodate any conditions which may arise during the progress of work prior to installation without additional compensation to this Contractor for such change. The responsibility for accurately laying out the work and coordinating his installation with other contractors rests with this Contractor. Should it be found that any of his work is laid out so that interference will occur, he shall so report that to the Engineer.

g) All of the pipes shall be concealed in walls, slabs unless otherwise shown on drawings or directed by the Engineer.

h) Special precaution shall be taken in the installation of piping concealed underground or in the building construction, to see that the piping is properly installed. Should it be necessary to correct piping so installed, this Contractor shall be held liable for any injury caused to other work in the correction of his piping.

i) Fixture connections, shown to be installed concealed in building construction, shall in general, be carried concealed to points above floor (near fixtures) where they shall break-out and rise exposed to fixtures, all as required or approved.

j) Reducing fittings, unless otherwise approved in special cases, shall be used in making reduction in size of pipe. Bushings will not be allowed unless specifically approved.

k) Where chrome plated piping is installed, this Contractor shall cut and thread his pipe so that no unplated pipe threads are visible when the work is complete.

l) Friction type wrenches and vices shall be used on all copper tubing and brass piping. Any pipe showing tools marks will be ordered to be removed and replaced with new materials, without additional cost.

m) Unions and flanges shall be provided at suitable intervals to enable easy assembly and disassembly of the pipes. All piping installation shall allow means of easy disassembly for cleaning and maintenance.

4. Installation of Non-Metallic Piping:

a) The complete installation of the non-metallic piping system shall be in accordance with the recommendations of the manufacturer.

b) All accessories, compression fitting, tees, elbows, supports, etc. shall be original manufacturer's products.

c) The Contractors shall ensure that all plumbers are trained by the manufacturer or there local agent and that only manufacturer's recommended tools are used. The Contractor shall establish a close co-ordination with the manufacturer/ local agent to ensure all work to comply with manufacturer's recommendations and Consultants approval.

5. Cutting and Patching:

Cutting will be done under specifications of other trades. This Contractor is called upon to set sleeves for pipes accurately before the concrete slabs or beams are poured or masonry wall put-up, or may set boxes on the forms so as to leave openings in the floors in which the required sleeves can be subsequently located, in which case he is called upon to fill-in the concrete voids around the sleeves.

All patching will be done under specifications of other trades. Should this Contractor neglect to perform his preliminary work and should cutting be required in order to install his piping or requirement, then the expense of the cutting and restoring of surfaces to their original condition shall be borne by this Contractor. This contractor shall also make all chases for installing piping, etc., and must also make good the chases.

6. Protective Painting & Coating:

Protective Painting & Coating shall be carried out on pipes as specified in clause "Painting, Coating & Stencilling" Clause 15020.

7. Testing:

a) Hydraulic testing to following pressures shall be carried out on the complete piping

For Cold water, Hot Water, Potable Water and Fire Protection piping-minimum 100Psi or 1.5 times maximum operating pressure, whichever is maximum.

No loss of pressure shall be indicated for 2 hours. Tests shall be conducted in the presence of the Engineer/Engineers Representative, and the Contractor shall submit test certificates to the Engineer or Engineers Representative & obtain certification that the tested piping system have passed the prescribed tests.

b) Defects disclosed by the tests shall be repaired or if required by the Engineer, defective work shall be replaced with new work without any extra charge to the Employer. Test shall be repeated as directed, until all work is proven satisfactory.

c) This Contractor shall furnish & pay for all devices, materials, supplies, labor and power required in connection with all tests. All tests shall be made in the presence of and to the satisfaction of the Engineer/Engineers Representative.

d) This Contractor shall also be responsible for the work of other trades that may be damaged or disturbed by the tests, or the repair or replacement of his own work, and he shall without extra charge to the Employer, restore to its original condition, work of the trades so damaged and disturbed, engaging the original Contractors to do the work of restoration.

8. Payments

All payment for metallic & non-metallic pipes shall be made per running foot/meter of the installed length of the pipes, which shall include all fittings such as elbows, wyes, tees, collars, junction boxes, etc., including supports, excavation and back filling, concrete bedding, testing and any other work required for the Piping, and the rates per foot/meter submitted by the Contractor for this item of the Bill of Quantities shall be deemed to include all such ancillary requirements.

END OF SPECIFICATIONS

SECTION NO : 22 13 18

BUILDING SANITARY WASTE, VENT & STORM WATER PIPING

1. Scope of Work:

The work includes in general the following:

a) Internal Soil, Waste Water, Vent Piping.

b) Internal Rainwater Drainage Piping.

c) Sub Soil Drainage Piping.

d) All specials shown, specified or needed.

e) Services and connection to site piping.

f) Other items specified, or shown on drawings.

2. Piping Material:

a) Cast Iron Pipes shall be manufactured by the centrifugal spun casting process and shall conform to standard DIN 1172 or BSS 416. heavy duty, of the bell and spigot type. Each pipe & fitting shall be class 20 psig and tested at the manufacturer's works at 20 Psig and shall show no leakage, sweating or other defects. Pipes shall be coated by immersion in a bath containing a uniformly heated composition of bitumastic base. Pipes supplied shall be accompanied by a test certificate and each pipe shall be so stamped.

b) Non-metallic Drainage Piping:

i) Polypropylene pipes to DIN 19560, with synthetic rubber seal rings to DIN 4060 (Part 1). All fittings shall be injection moulded push-fit type.

ii) uPVC Pipes to BS 4514, with synthetic rubber seal rings to BS 2494. All fittings shall be injection moulded push-fit type.

3. Subsoil Drainage Pipe:

Subsoil drainage pipe shall be uPVC, coiled, perforated corrugated pipes. Fittings and pipe shall be from single source of manufacture. Pipe shall be manufactured in conformity with DIN 1187.

Diameter of perforation shall be 0.1" to 0.15" and density of holes shall be 40% of total pipe surface area.

4. Piping Materials Application:

For piping application refer PIPING SCHEDULE under EQUIPMENT & MATERIAL SCHEDULE, Section 2.

5. Installation:

a) Each pipe shall be examined on arrival; defective pipes shall not be used. Drain shall be laid in straight lines and to even gradients between the levels shown, with pipes and fittings, of the type and diameter as shown on the drawings. Great care shall be exercised in setting out and determining the levels of the pipes and the Contractor shall provide suitable instruments, set up and maintain sight rails, and bench marks etc., necessary for the purpose. Cut pipe shall have smooth regular ends at right angles to length of pipe. All pipes to be cut with an approved cutter. All drains shall be kept free from earth, debris, superfluous cement and other obstructions during laying and until the completion of the Contract when they shall be handed over in a clean condition. Pipes shall be laid with the sockets leading upstream.

No pipes shall be laid on their collar or on blocks, tiles or other temporary supports.

b) Drainage line shall be accurately laid and shall be perfectly true to line and gradient from point to point in both vertical and horizontal planes.

c) Easily accessible clean-outs, flush with the floor finish should be provided at each bend and bottom of stacks and at all points shown on drawings. The clean-outs should be made of "WYE" of full size; the minimum size shall be Ø 75mm.

d) Special fittings required in the installation not generally cast by manufacturers shall be got specially cast by Contractor matching with the shell thickness specified.

e) Branch connection shall be made with "WYE" and long "TEE-WYE" fittings. Short bends, common offsets and double hubs will not be permitted. Short "Tee-Wye" fittings are to be used in vertical piping only. All fittings shall conform to code requirements.

f) Joints between cast iron to cast iron soil pipe shall be push fit joints. The joints shall be made tight and smoothly faced. Lead used in joints in cast iron piping shall be pure and soft and of best quality and shall be sufficiently heated to run joint full at one pouring without hardening. Dross shall not be allowed to accumulate in the melting pot.

g) All soil and waste lines hung from the ceiling shall be supported at not more than 1.5m centers for horizontal pipe and 2m for vertical pipes. Provide supports at all special fittings.

6. Testing and Inspection:

a) The entire drainage and vent system shall be subjected to testing after installation to ensure a leak-proof installation under operating conditions.

All the openings in the piping system shall be tightly closed by inserting test plugs of heavy rubber gasket that fit snugly all around the opening. The highest point will be left open to supply water and may be raised if necessary by temporary jointing to develop a minimum head of five (5) meters of water at each section of the system. Water is filled to the point of overflow and any drop in the level of water will indicate a leak that will be found by inspection. The water level will be checked for no drop for at least 15 to 30 minutes. No section will be tested at a pressure more than 6m of water. High stacks will be tested in sections, starting from the top section and then connecting top section to next lower section.

b) A final test of the completed drainage and vent system will be conducted by smoke to ensure that connection for water closets are absolutely gas and water tight and that fixture traps are sound.

All the traps will be filled with water and a thick smoke produced by burning oil, waste, tar paper or similar material in the combustion chamber of a smoke test machine, will be introduced into the entire system. When smoke appears at highest point it will be closed and pressure equivalent to 25mm of water column will be built and maintained.

The drainage pipe and building sewer will also be inspected for slopes which must conform to the slopes specified. The slopes will be checked with precision angle measuring instrument like universal protector, plumb and level. Any portion found not laid according to the given slope will be rectified at the Contractor's expenses.

c) This Contractor shall furnish & pay for all devices, materials, supplies, labour and power required in connection with all tests. All tests shall be made in the presence of and to the satisfaction of the Engineer.

d) This Contractor shall also be responsible for the work of other trades that may be damaged or disturbed by the tests, or the repair or replacement of his work and he shall, without extra charge to the Employer, restore to its original condition, work of the trades so damaged and disturbed, engaging the original contractors to do the work of restoration.

e) Defects disclosed by the tests shall be repaired, or if required by the Engineer, defective work shall be replaced with new work without extra charge to the Employer. Test shall be repeated as directed, until all work is proven satisfactory.

f) This Contractor shall notify the Engineer, Consultant and others having jurisdiction at least ten days in advance of making the required tests, so that arrangements may be made for their presence to witness the tests.

g) The Contractor shall submit test certificates to the Engineer or Engineers representative & obtain his certification that the tested piping system have passed the prescribed tests.

7. Payments

All payment for metallic & non metallic pipes shall be made per running foot/meter of the installed length of the pipes, which shall include all fittings such as elbows, wyes, tees, collars, junction boxes, etc., including supports, excavation and back filling, concrete bedding, testing and any other work required for the Piping, and the rates per foot/meter submitted by the Contractor for this item of the Bill of Quantities shall be deemed to include all such ancillary requirements.

END OF SPECIFICATIONS

SEC- 22 40 00

PLUMBING FIXTURES & FITTINGS

1. General:

All fixtures shall be free from imperfections, true as to line, angles, curves and colors, smooth, water tight and complete in every respect.

All fixtures specified to be of vitreous ware, shall be fired vitreous china ware of the best quality, non-absorbent and burned so that the whole mass is thoroughly fused and vitrified producing a material white or colored, which when manufactured will show a homogeneous mass, close grained and free from pores. The glazing and vitreous china fixtures shall be of a color approved by the Consultant, thoroughly fused, and united to the body, without discoloration, chips, or flaws and shall be free from craze. Warped or other imperfect fixtures will not be accepted.

All plumbing fixtures supplied shall be as specified & from source indicated.

All fixtures shall be furnished from one manufacturer unless otherwise specified.

All fittings, cast brass set screws, escutcheons faucets, traps, exposed piping, etc., shall be of brass, chrome plated over nickel plate with polished finished. Any supports nuts etc., visible shall likewise be chrome plate over nickel plate.

After installation of plumbing accessories, the Contractor shall ensure their protection against damage, misuse and general deterioration. Fixture outlets shall be plugged with suitable material to prevent entry of external debris. All chrome plated and other metallic fittings shall be provided with a coat of grease to prevent their deterioration. All items prior to handing over must be in perfect condition in the visual and operational sense.

All fixtures and accessories shall be first quality, imported, unless otherwise indicated.

All cracks between fixtures and walls shall be filled using approved silicone sealant.

2. Installation:

a) All screws, bolts and other anchoring devices shall be of stainless steel or chrome plated brass.

b) Install toilet fixtures, fittings and accessory units in accordance with manufacturer's instructions, using fasteners, which are appropriate to substrate and recommended by manufacturer of unit. Install units plumb and level, firmly anchored with brass screws and nylon anchors at locations and at heights indicated in drawings.

c) Set accessories plumb, level, and square at locations approved, in accordance with manufacturers instruction for type of substrata involved.

d) Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.

e) Remove and replace accessories which are broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents and vandalism.

f) Clean and polish all exposed surfaces after removing temporary labels and protective coatings.

END OF SPECIFICATIONS

SECTION NO : 21 11 16

EXTERNAL FIRE HYDRANT & STAND PIPES

1. Scope of Work:

The work under this section of the specifications consists of providing all material and labour for proper installation of fire water pipes and pipe fittings, including excavation & backfilling, jointing, laying, clamping, cleaning, painting etc., both above ground and underground and embedded in walls as shown on the drawings, as specified herein, or as directed by the Consultant.

The work includes, in general, the following:

a) Fire Protection Piping.

b) Fire Standpipes.

c) All valves, strainers, etc., shown, specified or needed.

d) Services and connections to Fire Fighting Equipment.

e) Other items as may be specified or shown on the drawings.

2. Dry Barrel –Pillar Hydrant – Double Headed:

Fire Stand Pipes shall be of Pillar Hydrant type, of size dia 150mm, tested to 250 psi. The pillar Hydrant shall be constructed of steel, and shall consist of four section, i.e. Dry Port, Upper Barrel, Lower Barrel, and Inlet Connection. The Dry Port shall be O'Ring sealed. The Upper Barrel shall be bolted on top to the Dry Port and at the Bottom to the Lower Barrel. The Upper Barrel shall house the outlet consisting of two nos. Ø 65mm hydrant valves with instantaneous couplings. The Lower Barrel shall carry the main hydrant valve, which shall be constructed of cast-iron and shall have a conical shaped synthetic rubber moulded disc which shall seat on to a precision machined bronze seat. The main hydrant valve shall be compression type opening against the pressure and closing with it, and shall be actuated by a cast bronze nut which shall rotate the steel hydrant rod. Hydrant valve shall be provided with flanged inlet and tee-base. All nuts and bolts shall be zinc passivated and plated. Hydrant barrel shall be painted inside and out with a primer, and finish painted on sections below ground level with black bituminous paint, while exposed surfaces shall have red high glass enamel.

3. Double Delivery Standpipe:

Shall be manufactured using Ø 6inch Schedule 40, Black steel pipe, fully welded, conforming to dimensions given in A+ Engineers detail drawing, approximately 36 inch high, and with the top end capped. The barrel will be provided at the top with two dia 2½ " hydrant valves, placed 180° apart, and each outlet shall be provided with an instantaneous coupling. The bottom of the standpipe shall be flanged. When installing the

standpipe, the piping leading to the standpipe shall be provided with concrete foundation/thrust block as shown in A+ Engineers detail drawing.

END OF SPECIFICATIONS

SECTION NO : 21 12 13

BUILDING HOSE REEL & HOSE RACK

1. Fire Brigade Connection:

Supply & install where shown on the drawings a ∅ 65mm×∅ 65mm x ∅ 100mm Fire Department Connection, rated for use upto a maximum pressure of 175 psi. The inlet connections shall be ∅ 65mm with threads compatible for use with Pakistan Fire Brigade Standards, and the outlet connections shall be ∅100mm. The connection body, clapper, swivel, and swivel plug shall be cast from an aluminium magnesium alloy. Escutcheon plate shall also be provided. Connections shall be straight, red painted, with standpipe identification.

2. Fire Hose Reel:

The Contractor shall supply and install recessed, swinging arm type, Fire Hose Reels, where indicated on the drawing. The Hose Reels shall conform to BS 5274:1985 and shall consist of:

a) **Hose Reel Lock Shield Valve**: manufactured from materials resistant to de-zincification, ∅25mm, threaded.

b) **Side Disks:** 18SWG, galvanised steel sheets, powder coated, post office red color.

c) **Hose:** Red rubber smooth, covered to BS3169 Type 1, Class B; ∅25mm and 30.5m long.

d) **Control Nozzle:** Nylon lever operated jet/spray

3. Fire Hose Reel Cabinet:

Provide and install Fire Hose Reel Cabinet constructed from 16SWG galvanised sheet steel, powder coated to BS18 B25. Cabinet shall be minimum of size 850mm x 850mm and shall be minimum 350mm deep.

a) **Water Entry:** Top, bottom, back or side, 50 dia knockouts to suit pipework requirements.

b) **Architrave:** 20SWG stainless steel, brushed satin finish.

c) **Door:** 15mm MDF finished in pre-catalysed lacquer both sides and edges in BS06 C33.

d) **Concealed Hinges:** Concealed hinges, left or right as required.

e) **Name Panel/Finger Pull:** Recessed stainless steel, brushed satin finish. Caption "FIRE HOSE REEL" in red 45mm high. Universal logo showing fire hose reel shall also be provided.

f) **Instruction on reverse of panel:** "IN CASE OF FIRE PULL HOSE FROM REEL AND WATER WILL TURN ON AUTOMATICALLY".

4. Fire Hose Reel Cabinet Door:

Where steel cabinet is not felt necessary, only the Door will be installed over a recesses in the masonry construction for the hose reel, and / or extinguishers, as shown in the detail drawings.

Separate doors, one on top of another shall be provided & installed. The top door shall be for the hose reel, while the bottom door shall be to house fire extinguishers, as shown in the detail drawings.

Doors shall conform to specifications given at Clause 3 above for Hose Reel Cabinet.

5. Fire Hose Rack:

The Contractor shall supply and install fire-hose rack with hose of diameter 40mm with instantaneous coupling terminated with light alloy jet / spray nozzle.

Hose shall attaché to Ø 65mm fire hydrant valve (angle valve). Length of hose shall be 30 meter. Hose shall comply with British Standards BS-3169.

Fire hose shall be rubber lined with nylon hose.

Hose shall be as approved by the Consultant.

6. Hose Rack Cabinet

Provide and install fire hose rack cabinet constructed from 16SWG galvanised steel sheet, powder coated to fire red colour according to BS 18 B 25. Cabinet shall have a minimum size of 600mm wide x 800mm high x 150mm deep, and shall have a full glass door.

7. Orifice Plates:

Where the dynamic pressure at the inlet to Fire Hose Reel exceeds 2.75 bars (40 psi) an orifice plate shall be installed prior to the inlet of Fire Hose Reel. The orifice plate shall be fabricated of 6mm thick stainless steel (SS 304) and installed between steel flanges. Size of the bore shall be determined by the contractor. Shop drawing shall be submitted to the Consultant for approval prior to the fabrication.

END OF SPECIFICATIONS

SECTION NO : 21 23 16

PORTABLE FIRE EXTINGUISHING EQUIPMENT

1. Portable Fire Extinguishers:

a) General: Specific type Portable Fire Extinguishers shall be installed at locations shown on the drawings. All extinguishers shall be of suitable construction tested to at least 20 bars pressure, and shall have suitable anti-corrosive protection and shall have powder coated red finish with non-damaging instruction label. Extinguishers shall be installed on purpose made hooks at a suitable height as approved by the Engineer. The extinguishers shall be provided complete with initial charge. In each case provide refill kits where available, suitable for one recharging. The extinguishers shall be of the following types.

b) Dry Chemical Powder Fire Extinguishers: Extinguisher shall conform to BS 3465 and shall contain Dry Chemical Powder in main body and carbon dioxide gas in external steel bottle, powder content as indicated in the BOQ.

c) Chemical Foam Fire Extinguishers: Conforming to BS 740

d) Carbon Dioxide Fire Extinguisher: complete with hose and horn, of capacity as indicated in the BOQ.

e) Trolley Chemical Foam Extinguisher: Provide steel tubular frame trolley with 2 rubber tyres of 16 inch diameter, mounted with Chemical Foam extinguisher having a capacity of 150 litres (34 gallons) Extinguisher main body shall be of 10 SWG M.S sheet, electrically welded and tested to 20 bars, and internally and externally powder coated. Cap and other parts shall be of gun-metal. Provide a minimum length of 20ft (6.0m) long high pressure hose, with open and shut-off control cock and discharge nozzle.

f) Trolley Mounted Dry Chemical Powder: Similar to Clause 'e' above, except Dry Chemical Powder Extinguishers having a capacity of 50kg.

g) Cabinet for Fire Extinguishers:
Where indicated on drawings, provide portable fire extinguishers in concrete recess, provided with red powder coated aluminium frame with hinged 5mm steel door. Size of the cabinet shall be adequate for size & quantity of fire extinguishers to be placed. Cabinet shall be minimum 400mm deep. Cabinet door shall be painted with the following caption "PORTABLE FIRE EXTINGUISHER, OPEN IN CASE OF FIRE". Universal logo showing portable fire extinguisher shall also be provided.

2. Fire Buckets:

Where shown on drawings provide Fire Bucket set each consisting of 8 Nos. provide 2 IGAL Galvanised Iron bucket, hung on ø 40mm G.I. pipe stand. The stand and buckets shall be painted with two coats of primer and two finish coat of red paint, and on each bucket the word "FIRE" shall be painted.

3. Fire Blanket:

Blanket shall be of size 900mm x 900mm minimum and shall be made of texturized woven glass Fibre. Blanket shall be provided in storage container of non-corrosive, rigid, self extinguishing white PVC.

4. Fire Fighting Accessories:

The Contractor shall supply the following fire fighting accessories and shall store them at a suitable location indicated by the Employer.

a) 2 Nos. Crow bar.

b) 2 Nos. Fire Beater.

c) 2 Nos. Fire Hook.

d) 2 Nos. Fire man's axe with rubberised handle.

e) 3 Nos. Gas Masks, haled face, Model 'TRILLIX-II' 'AVER' brand West Germany with gas filter and 2 spare filter elements for each mask.

f) 3 Pairs gloves, asbestos, heat resistant, size 400mm.

g) 3 Pairs gloves, rubber suitable for 11000 volts.

h) 3 Pairs Boot Cover, asbestos with rubber boots.

i) 3 Nos. Steel Helmets.

j) 4 Nos. - 30m long, Ø 65mm imported fire hose, rubber lined with nylon top, fitted with couplings.

k) 4 Nos. - Ø 65mm London gun metal nozzle with hand controlled branch pipe for jet/spray.

l) Glass fronted steel cabinet to house above accessories.

END OF SPECIFICATIONS

FIRE PUMP SET, ELECTRIC & DIESEL ENGINE OPERATED (HYDRANT/SPRINKLER APPLICATION)

1. General:

Scope: The contractor shall supply & install packaged fire pump sets consisting of the following:

- 1 X diesel engine driven fire pump with controller
- 1 X electric motor driven fire pump with controller
- 1 X jockey pump with controller

Each of the above pump sets shall be factory installed on a suitable steel skid, along with all necessary controls, instrumentation, piping, valves, etc., required for testing of each pump set individually in accordance with NFPA 20 standards, and the pump sets shall be so tested at the manufacturer's factory and an FM approval certificate obtained. All steel surfaces shall be sand blasted and painted with two coats of primer and finish paint of fire red colour. All pump sets shall be UL listed & FM approved.

Service Condition & Design Standard: Fire Pump Set shall be designed and constructed to operate satisfactorily in a typical fire protection application. Pump, motor, engine & controller shall be the products of manufacturers regularly engaged in their production and marketing. Fire pump set shall conform to the requirements of the latest edition of NFPA-20 (Standard for the installation of Centrifugal Fire Pumps).

If so indicated in the EQUIPMENT & MATERIAL SCHEDULE & DATA SHEETS (Section 2), the Fire Pump Set shall be listed for fire protection service and so certified by Factory Mutual or NFPA or Underwriters Laboratories.

2. Fire Pump:

Operating Conditions: The pump(s) shall be of the type and sized to provide a flow rate and total head as scheduled under Section 2, EQUIPMENT & MATERIAL SCHEDULE & DATA SHEETS. At 150% of the rated capacity the fire pump shall develop at-least 65% of its rated head and shall not exceed 120% of its rated head at zero capacity as per Table 2-20 of NFPA 20. Each pump shall be furnished with a certified performance curve indicating pressure, capacity & horsepower requirements.

End Suction Centrifugal Pumps:

Casing shall be vertical or horizontally split, with centreline discharge, foot-supported and made of cast iron. Casings shall be provided with tapped and plugged holes for priming vent and drain.

Impeller: shall be the single section enclosed type of bronze. Impeller shall be statically and hydraulically balanced. Drilled holes shall be provided through the impeller hub to balance axial thrust loads and keep positive pressure on the stuffing box. Impeller shall be keyed & locked to the shaft with a hexagonal head impeller nut, and shall be easily removable without the use of special tools.

Shaft: Pump shaft shall be high strength stainless steel sized to provide a minimum amount of deflection.

Mechanical Seal: Pumps shall be provided with mechanical seal. Carbon against Ni resist faces having stainless steel metal parts & nitrile elastomers.

Bearing Frame: shall be rigid, one-piece cast iron construction. Frame shall be provided with catch basin reservoir with tapped drain hole to collect and pipe away drip.

Bearings: shall be ball type on both ends of the frame. Both bearings shall be locked in place and be sized to provide long life under thrust loads encountered. Both the bearings shall be enclosed by replaceable box.

Bearing Lubrication: Ball bearings shall be grease lubricated with provisions for the addition and relief of grease.

Baseplate: shall be fabricated steel centre drain or cast iron drip lip sufficiently rigid to support the pump and the driving motor with tap hole to pipe away leakage and condensation.

Coupling: shall be flexible type.

Coupling-Guard: shall be all metal and fastened to the base plate.

3. Diesel Engine & Accessories

The engine shall be of the four stroke, compression ignition, mechanical injection type turbo-charged, water-cooled, capable of operating continuously on full load at site elevation for a period of six hours.

The engine shall be equipped with the following methods of starting:

a) Automatic by means of a pressure switch through a battery powered electric starter motor.

b) Manually activated electric starter motor.

c) Manually cranked stating.

Each starting arrangement shall have its own separate relay system and set of batteries but the same starter motor shall be used for automatic or manual starting. The engine will continue to run until shut-off manually. The stop control shall be so arranged so that the engine shutdown mechanism returns automatically to the starting position after use.

The pump-engine connecting flexible coupling shall be so designed that either the pump or engine can be removed without disturbing the other. All rotating parts shall be guarded.

Engine shall be complete with:

A. 24 volt electric starting equipment comprising:

a) starter motor

b) two sets of lead-acid batteries mounted on the base plate, each adequate for 12 cycles of cranking a cold engine at 4°C.

c) battery leads and connectors.

d) hydrometer, to enable the state of charge of the batteries to be determined.

e) two manual emergency start switches

f) alternator 24V

B. A fuel system comprising:

a) fuel tank of sufficient capacity to allow the engine to run on full load for 6 hours. This shall be fitted with sludge and sediment trap, special fuel level gauge and an inspection and cleaning hole. Fuel feed pipe valve with facility for locking in the 'open' position and interconnecting flexible fuel supply pipe shall be provided.

b) fuel pump with mechanical governor & over-speed switch

c) fuel solenoid actuator energised to stop

d) fuel and lubricating oil filters

C. An exhaust system comprising:

a) flanged exhaust silencer (industrial duty)

b) flanged flexible exhaust connector (stainless steel)

c) mild steel exhaust pipe as required for appropriate exhaust outlet

d) protected exhaust manifold (insulated)

D. An engine cooling system comprising of the following:

a) cooling system with mounted heat exchanger & circulating pump

b) expansion tank

c) thermostat & piping

d) engine jacket heater 400V, 1kW with thermostat (if required)

E. Instrumentation:

a) instrument panel containing oil pressure gauge, water temperature gauge, tachometer, hour-meter and ammeter

b) all necessary switches for cooling water temperature high, lubricating oil pressure low, etc.

c) magnetic pick up for tacho drive

F. Miscellaneous

a) air-cleaner (duty as required)

b) SAE flywheel and housing

c) engine wiring to a terminal box

d) red paint finish to BS 4800/04D45

e) tool kit

f) operations manuals & parts list

G. Spares

Spares shall be supplied in accordance with the list given under LIST OF SPARES in EQUIPMENT & MATERIAL SCHEDULE (Section 2).

An "Operation and Maintenance" manual shall be supplied with the fire pump set.

4. Jockey Pump:

Selection Data: The jockey pump shall be suitable for providing a flow rate and total head as scheduled in Section 2, EQUIPMENT AND MATERIAL SELECTION DATA.

Type: Pump shall be vertical multi stage type with direct mounted motor, similar to Grundfos Model CP or approved equivalent.

Casing: Suction and delivery chambers shall be of cast iron, with intermediate and diffusers of stainless steel.

- Impellers : Stainless steel
- Shaft : Stainless steel
- Shaft-seal : Mechanical
- Bearings : Bronze

5. Electric Motor-Drive:

Motor horsepower & locked rotor current shall be as per Table 6-4.1.1 of NFPA 20 (1996). Motor shall be TEFC, IP-54 with class F insulation with a maximum temperature rise of 80°C in an ambient temperature of 40°C, conforming to specifications under Section 15024 (Motors). All motors shall be specifically listed for fire pump service. Conduit termination shall be arranged to prevent entrance of water. Motor hip shall be suitable to ensure non-overloading operation of the motor at any point of the pump operation curve.

6. Fire Pump Controller:

If so indicated in the EQUIPMENT & MATERIAL SCHEDULE (Section 2), the Fire Pump Controller shall be as per NFPA standard & must be listed by Underwriters Laboratories and approved by Factory Mutual.

Operation: The Fire Pump Controller shall be designed to operate the jockey pump automatically through a pressure switch control to maintain constant pre-set pressures in the fire mains. The main fire pump shall be started automatically when the pressure in the fire mains drops to a pre-set low level, and shall continue to run the fire pump until shut down manually. When the electric pump does not start or pressure falls lower than the pre-set value, the Fire Pump Controller shall start the diesel engine. Whenever the main fire-pump(s) operate, an audible signal shall be activated. The fire pump shall also start thru panel mounted push-buttons, and shall have interlock provisions to start pump through remote break-glass switch, flow-switch or deluge valve switch. An override emergency manual start facility shall also be provided.

Enclosure: The enclosure shall be constructed of 14 gauge steel, provided with baked enamel paint, with a fully gasketed lockable hinged door and removable un-drilled gland plate located in the base. Degree of protection shall be IP-54.

A. Controller Configuration For Electric Motor Operated Pumps Shall Be As Follows:

Mounted on the front of the controller panel:

1 - start-stop push button(s) for fire pump(s). Stop push button shall be inoperative when pump is on demand.

1 - start-stop push button for jockey pump.

1 – Lamps, normally lit to provide visual indication of all three phases and control circuit healthy.

1 – Lamps to indicate jockey pump overload.

1 – Lamp to indicate low fire water in storage tank (provision for interlocking).

1 – Ammeter(s) to give indication of fire-pump motor(s) current, with selector switch.

1 – Label engraved 'FIRE HYDRANT PUMP MOTOR SUPPLY – NOT TO BE SWITCHED OFF IN THE EVENT OF FIRE'.

Mounted inside the controller panel:

1 – Single handle, triple pole incoming isolator.

1 – Control circuit fuses.

1 – Electronic phase monitor, giving phase failure & phase reversal alarm. This shall provide alarm only & shall NOT be interlocked to shut off pump.

1 – Set of main power terminals.

1 – Set of control and alarm terminals.

1 – Minimum run timer (adjustable) for fire pump.

1 – Sets of volt-free contact(s) shall be provided in the controller to pre-signal the starting of the main fire-pump or power supply failure.

The starters for fire & jockey pumps shall be wired to give a signal to a remote (mounted at suitable remote location, and wired to the panel) alarm bell (90 dBA at 3 meters) in the event of 'pump on demand' or of a 'power failure' in any one phase of the supply, or over-load of the jockey pump, or any other alarm condition. Alarm bell shall be provided loose for field mounting.

For Fire Pump(s):

1 – Triple pole, MCCB of suitable size for carrying the stalled current of the motor for a period of not less than 75% of the period which such a current would cause the motor windings to fail.

1 – DOL triple pole contactor

Note: Control system shall be designed to limit start/stop per hour for manual starting. However in auto position, pump start thru pressure switch will not have this limitation and will start regardless of lockout time.

1 – Hand-off-Auto switch

1 – Auto-start/manual stop pressure switch

For Jockey Pump:

1 – Triple pole MCCB of suitable size.

1 – DOL starting system comprising:

1–Triple pole contactor

1–Overload thermal relay

1 – Hand–off–auto switch

1 – Auto–reset pressure switch

B. **Controller Configuration For Diesel Engine Operated Pump Shall Be As Follows:**

The controller shall be programmed to give up to six engine cranks, each of 15 seconds duration, separated by dwell periods of 10 seconds.

After the fire pump has started, an engine driven frequency generator shall provide a signal to the electronic speed sensor in the controller which shall cancel further cranking and automatically reset the controller for future operation.

Should the engine fail to start after six crank attempts, visual and audible alarm shall be given.

An over–ride emergency manual start facility shall be provided by means of a push button located behind a break–glass cover.

The controller shall be also fitted with a manual start test facility which shall only become operative after completion of an automatic start.

Mounted on the front of the controller panel:

1set– Lamps to provide visual indication of:

- Charger No.1 healthy
- Charger No.2 healthy
- Battery No.1 healthy
- Battery No.2 healthy
- Battery/Charger fault
- Automatic battery switch–over failure
- Control circuit healthy
- Auto–start switched off
- Pump on demand
- Failed to start
- Operate manual start test push button
- Low oil pressure
- High water temperature (24 volt system only)
- Pump on demand
- Engine over–speed
- Fuel tank empty

2– Ammeters to indicate charging current to each battery

1– Electronic sounder to provide audible alarm.

1– Tachometer to indicate engine speed

1– Automatic battery selector switch

1– Hours run meter.

1- "Manual start test" push button

1- "Alarm mute" push button

1- "Fault reset" push button

1- "Emergency manual start" push button mounted behind a "break-glass" cover.

Mounted inside the controller panel:

2- Completely independent, fully automatic constant potential battery chargers with current limiting/short circuit protection and "charger failure/battery fault" alarm output.

Main printed circuit board fitted with:

1 – "Auto-start" isolating switch
2 – Heavy duty cranking relays
1 – Voltage regulator for the permanently energised circuits
2 – Control circuit fuses
2 – Battery main fuses
1 – Set of mains, control and alarm terminals
4 – Non interchangeable, auxiliary plug-in printed circuit boards for the control of the following

Board 1 – Initiation circuits
Board 2 – Speed sensing circuits
Board 3 – Alarm circuits
Board 4 – Supplies Monitoring circuits

To ensure maximum reliability of both systems the controller shall have two completely independent battery chargers, each connected to one set of batteries. These fully automatic chargers shall be totally solid state, utilising phase-controlled full wave thyristor bridge network to regulate the output currents according to individual battery demand. They shall incorporate electronic protection against short circuit and battery reverse polarity.

Special circuits shall be able to differentiate between battery voltage and charger voltage and thereby provide permanent battery supply monitoring even whilst the chargers are energised.

Local visual and audible alarm shall be given on loss of either battery. Facilities shall also be provided for remote alarm of both battery and battery charger failure.

During any stage in the starting sequence should the "automatic" battery have insufficient power to crank the engine, further crank shall automatically be made from the battery connected in the "manual" start system.

The power available from both batteries shall be used to give the best engine starting characteristic under emergency manual starting conditions.

Visual alarm indications shall be by means of long life, light emitting diodes.

Volt free normally closed contacts shall be provided for remote indications of:

1. Pump on demand
2. Pump running
3. Trouble at engine/controller which monitors the following:
   a) Automatic start switched off
   b) Pump failed to start
   c) High water temperature (24 volt systems only)
   d) Low oil pressure
   e) Battery/Charger fault
   f) Automatic battery failed

The initiation circuit shall be of a "fail safe" design arranged to start the fire pump set on the opening of the pressure switch contact or loss of normally closed signal.

7. Piping, Valves & Fittings:

a) Piping material & standard shall be as indicated in EQUIPMENT & MATERIAL SCHEDULE (Section-2).

Adequate provision shall be made to disassemble the piping through flanges and unions. The size of the pump suction & discharge piping & fittings shall not be less than that given in Table-2-20 of NFPA 20 (1996).

b) Valves shall conform to specifications given under Section 15021. The pump set shall be furnished with:

- Gate valve on pump discharge
- Check valve on pump discharge
- Tee before gate valve to pipe to hose header.

c) Fittings: The pump set shall be furnished with:

- Automatic air release valve
- Compound pressure gage on suction, (Dial size 4½"), ¼inch gate valve.
- Pressure gage on discharge; (Dial size 4½") range approx. twice the working pressure, but not less than 200psi, ¼ inch gate valve.
- Automatic Circulation relief valve, set below the shut-off pressure at minimum suction pressure. It shall provide sufficient flow to prevent the pump from overheating when operating with no discharge. Minimum size shall be ¾"dia.

8. Testing at Manufacturers Works

The fire pumps & controller shall be subjected to complete testing at the manufacturer's works, to determine conformance to NFPA 20 requirements and FM approval standards.

9. Foundation:

Foundation shall be 1:2:4 concrete sized to provide an inertia block having a mass equal to 3 times the weight of the pump and motor. The foundation shall be isolated from the structure and plant room floor by using 50mm thick high-density cork. Edges of the foundation shall be provided with a 25×25×3mm angle-iron frame and the same shall be provided with two coats of oil paint.

10. Installation:

    During installation pump shall be properly levelled, grouted in and realigned before operation in accordance with the manufacturer's recommendations. Suction and discharge connections shall be installed through flexible connectors, and electrical wiring shall be done.

    For pumps taking suction from a stored water tank, an anti-vortex suction plate shall be installed at the entrance to the suction pipe.

11. Commissioning and Testing:

    The pump shall be commissioned and tested by the Contractor, in accordance with the manufacturer's recommendations. The pump operational curve shall be identified by taking no-flow reading and shall be charted on the pump curve. Operational point at full flow shall be identified and submitted to the Consultant. Tests shall be conducted and test reports submitted to the Consultant and approval obtained.

12. Spares:

    Spares shall be supplied in accordance with the list given under LIST OF SPARES in EQUIPMENT & MATERIAL SCHEDULE, (Section 2).

    An "Operation and Maintenance" manual shall be supplied with the fire pump set.

END OF SPECIFICATIONS

SPECIFICATION DATA SHEET FOR FANS

PROJECT NAME: IBA HOSTEL, MAIN CAMPUS KARACHI

PROJECT NO: 55

SPECIFICATION DATA SHEET NO: 23 34 16

REVISION NO: 0

DATE: 25th FEB, 2014

ISSUED FOR: TENDER

SECTION NO: 23 34 16

S. No.	DESCRIPTION	UNIT SPECIFIED DATA		
1	FAN No.	-	E.A.F-01, 02, 03, 04, 05 & 06	E.A.F-06, 07, 08, 09, 10 & 11
2	Application area	-	Kitchen Exhaust	Wash Room
3	Type of Fan	-	Propeller Type	Cabinet Type
4	Quantity	No.	6	6
5	Altitude Above mean sea level	ft	13	13
6	Air Flow rate	CFM	100	1,500
7	External static pressure on Fan	Inch WC	1.2	1.2
8	Motor power	kW	As required	As required
9	Power supply (V/Ph/HZ)	-	400/3/50	400/3/50
10	Remarks		-	-

SPECIFICATION DATA SHEET FOR HVAC INSULATION, HOSTEL BUILDING

PROJECT NAME: IBA HOSTEL, MAIN CAMPUS KARACHI

PROJECT NO: 55

SPECIFICATION DATA SHEET NO:23 20 10.1

REVISION NO: 0

DATE:27TH FEB, 2014

ISSUED FOR: TENDER

S. No.	DESCRIPTION	MATERIAL SPECIFICATIONS	THICKNESS	THERMAL CONDUCTIVITY	DENSITY	Vapor Barrier/ Jacketing/ Cladding
			(Inch)	(BTU.in/hr ft²°F)	(lb./Ft.³)	
I / 1A	REFRIGERANT PIPING	CLOSED CELL FOAM INSULATION, FIRE RETARDANT ON DIA 1/2" OR SMALLER PIPES	3/8"	0.26 @75°F	5-7	Insulation tape all around
I / 1B	REFRIGERANT PIPING	CLOSED CELL FOAM INSULATION, FIRE RETARDANT ON PIPES LARGER THAN DIA 1/2"	1/2"	0.26 @75°F	5-7	Insulation tape all around
I / 2	CONDENSATE DRAIN PIPING FROM AIR-CONDITIONERS	uPVC CLASS D(12 BAR), SOLVENT WELDED	3/8"	0.26 @75°F	5-7	Insulation tape all around

SPECIFICATION DATA SHEET FOR HVAC PIPING, HOSTEL BUILDING

PROJECT NAME: IBA HOSTEL, MAIN CAMPUS KARACHI

PROJECT NO: 55

SPECIFICATION DATA SHEET NO: 22 05 53.1

REVISION NO: 0

DATE: 25TH FEB, 2014

ISSUED FOR: TENDER

S. No.	DESCRIPTION	TYPE OF MATERIAL	MATERIAL SPECIFICATIONS	STANDARDS	SPECIFIED MANUFACTURERS
P/1	REFRIGERANT PIPING	COPPER	SEAMLESS HARD DRAWN, TYPE L	ASTM B88	(1) MUELLER, USA (2) APPROVED EQUIVALLENT
P/2	CONDENSATE DRAIN PIPING FROM AIR-CONDITIONERS	uPVC	CLASS D(12 BAR), SOLVENT WELDED	ASTM D1785 BS 3505	(1) DADEX (2) HEPWORTH (3) VESBO (4) APPROVED EQUIVALLENT

SPECIFICATION DATA SHEET FOR SMALL SPLIT AIR-CONDITIONERS, HOSTEL BUILDING

PROJECT NAME: IBA HOSTEL, MAIN CAMPUS KARACHI

PROJECT NO: 55

SPECIFICATION DATA SHEET NO: 23 81 27.1

REVISION NO: 0

DATE: 25TH FEB, 2014

ISSUED FOR: TENDER

S. No.	Description	Unit	Specified data
1	**INDOOR UNIT**		
2	**Quantity**	Nos	12
3	**Evaporator Material**		Copper
4	**Refrigerant**	–	R-407c/R-134a or any other refrigerant with zero ozone depletion potential
5	**Application Area**	-	Lounges
6	**Total Capacity (Nominal)**	TR of each A/C	1.5
7	**Evaporator Fan Type**		Centrifugal Forward Curve
8	**Type of Indoor unit**	–	Wall Mounted
9			Split Unit
10	**OUTDOOR UNIT**		
11	**Compressor**		
12	**Type of compressor**		scroll
13	**Type of motor**		Hermetic/ Semi-hermetic
14	**Refrigerant**		R-407c/R-134a or any other refrigerant with zero ozone depletion potential
15	**Power Supply**	V/Ph/Hz	230/1/50
16	**Condenser Material**		Copper
17	**Condenser Fin material**		Aluminum
18	**Condenser Fins coating material**		special anti-corrosive golden coating
	Note:		

SPECIFICATION DATA SHEET FOR HOT WATER HEATER, HOSTEL B&C BUILDING				
PROJECT NAME: IBA, MAIN CAMPUS KARACHI				
PROJECT NO: 55				
SPECIFICATION DATA SHEET NO 22 33 34.1				
REVISION NO: 0				
DATE: 25TH FEB 2014				
ISSUED FOR: TENDER				
	Performance			
1	Quantity	Nos	6	2
2	Storage Capacity	Usgallons	542	140
3	Maximum Water Flow Rate	USGPM	-	-
4	Heating Capacity	Btu/hr	212,000	65,000
5	Natural gas consumption	ft3/h	240	75
7	Application	-	Toilets	kitchen
	Construction			
8	Required height	ft	less than 5'-0"	less than 5'-0"
	Required diameter	ft	as per selection	as per selection
9	Remarks	-		

SPECIFICATION DATA SHEET FOR PIPE INSULATION-PLUMBING, HOSTEL B&C BUILDING
PROJECT NAME: IBA, MAIN CAMPUS KARACHI
PROJECT NO: 55
SPECIFICATION DATA SHEET NO:22 20 10.2
REVISION NO: 0
DATE: 25TH FEB,2014
ISSUED FOR: TENDER

S. No.	DESCRIPTION	MATERIAL SPECIFICATIONS	THICKNESS	THERMAL CONDUCTIVITY	DENSITY	Vapor Barrier/ Jacketing/ Cladding
			(Inch)	(BTU.in/hr ft^2°F)	(lb./$Ft.^3$)	
	HOT WATER PIPING					
a	Hot water PPR piping embedded in wall	Non-insulated				
b	Hot water PPR piping except embedded pipes in wall	Closed cell foam insulation, Fire retardant	3/8 inch	0.26 @75°F	5-7	Insulation tape all around.

SPECIFICATION DATA SHEET FOR PIPING-PLUMBING, HOSTEL B&C BUILDING				
PROJECT NAME: IBA, MAIN CAMPUS KARACHI				
PROJECT NO: 55				
SPECIFICATION DATA SHEET NO:22 13 16.1				
REVISION NO: 0				
DATE: 25TH FEB,2014				
ISSUED FOR: TENDER				
S. No.	**Description**	**Type**	**Standards**	**Approved Manufacturers**
P/1	Building water supply in false ceiling cavity and covered areas	Polypropylene Random (PPR) , PN-20	DIN 8077 & 8078	(1) Dadex (Pakistan) Pipe With Dadex Fittings (2) Kelen (UK) Pipe with Kelen fittings (3) Vesbo (Turkey) Pipe with Vesbo fittings
P/2	Building water supply in areas exposed to sun	Galvanized Steel, Medium	BS 1387	IIL, APPROVED EQUIVALENT
P/3	Building Drainage (Soil & Waste)	UPVC Class B, Solvent Welded	ISO 3633/ EN 1329 and PS 3214	(1) Dadex (Pakistan) Pipe With Dadex Fittings (2) Hepworth (UK) Pipe with Hepworth fittings (3) Vesbo (Turkey) Pipe with Vesbo fittings
P/4	External Drainage (Soil & Waste)	Pressure pipe, UPVC Class B, Solvent Welded	ASTM D1785 BS 3505	(1) Dadex (Pakistan) Pipe With Dadex Fittings (2) Approved Equivallent
P/5	Fire protection Piping	Black Steel, Schedule-40, Seamless	ASTM-A53 Grade-B	1) Huffaz, Pakistan 2) Lontrin, China

SPECIFICATION DATA SHEET FOR PUMPS, HOSTEL B&C BUILDING				
PROJECT NAME: IBA, MAIN CAMPUS KARACHI				
PROJECT NO: 55				
SPECIFICATION DATA SHEET NO:23 11 23.1				
REVISION NO: 0				
DATE: 25TH FEB 2014				
ISSUED FOR: TENDER				
S. No.	**Description**	**Unit**	**Specified Data**	**Specified Data**
1	**Pump No.**	-	**P-01,02**	**P-03,04**
2	Application area	-	Hostel-B,Water supply to OHWT, One Stand-by	Hostel-CWater supply to OHWT, One Stand-by
3	**Type of Pump**	**-**	**End Suction, Horizontal, Centrifugal**	**End Suction, Horizontal, Centrifugal**
4	**Quantity**	**No.**	**2**	**2**
5	Flow Rate	USGPM	70	70
6	Total Head	ft of WC	60	60
7	Type of fluid to be handled	-	City Water	City Water
8	Pump Speed	RPM	1500/2900	1500/2900
9	NPSH Available	ft of WC		
10	Operating power	kW	As required	As required
11	Motorpower	kW	As required	As required
12	Design Pressure	Psig	100	100
13	Design Temperature	F	200	200
14	Casing Material	-	Cast Iron	Cast Iron
15	Impeller Material	-	Stainless Steel AISI 304	Stainless Steel AISI 304
16	Shaft Material	-	Stainless Steel AISI 304	Stainless Steel AISI 304

17	Base Plate Material	-	Cast Iron	Cast Iron
18	Seal type		Mechanical	
19	Coupling		Spacer	
20	Motor Type	-	TEFC, Copper winding	TEFC, Copper winding
21	Motor Insulation Class (VDE 0530)	-	F	F
22	Motor Voltage Variation	%	$\pm$ 10	$\pm$ 10
23	Power supply (V/Ph/HZ)	-	400/3/50	400/3/50
24	Remarks	-	One stand-by, at 50% increased head, pump performance should lie in the acceptable selection zone on pump curve	One stand-by, at 50% increased head, pump performance should lie in the acceptable selection zone on pump curve

SPECIFICATION DATA SHEET FOR FIRE PIPING					
PROJECT NAME: IBA HOSTEL,MAIN CAMPUS KARACHI					
PROJECT NO: 55					
SPECIFICATION DATA SHEET NO:22 40 00.1					
REVISION NO: 0					
DATE:25th FEB, 2014					
ISSUED FOR: TENDER					
S. No.	**DESCRIPTION**	**TYPE OF MATERIAL**	**MATERIAL SPECIFICATIONS**	**STANDARDS**	**SPECIFIED MANUFACTURERS**
P/1	Fire protection Piping	Black Steel	Seamless, Schedule-40	ASTM-A53 Grade-B	1) Huffaz, Pakistan 2) Lontrin, China

SPECIFICATION DATA SHEET FOR TOILET FIXTURES & FITTINGS, HOSTEL B&C BUILDING
PROJECT NAME: IBA, MAIN CAMPUS KARACHI
PROJECT NO: 55
SPECIFICATION DATA SHEET NO:22 40 00.1
REVISION NO: 0
DATE: 25TH FEB, 2014
ISSUED FOR: TENDER

Fixture No.	Item	Description	Specified model data
PF-01	WC – Western, Wall Mounted, Concealed Cistern Operated	Best quality, white/colored as approved, vitreous china wall mounted WC with matching coupled dual flush (3/6 liter) water saves model cistern, with special plastic seat & cover with stainless steel fixings, CP brass inlet pipe to cistern, stainless steel thimble, angle valve 15mm (Zilver).	Standard-CW 620 J Toto (Japan)
	Other fittings and accessories for PF-01	CP brass inlet pipe to cistern, stainless steel thimble, angle valve 15mm.	Zilver (Italy)
PF-02	WC Hand shower	CP Brass Bib-cock Outlet With PVC Hose & Shower With Trigger	Master (Pakistan), Sonex (Pakistan)
PF-03	Wash Basin Wall Mounted	Best quality, white/colored as approved, vitreous china wash basin	Avante LW-316 J, Toto (Japan)
	other fittings & accessories for PF-03	CI support arrangement, Ø 32mm PVC Bottle-trap (Viega or sheffer), CP brass inlet pipe, two T-stop cocks (Zilver).	Zilver (Italy)
PF-04	Wash Basin Single lever Mixer	35mm Cartridge Brass body, Zinc Alloy Handle Nickle Plated/Chrome Plated (as approved by the Architect) Including 2 Hose	PL-B1222-Zilver (Italy)
PF-05	Bath Mixer and shower rose	35mm Cartridge Brass body, Zinc Alloy Handle Nickle Plated/ Chrome Plated (as approved by the Architect) Including 2 Hose, luxury open shower rod head shower	PL-B1238 and PL-8307-Zilver (Italy)
PF-06	Kitchen Sink	Best quality stainless steel sink as per user requirement	Toto (Japan) or Reginox
PF-07	Sink mixer	Best quality elbow operated goose neck type as per user requirement	Zilver (Italy)

PF-8	other fittings & accessories for PF-09	Ø 32mm PVC Bottle-trap (Viega or sheffer), CP brass inlet pipe, one T-stop cocks	Zilver (Italy)
PF-9	JANITOR BIB COCK	CP brass Ø 15mm with 150mm extended arm from wall	Zilver (Italy)
PF-10	BIB COCK	CP brass, Ø 15mm	Zilver (Italy)
PF-11	Wall Hung Urinal with integral trap and exposed flush valve	Best quality, white/colored as approved, wall hung vitreous china urinal, with integral trap,	Toto model UW-930 Jwith TX-501 U flush valve

SPECIFICATION DATA SHEET FOR FIRE PUMPS, HOSTEL B&C BUILDING			
PROJECT NAME: IBA, MAIN CAMPUS KARACHI			
PROJECT NO: 55			
SPECIFICATION DATA SHEET NO:22 06 10.1			
REVISION NO: 0			
DATE: 25TH FEB 2014			
ISSUED FOR: TENDER			
S. No.	**Description**	**Unit**	**Specified Data**
1	**Pump No.**	-	**P-03**
2	Application area	-	Fire protection system water supply to Class II hose reels in Hostel B & C
3	**Type of Pump**	-	**End Suction, Horizontal, Centrifugal**
4	**Quantity**	**No.**	**1**
5	Flow Rate	USGPM	100
6	Total Head	PSI	125
7	Type of fluid to be handled	-	City Water
8	Pump Speed	RPM	1500/2900
9	NPSH Available	ft of WC	
10	Operating power	kW	As required
11	Motorpower	kW	As required
12	Design Pressure	Psig	250
13	Design Temperature	F	200
14	Casing Material	-	Cast Iron
15	Impeller Material	-	Bronze
16	Shaft Material	-	Stainless Steel AISI 304
17	Base Plate Material	-	Cast Iron
18	Seal type		Mechanical
19	Coupling		Spacer
20	Motor Type	-	TEFC, Copper winding
21	Motor Insulation Class (VDE 0530)	-	F
22	Motor Voltage Variation	%	± 10
23	Power supply (V/Ph/HZ)	-	400/3/50
24	Remarks	-	