

SECTION 6800 PLUMBING AND SANITARY INSTALLATION WORKS

6801 General

(1) General

This Section covers technical specifications for the plumbing and sanitary installation systems in the building.

The concerning Sub-Sections of Division 6, building Works shall be applied to this section.

(2) Scope of Works

The works shall include design, transportation of the materials, installation, adjustment and testing of the plumbing and sanitary systems for the El Salaam No. 7 Pumping Station as listed as follows.

- a. Water Supply System
- b. Sewage Treatment System
- c. Building Plumbing System

6802 Water Supply System

(1) General

The canal water is fed by the pump, reserved, chlorinated and filtered to use as potable water in the pump station.

The water supply system shall consist of the following main items.

- a. 2 Units of Water Feed Pumps
- b. Water Reservoir
- c. 2 Units of Water Supply Pumps
- d. Chlorination Facility
- e. Filtration facility
- f. Piping and pipe fittings

(2) Applicable Codes and Standards

All works shall be in accordance with the rules and regulations of Egypt.

(3) Design Criteria

(a) Water Feed Pump

Submersible water feed pump with each capacity 60 liter/min, head of 20 m, motor capacity is 1.1 kW and to be installed in the suction chamber located in the suction sump

of the Pumping Station.

These pumps shall be operated by the water level of the water reservoir in the manner of automatic alternative operation.

(b) Water Reservoir

The water reservoir shall be made of reinforcement concrete with capacity 4 m³, and installed on the ground at the location of the north east corner of the pump station site.

The reservoir shall be provided with water level detectors for operation of the water feed pumps.

(c) Water Supply Pumps

Submersible type water supply pumps with each capacity of 60 liter/min, head of 40 m, motor capacity of 1.1 kW shall be installed in the water reservoir.

These pumps shall be operated by the water level of the elevated tank in the manner of automatic alternative operation.

(d) Filtration Facility

Recommendable filtration facility shall be installed on the roof of reservoir tank.

(e) Chlorinating Facility: One unit

Recommendable chlorinating facility shall be installed on the roof of reservoir tank.

(f) Elevated tank

The elevated tank made of FRP (Fiberglass Reinforced Plastic) shall be installed on the roof of the No. 7 Pumping Station building.

Capacity of tank shall be not less than 4 m³.

Water level detector shall be provided.

(f) Piping and Pipe Fittings

The pipe used to the water supply system shall be the welding seam or seamless galvanized steel sized as indicated on the drawing.

All valves used to the system shall be specified in the Sub-Section 7102, (5) Small valves (for General use)

6803 Sewage Treatment System

(1) General

The waste from the pump station, including toilets, basin, shower and washbasins etc. should discharge into the drainage system and then to the septic tank.

The effluent of the septic tank shall be fed to the evaporation pit.

The sewage treatment system shall consist of the following main items.

- a. Septic Tank
- b. Evaporation Pit
- c. Piping and pipe fittings

(2) Applicable Codes and Standards

All works shall be in accordance with the rules and regulations of Egypt.

(3) Design Criteria

(a) Septic Tank: One unit

The septic tank shall have a minimum capacity of 12 m³, and two compartments.

The septic tank shall be made of reinforcement concrete and installed at the north west corner of the pump station site.

The capacity of Inlet chamber shall be two-third of the total capacity and liquid depth shall be not less than 2 m.

The septic tank shall be provided with inspection hole and manhole for inspection inside of the tank and for remove sediments.

(b) Evaporation Pit

All sides and bottom of the evaporation pit shall be finished with mortar to prevent seepage of the effluent.

(c) Piping and pipe fittings

In order to prevent high velocities of waste at the entrance to the septic tank three to five meter of the sewer ahead of the septic tank should not slope more than one-fifty.

The pipe used to the sewage treatment system shall be the PVC pipe of 100 mm diameter.

6804 Building Plumbing Systems

(1) General

The building plumbing systems shall consist of the following main items.

- a. Roof and floor drainage system
- b. Sanitary equipment
- c. Personal shower system
- d. Piping and pipe fittings

(2) Applicable Codes and Standards

All works shall be in accordance with the rules and regulations of Egypt.

(3) Roof and Floor Drainage System

The Contractor shall be required to install suitable drainage system to the roof and toilets of the No. 7 Pumping Station.

(b) Roof Drainage

Roof leaders water down pipes shall be carried along the outside facade of the buildings to discharge rain water to the canal. Down pipe size in relation to the drained, sloped roof area shall be 150 mm diameter.

(a) Floor Drainage

Floor drains shall be provided in toilet rooms, pantry and in shower room, all connected to the sanitary drainage system. In a monolithic finish, the top of drain shall be placed 10 mm below finished floor elevation. Floor drains in toilet, shower rooms and pantry shall have an adjustable round top with chrome plated grate. Drain pipe size shall be of 50 mm diameter.

(4) Sanitary Equipment

The system shall consist of the following main items.

- a. Water closet including with flush valve: 4 Units
- b. Wall urinal including with flush valve: 2 Units
- c. Lavatory: 4 units
- d. Service sink: 1 unit
- e. Kitchen Unit: 1 unit
- f. Piping and pipe fittings

The pipes used to the water supply systems shall be of the galvanized seamless steel and used to drainage system shall be of PVC.

6805 Technical Requirements

(1) Submittals

The Contractor shall prior to commencement of the works, prepare and submit to the Engineer detailed shop drawings, indicating the layout and schematic diagram of all piping, fittings and valves, the location of sanitary fixtures, roof and floor drains, kitchen unit and etc. Piping shall be indicated by diameter, slope and invert level.

The contractor shall have the responsibility to check the accuracy of all dimensions taken from the drawings in the preparation of the shop drawings. Where pipe routing is left to the Contractor's discretion, he shall prepare the detailed and accurate pipe arrangement plans and obtain the Engineer's approval early enough to ensure that the necessary slots and recesses can be provided. The Engineer's approval shall not be deemed to limit the

Contractor's responsibility in any way.

All drawings submitted by the Contractor and approved by the Engineer shall not in any way relieve the Contractor from his responsibility, or to provide equipment of suitable dimension, for construction and finish to the location in which it is to be installed.

The Contractor shall provide to any discrepancies, errors or omissions, which are not due to inaccurate information or particulars furnished in writing to the Contractor by the Engineer.

The Contractor shall keep on the site at least one set of drawings to show the progress of the work installed. This set shall be kept up to date showing all modifications and sections of work tested. The Contractor shall submit to the Engineer for approval a description, drawings, pamphlets and/or data sheets showing all technical conditions, characteristics, make, type, capacity and address of Manufacturer, etc. of the materials, fixtures or equipment offered.

(2) Layout Plan

The Contractor shall exercise and consider carefully when progressing the layout plan and shall plan all pipe runs to fit into the surroundings as neatly and unobtrusively as possible and shall position all equipment with due consideration for appearance, so that they shall not clash or interfere with other systems.

Any pipes fittings, appliances or equipment, which the Engineer shall consider to be incorrectly installed, shall be removed and correctly relocated at the expense of the Contractor. Piping for drainage or water supply systems shall not be routed over electrical equipment.

6806 Materials

(1) General

All material and structural components not standardized shall be used only with the approval of the Engineer. Prior to placing order, the Contractor shall in any case submit a description and/or drawings showing all technical characteristics, make, type and address of manufacturer, etc., of the offered materials for approval by the Engineer. Minimum quality requirements of materials shall be as follows.

- a. Galvanized mild steel pipe with welded seams; ASTM, A-120, Schedule 40.
- b. Threaded malleable iron fittings ASTM A 338-51
- c. Ductile cast iron pipe according to ISO 2531.

(2) Requirements for Sanitary Fixtures

(a) General

All fixtures specified as hereinafter and shown on the plans shall be furnished and set by the Contractor in a neat and finished manner, making connections with all supply, waste, oil,

electrical and vent pipes connections complete in every respect.

(b) Ceramic Fixtures

All ceramic fixtures shall be of first quality, regular selection, white porcelain thoroughly fused, producing a white material which, when fractured, shall show a homogeneous mass with close grain and free from pores. All surfaces coming in contact with walls, floors, or surfaces of other fixtures shall be reasonably flat and sealed with elastic (silicon) filler, colour matching the cement filler of the tiling work.

(c) Requirements for Fixtures

All fixtures shall be of the same manufacturer, unless otherwise directed by the Engineer. Plumbing fixtures and installation shall be in accordance with manufacturer's printed instructions for conditions indicated and as required to obtain a rigid installation. The location of each fixture and the fixing method of ceramic fixtures shall be as shown on the drawings or as directed by the Engineer.

The Contractor shall be responsible for protecting of all plumbing fixtures against injury from building material, acids, tools and equipment.

After completion test finishing and before handing over the Contractor shall clean all fixtures thoroughly, or removing all plaster, stickers, rust stains and other foreign matter or discoloration of fixtures, leaving every part in perfect condition and ready for use.

(d) Plumbing Fixtures and Accessories

(i) General

Plumbing fixtures and accessories shall be provided as indicated on the approved drawings or otherwise specified. Catalogue designations are listed for convenience in identification and to establish quality and type required. Fixtures and accessories of the other makers, which are approved as equal quality and appearance by the Engineer, will be able to adopt for this works.

(ii) Material

Plumbing fixtures and accessories shall be provided as indicated on the approved drawings or otherwise specified. For connection between fixture and pipe end the chrome plated soft copper tube shall be used.

Indoor sewer piping shall be extra heavy cast iron (XH C.I.) soil pipe per ASTM A74 with bell and spigot or other approved joining method. Minimum slope grade of sewer piping shall be 1%.

Drainage and vent piping above ground may also be XH C.I. or PE-hard of approved manufacture with heat fused joints. When install PE-hard pipes, installation method shall be strictly according to manufacturer's recommendations.

All water piping shall be galvanized, seamless or welded seam steel pipe with threaded, galvanized malleable iron fittings.

(e) Kitchen Unit for Pantry

Kitchen unit for pantry shall consist of the following items.

- a. One compact kitchen element consisting of a one-bowl stainless steel sink, faucet, cooking range, with all accessories encased in a cupboard-link element; size: L=180 cm, D=63 cm with the height: 87.5 cm.
- d. Top hung wall cupboard 100 x 60 x 40 cm

6807 Workmanship

(1) General

The Contractor shall provide all material, labour, plant and equipment to execute, complete and maintain. The Contractor shall carry out the tests required by and under the supervision of the Engineer and shall make good and replace any defective work. The Contractor shall be responsible for protection of all plumbing from any damage whether due to concurrent work of other trades or otherwise and he shall clean up on completion and leave all works in perfect working order and to the satisfaction of the Engineer.

Exactness and a good finished appearance of all work carried out are an essential requirement and inferior works or workmanship shall be not accepted.

High standard must be maintained throughout the period of the Construction. The Contractor shall ensure that pipe works, equipment, etc. is mounted at the correct height as shown on the shop drawings. Pipe Sizes: smallest pipe size to be 1/2"

Actual mm	Nominal ANSI Std. Inch	Actual Inside dia ANSI Std.	Nominal mm
12.7	1/2"	15.8 mm	13
19.05	3/4"	21.0 mm	20
1" = 25.4	1"	26.6 mm	25
31.75	1 1/4"	35.1 mm	32
38.1	1 1/2"	40.9 mm	40
50.8	2"	52.5 mm	50
63.5	2 1/2"	62.7 mm	60 (65)
76.2	3"	77.9 mm	75 (80)
101.6	4"	102.3 mm	100
127	5"	128.2 mm	125
152.4	6"	154.1 mm	150

All plumbing fixtures and accessories shall be installed in strict accordance with manufacturer's printed instructions. After installation is completed, the Contractor shall thoroughly clean all plumbing fixtures and accessories. Surface of all fixtures and accessories shall be free of stains, markings, scratches and debris. All parts of sanitary installations shall suitably be adapted to each other so that the required performance is achieved, safety in operations ensured and corrosion processes largely reduced.

The Contractor shall prepare installation, foundation, slot, and penetration drawings based on the construction drawings and shall reconcile these with the Engineer's requirements.

The Contractor shall check any existing slot and penetration drawings.

(2) Installation of Pipes

(a) General

The Contractor shall ensure that no obstruction is left in any piping or fitting and that the full bore is maintained throughout. Any ends of pipe work or fittings left open during the course of the work shall be plugged with plastic or soft work plugs. After completion of the work, all systems shall be flushed out with clean water and all strainers shall then be cleaned out. All cuts shall be made square to the pipe axis by approved means. The cut ends of piping shall, before fitting, be carefully reamed out to restore the original bore of the piping.

Piping shall be installed so that it follows the lines of the building structure and horizontal piping shall be graded wherever necessary to allow for venting and draining of the pipe work. The minimum clearance between the building structure and the surface of insulation on covered pipes shall be 25 mm. Where two adjacent pipes are to be insulated they shall be fitted to allow a minimum clearance of 25 mm between finished surfaces of the insulation. The clearance between the building structure and the surface of non-insulated pipes shall be:

- a. 50 mm for pipes of 54 mm overall diameter and over
- b. 32 mm for pipes of 35 mm and 42 mm overall diameter
- c. 25 mm for pipes of 28 mm overall diameter and below

At junctions with other lines, specifically electric cables, and heating pipes, these shall be protected from damage and adverse influences as the respective line or pipe may require. All embedded piping shall be installed on the correct elevations, gradient, and alignment as shown on the drawings, or as directed by the Engineer. Insulation of pipes shall be made in accordance with the instructions of the Engineer.

All pipes shall be cut accurately to measurements established on the job and shall be worked into place without springing or forcing. Connections to equipment shall be made so that no stress will be placed therein because of improper alignment or hanging. Certain equipment will require special piping provisions, and the Contractor shall comply with all manufacturers' instructions in this respect.

(b) Pipe Sleeves

Where pipes are required to pass through walls, floors, etc., they are to be enclosed in a sleeve having a diameter one size larger than the pipe concerned and constructed of the same material. The length of the sleeves is to be 6 mm more than the thickness of the wall, floor etc. and the ends are to be provided with approved type floor and ceiling plates fastened securely to the sleeve.

Sleeves through slabs of upper story wet rooms, even if concealed in pipe spaces shall be

extending 50 mm above finished floor and sealed waterproof with mastic. The Contractor shall be responsible for supervising the positioning and building in of the sleeves.

(c) Joints

For pipe connections not made for longitudinal forces, e.g., socket joints, in which an internal pressure normally exists or may arise owing to particular operating direction, secure the pipes against sliding apart (at pressure test and under operating conditions) by fixing them to abutments. All reaction forces generated by expansion members, compensators, and vibration dampers shall be absorbed at the fixed points in the piping.

Where required by installation instructions for such structural components, an axial guide of the pipe shall be ensured by an appropriate limitation. Fitting and connections shall be arranged at the intersection of joints in tiling, as required the Contractor shall consider such pertinent information in good time, as, e.g.

- a. Type of fixing (mortar or glue)
- b. Height of tile skirting
- c. Size of tiles
- d. Joint width
- e. Exact definition of walls on which tile laying is to start
- f. Distance of first tile from these walls as measured at a height of 1 m from the finished floor
- g. No pipe work of any description shall be joined in walls, solid floors or any other position where access for maintenance is difficult or impossible.

(d) Pipe Supports

Pipe concealed in ceilings or ducts shall be fixed with cleave hangers of material compatible to the pipe material and extension rods to channels, back plates or angles fastened to the concrete structure.

Distribution pipe work exposed on ceilings or walls shall be fixed with brass split pipe rings with mild steel extension rods to the required length and base plates fixed to the walls and ceilings.

Contraction and expansion of the piping shall be allowed and provided for throughout, wherever possible be means of off-setting longer pipe runs by more than one meter and properly anchoring them on one side. Bellow type devices are prohibited.

All hangers shall be spaced in the following table.

Type of Pipe	Pipe Size Nominal	Max. Spacing Rod Size Meters	Millimeters Diameter
Steel pipe	13 - 32 mm	2.50	10
	40 - 65 mm	3.00	10
	75 mm	3.50	12
	100-150 mm	4.25	12
PVC PVC, PP, PE	13 - 15 mm	1.20	10
	32 - 40 mm	1.50	10
	50 - 75 mm	2.00	10
	100-150 mm	2.50	12
Cast-iron drainage pipe	50 - 60 mm	1.0	
	80 + above	1.5	

(e) Method of Fixing

The size of bolts or screws shall be the largest permitted by the diameter of the hole in the apparatus concerned, and shall be of adequate length. When fixing any item of equipment, all bolts or screw holes provided therein should be used and the fixing in each hole is to be secure.

All lightweight fixings of equipment to brick, block or concrete shall be made with greased round headed steel screws and fibrous or plastic plugs. Wood plugs shall not be used. In damp or exposed situations but greased, brass screws and soft metal non-deteriorating plugs must be employed. Holes of the requisite size for the plug shall suit the screw used and will be neatly drilled in the concrete, brickwork (not in joints between bricks/blocks) to a depth, excluding plaster or soft wall finish, equal to the length of the plug to be used. The plug length shall be such that when the screw is in place all the threaded length is in the plug.

Fixings to timber shall be made with brass round headed screws. For fixings to hollow tiles, etc. screw anchor type fixings shall be used as far as possible. Fixing to soft or hard fiberboard etc. which are inaccessible to the back, shall be made with self-tapping screws of appropriate size or with spring and gravity toggles.

All heavy weight fixings of equipment to brick, block and concrete shall be by means of mild steel bolts of appropriate size of the grouted bolt type or by one of the various types of expanding bolt fixings. The use of shot fired fixings into concrete or steel is subject to prior approval of the Engineer. Where permission is granted for the use of such fixings only the low velocity piston type tool to be used. The tool should incorporate a device to prevent it being fired until pressure has been applied to the fixing center.

(f) Metal for Brackets

Purpose made steel brackets required fixing accessories or items of equipment to walls or structures shall be constructed in a neat and workmanlike manner and shall be subject to the approval of the Engineer. All steelwork shall be buffed free of burrs and rags shall be thoroughly cleaned before painting.

(g) Jointing Pipes

All pipe work shall be in the maximum lengths possible to avoid unnecessary jointing. Pipes shall be fixed to sufficient falls to prevent air locks and to enable the system to be drained through the draw-off and drainage taps provided. Joints in all types of pipe work shall be perfectly smooth inside. Jointing of pipes shall be made according to the different kinds of pipes by caulked lead, screwing, welding, flanges, or flexible joints, etc.

All bends shall be swept bends, no elbows shall be used. All tees shall be pitcher tees. Joints in cast iron pipes shall be made with a tarred gasket caulked home to a minimum depth of 32 mm and the remainder of the socket filled with lead fiber solidly caulked skein by skein until the joints is filled. The pipes shall be cleared out as the work proceeds and left free from obstructions. Cast iron pipes shall be fixed to true lines with one holder bat to each socket. Cast iron rainwater down pipes shall be fixed to true lines all in accordance with the manufacturer's instructions.

Polyethylene pipes and fittings shall be jointed as recommended by the manufacturer. Connections to fittings shall have a provision for disconnection using screwed joints. Straight lengths of pipe exceeding 6 meters shall be fitted with expansion joints. Vertical pipes shall be fixed with approved molded holding clips at centers not greater than 600 mm. Horizontal pipes where continuously supported shall be similarly fixed, but where not continuously supported the clips shall be at centers not greater than 300 mm.

Joints to pipe work and fittings shall be complete with all necessary thimbles, ferrules, adapters and fittings together with jointing materials. The connections between pipes of differing materials to be as required herein below.

- a. Joints between different metallic material shall be made with suitable insulators to prevent electrolytic action.
- b. The Contractor shall perform all necessary jointing in services and wastes etc., assemble, fix and connect up to all sanitary fittings, tanks and drains.
- c. Joints between metal pipes, which depend on putty or cement, will not be permitted. This applies particularly in the jointing of the traps of sinks, lavatory basins etc., to the waste pipes. Such joints shall be by means of suitable screwed unions in the case of wrought iron or steel, by compression fittings in case of copper, by caulked run lead joints in the case of cast iron and by wiped caulked joints in the case of lead. In all cases provision shall be arranged for cleaning the traps in the event of blockage.
- d. Wastes of sinks, lavatory basins etc., shall be set into appliances with white lead and secured with screw fittings.
- e. The use of flexible connectors between services and sanitary fittings will not be permitted. Such connections shall generally be formed of pipe similar to the service, provided that all bending is carefully carried out with no diminution of the waterway.
- f. Care shall be taken to ensure that all piping and fittings are clean internally and free from particles of soil, metal filings and chips, etc.

(h) Table of Joints

Steel to steel	Taper thread screwed couplings
Non-elasticized PVC	Solvent welded with approved fittings Cemented spigot and socket with brass and gunmetal compression fittings or with flanges
Polyethylene (PE) to polyethylene and polyethylene to copper	Approved compression fittings or heat fused joints.

(i) Pipes and Fittings

Inside the building, the pipes shall be embedded in the walls except where distribution pipes are installed in the suspended ceilings or in such cases the Engineer decides to install surface mounted pipes. Piping shall be insulated with polystyrene or other approved material. Immediately after the building entry, the supply main shall be fitted with two isolating valves and between them a non-return valve and if required other control and regulating special valves. In toilet rooms, appropriate size shock absorbers shall be installed in each branch serving flush valves. Branches with quick closing valves throughout shall also be provided with shock absorbers. Job made air chambers are not acceptable.

All valves and specialties installed in ceilings or behind walls shall be made accessible through ample size access panels. Panels to be subject to approval by the Engineer. All required fittings, such as full-bore valves, non-return valves, angles valves, strainer, discharge taps, etc., shall be made of red brass, brass or other material, if approved by the Engineer.

All exposed parts must be chromium-plated. All pipefitting shall be of the correct sizes. All reductions in size on horizontal pipes shall be made with eccentric reducing tees or eccentric reducing sockets. Concentric fittings may be used on vertical pipes. Bushing down will not be permitted.

Distribution piping shall be laid out so as to avoid formation of air pockets. De-aeration and drain devices shall be provided. Block-out and drilling of holes for pipes and all necessary fastening of pipes, ducts, and other equipment concerning in and touching up shall be included in the offer.

No wood supports shall be embedded in concrete. For piping works care shall be taken to prevent the piping from becoming clogged during the progress of the work and should any pipe become either partially or wholly clogged before acceptance of the work. It shall be cleaned out by the Contractor in a manner satisfactory to the Engineer or otherwise suitably closed when work is suspended for any reason.

(3) Sanitary Appliances

Installation of sanitary appliances shall comply with approved standards of practice and the regulations and standards set by the local Authority. The Contractor shall submit leaflets or

catalogues to determine design and shape of accessories, such as sanitary equipment, valves, etc., All protective paper etc. on the supplies shall be removed as late as possible during installation and the sanitary fittings shall be left in a clean condition.

Sanitary appliances shall be free from all flaws and defects, heavily and evenly glazed, true to pattern, with proper falls to outlets and carefully fixed and secured. Any fittings working loose during the maintenance period or providing defective are to be replaced at the Contractor's expense at completion. Point around sanitary fittings with approved mastic. All sanitary fittings are to be carefully protected against misuse by workmen engaged on the Works and any defective, soiled or broken fittings are to be replaced.

Flexible sheet pipe lagging shall be wrapped round the pipe with an axial but joint and spirally bound with galvanized steel wire. Rigid section pipe lagging shall be fixed with metal clips. Insulation shall generally be fitted in accordance with approved standards.

Special equipment, such as pressure gauges, pressure reduce valves, sight flow gauges, shall be installed in accordance with the manufacturer's directions.

When equipment and fixtures are installed, the Contractor shall install such types of fixing devices as are required to provide for the convenience of the equipment and fixtures. Lavatory brackets, cisterns, etc., shall be sufficiently fixed to the walls, if deemed necessary by the Engineer by bolts going through the wall. All valves shall be installed vertically except where lack of clearance space or where accessibility requires otherwise. Great care shall be taken in setting out and determining the general levels and falls of drainpipes, so that a fall giving a self-cleaning velocity shall be obtained.

(4) Drain Points

Drain points shall be provided at all low points in the paperwork or as indicated on the drawings. Drain points shall be consisting of 15 mm key operated cocks with hose union connector.

(5) Cleaning

(a) General

The Contractor shall carefully clean out all water tanks, service pipes, sanitary fittings throughout, traps and wastes. The Contractor shall also overhaul and make good all flushing valves, check regulating valves, check taps including re-washer as necessary and leave all works in perfectly clean and working condition.

(b) Free from rust

The Contractor shall include for cleaning off and painting piping, fittings and brackets one coat of red lead paint immediately the piping is installed.

(6) Auxiliary Works

Unless otherwise specified, all and any kind of works, materials, services, safety measures, etc., as well, and if so required by the Engineer, all tests and samples required for the completion of the work shall be included in the Contract Price.

Auxiliary works, which even if not specifically mentioned in the Bill of Quantities shall be included in the rate quoted for the respective item. The following works shall, among others, be considered as auxiliary works:

- a. Protection and safety measures as required;
- b. Protection of the executed works and of the item made available for execution of the works from damage and theft till the time of acceptance.
- c. Supply and installation of discharge valve, siphon (tube siphon), angle valves connections include all necessary fixings, etc.
- d. Removal of all contamination (refuse, building rubbish and the like) arising from or in connection with the Contractor's work;
- e. Instructing the operation and maintenance personnel
- f. Supply of simple type pipe coverings, e.g., in the shape of pipe sheathings with corrugated cardboard and the like
- g. Supply and fitting of pipe fastening elements, e.g., pipe clips, hangers, etc.
- h. All form and junction pieces, fittings, adopters, etc.,
- i. All sealing and joining materials,
- j. All valves, drain valves, air valves, surface boxes, etc.,
- k. All concrete thrust blocks and concrete encasement of pipes under works,
- l. All pipeline and valve markers,
- m. All necessary plant and equipment required for laying the pipes,
- n. Transportation, storage and protection against damage
- o. Pressure and leakage testing and all equipment and instruments required therefore,
- p. Disinfecting and rinsing of pipeline.

(7) Underground Pipe Works

All underground pipe work shall be laid in straight lines and to gradients following the general contours of the ground with pipes and specials of the type and diameter shown. They shall fall continuously towards the drain valves and rise to air valves. Pipes of malleable material shall be laid with a light snaking. Pipes shall not be laid in avoidable foul or injurious soil or material. Where pipe laying in foul or injurious soil or material is unavoidable, it shall be protected by the approved method.

All metal pipes other than cast iron laid in ground shall be wrapped with bitumastic tape or other wrapping approved by the Engineer. Water lines if installed in the same trench with sewer or other drainage lines, the width of the trench must be in steps. Potable water line must be installed in the topmost tier. No pipes shall be laid on their collars or on bricks, block, tiles or other temporary supports. If the bottom of the trench has been taken too low it shall be made up with well-rammed fill. Joint holes if necessary shall be formed in the

bottom of the trench ahead of the work in order that joints may be properly made. The joint holes shall be as short as practicable.

Care shall be taken to ensure that the bed on which the pipes are laid and the back filling immediately adjacent to the pipes does not contain any sharp edged stones. All pipes shall be laid on the natural bed of the trench except that in rock bands, boulders, large stones or other irregular hard spots. Pipes installed to the hard spots location, shall be laid on a 75 mm thick bed of crushed stone or gravel, or coarse sand, or sand gravel as it comes from the quarry providing that the maximum size does not exceed 20 mm.

Pipes shall be kept free from sand, mud, debris, superfluous jointing material or obstructions during lay works and until completion of the Contract. Where pipes pass through foundations, wall and floors, they shall pass through sleeves of insert material. Where pipes are carried on piers or are suspended inside buildings, they shall be rigidly fixed so that no movement of the joint can occur when internal pressure is applied to the pipe.

Where PVC or polyethylene (PE) pipes are laid underground, care shall be taken to ensure that the bed on which the pipes are laid and the back filling immediately adjacent to the pipes does not contain any sharp edged stones. PVC or PE drainage lines installed in the ground within buildings shall be laid on a continuous concrete pad and after completion, inspection and testing be fully encased in concrete.

The Contractor shall provide all necessary stoppers, etc., and shall test the drains and pipes in the presence of the Engineer as often as required, by filling them with water (for the water supply pipes under a pressure of 10 kg/sq.cm). Where piping is found to be unsatisfactory in any way, the relevant part of it shall be removed and re-laid at the Contractor's expense. Before covering the pipe work, pressure test must be carried out to be satisfaction of the Engineer.

6808 Quality Assurance/Quality Control (QA/QC)

(1) General

The QA/QC procedures shall include the requirements defined in this specification. All materials shall be supplied and installed in accordance with the relevant standards.

(2) Inspection and Testing

The water mains shall be tested prior to being buried or otherwise covered. The valve jointing the water mains to the main supply shall be closed and the open end of the mains at the water tank stopped with appropriate means. A test pressure of 10 bars shall be applied by means of a booster pump or other approved means. The test pressure shall be held for a period of at least 2 hours and the mains and joints inspected for leaks or defects. All leakage shall be made good and all defective parts replaced such that the system passes the

test to the satisfaction of the Engineer.

When the installation has been completed to the satisfaction of the Engineer, it shall be tested in the following manner.

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

The Contractor shall provide all labour, materials, apparatus and properly calibrated and certified instruments for carrying out necessary tests of his own work. The Engineer shall have access at all time to such parts of the Contractor's work and premises as necessary for the purpose of inspecting, examining and testing the materials, workmanship and performance of plant.

The works shall not be accepted as complete until satisfactory acceptance tests on the functional system have been carried out. The Contractor shall give the Engineer reasonable notice of his intention to carry out the acceptance tests after he has satisfied himself that the installation has progressed sufficiently to this stage.

Supply of test water shall be included in this contract.

(3) Tests

The Contractor shall test all drainage systems and plumbing fixtures and accessories after installation to ensure the proper operation as follows:

(a) For Water Supply Pipes

The hydrostatic test of water supply pipes shall be carried out prior to coating work during piping work or prior to shielding and back filling, or after completion of piping. The minimum pressure retention time shall be two minutes. The test pressure of piping below elevated water tanks shall be twice pressure equivalent to the static head.

(b) For Drainage Pipes

The water filling test of the drainage pipes shall be carried out prior to coating work during piping work or prior to shielding and back filling, or after completion of piping. The water passage test of sanitary drainpipes shall be carried out after sanitary wares, etc. have been attached. The minimum water retention time in case of water filling test shall be 30 minutes or more and that in case of the water passage test shall be 15 minutes or more.

(4) Inspection of Covered Works

Where the Engineer has given notice to the Contractor that any part of the works must be inspected prior to its being covered or hidden the Contractor shall give 7 days notice in writing to the Engineer before such work shall be covered or hidden. Should any such work

be covered or hidden without the written authority of the Engineer the Contractor may be required to uncover the same at his own expense.

(5) Spares and Tools

On completion of testing and commissioning, but prior to the over date of the installation, the Contractor shall provide the following spares and tools.

- a. Duplicate sets of keys to fit each size of lock shield valve, drain cocks and air cock installed.
- b. One set of forged steel spanners to fit all valve glands together with any special tools required for the maintenance of the plant.

(6) Instruction on Operation

At the completion of the works the Contractor shall instruct operation method to the operational person on the site.

The Contractor shall prepare the operating instructions required for the proper and safe operation of all-plumbing and sanitary equipment or parts thereof. The Contractor shall submit these to the Engineer upon acceptance of the plant, together with as-built drawings, schematic diagrams, and descriptions of the installed plant, as well as manufacturer's maintenance instructions.

(7) Submittals

The Contractor shall submit to the Engineer at practical completion of the tests.

- a. Test certificates of factory test.
- b. Test certificates proceeded during installation, viz.: hydraulic and heat tests or any special tests as required.

6809 Measurement and Payment

(1) For Water Supply System

- a. The plant equipment shall consist of the following items.
 - Submersible Water Feed Pumps
 - Submersible Water Supply Pumps
 - Elevated Water tank
 - Water Reservoir
 - Filtration facility
 - Chlorination facility
 - Piping
- b. Measurement for payment shall be based on the progress and number of unit installed as approved by the Engineer.
- c. Payment shall be made under lump sum items of water supply system as each item furnished and installed.

- d. The unit price shall include but not limited to all labour, materials, etc. as required for complete furnishing and installation of work.

(2) For Sewage Treatment System

- a. The plant equipment shall consist of the following items.
 - Septic tank
 - Evaporation pit
 - Piping
- b. Measurement for payment shall be based on the progress and number of unit installed as approved by the Engineer.
- c. Payment shall be made under lump sum items of sewage treatment system as each item furnished and installed.
- d. The unit price shall include but not limited to all labour, materials, etc. as required for complete furnishing and installation of work.

(3) Plumbing Fixtures and others

- a. Measurement for payment shall be based on the number of each type of unit furnished and installed as approved by the Engineer.
- b. Payment shall be made at the contract unit price for each item furnished.
- c. The unit price shall include but not limited to all labour, materials, all piping to main connection headers, all drains, hardware testing, etc. as required for complete furnishing, transporting and installation of work.

(4) Drainage Devices and Pipe Fittings

- a. The following items are included in this close.
 - Floor drains
 - Roof drains
 - Piping
 - Valves
- b. Measurement for payment shall be based on the progress of each item furnished or installed as approved by the Engineer.
- c. Payment shall be made at the Contract unit price per meter or item furnished.
- d. The unit price shall include but not be limited to all labour, material, necessary attachments, testing etc., as required for complete furnishing, transporting and installation of work.

SECTION 6900 VENTILATION AND AIR CONDITIONING WORKS

6901 General

(1) General

This Section shall covers the technical specification for the ventilation and sir-conditioning systems installed in the pump house building.

(2) Scope of Works

This works shall include designing, equipment/material supplying, testing, transport to the site, erection and completion of the systems listed hereinafter.

- a. For Work shop: Wall mounted exhaust fan (400 mm diameter, Q=82 CMM, 0.4 kW)
- b. For Aux. Substation area: Wall mounted exhaust fan (450 mm diameter, Q=96 CMM, 0.4 kW)
- c. For Office, Manager room, and Conference room: Window type air-conditioners (Cooling capacity: 3 kW to 3.5 kW)
- d. For Control room: Air cooled split type sir-conditioners (cooling capacity: 7.8 kW)
- e. For Toilets: Wall mounted exhaust fan (300 mm diameter, Q=20 CMM, 0.05 kW)
- f. For basement floor of the pump house building: Exhaust fans

6902 Applicable Codes and Standards

- a. ADC: Air Diffusion Council
- b. AMCA: Air Moving and Conditioning Association
- c. ANSI: American National Standards Institute
- d. ASTM: American Society for Testing and Materials
- e. ASHRAE: American Society of Heating, Refrigerating and Air-conditioning
- f. ARI: Air-conditioning and Refrigeration Institute
- g. NEFPA: National Fire Protection Association
- h. AWS: American Welding Society
- i. IEC: International Electrotechnical Commission
- j. UL: Underwriter Laboratories Inc.
- k. NEMA: National Electrical Manufacturers

6903 Equipment Requirements

(1) General

The air-conditioning and ventilating systems shall include all materials and installations as described herein and in the relevant Specifications. The Contractor is liable to furnish evidence that his design/construction package will be complete and will comply with the Technical Specifications as set out herein in order to achieve complete operational systems.

All equipment and/or accessories not specifically mentioned in the Specifications, but which are necessary for the proper and normal operation, service or maintenance of the systems, must be included in the design /construct package. The Contractor shall provide and execute such works as a part of the Contract and shall on no account be entitled to any extra payment.

Design calculation and shop drawings of all air-conditioning and ventilation systems shall be submitted to the Employer/Engineer for his review and approval, before the Contractor may begin with procurement fabrication and construction or erection. Different interpretation shall clarified and decided by the Engineer.

(2) Child Water System

(a) Air Cooled Split arrangement

(i) Split Air-cooled Plant Comprises

- a. Evaporator unit for indoor installation
- b. Compressor and condensing unit for outdoor installation
- c. Refrigerant piping for unit connection

(ii) Condenser Unit

The unit shall be placed on the roof or other location where ambient air is available for cooling of the condenser.

(iii) Compressor-Condensing Unit

The unit shall be located in separate plant area, mounted on concrete slab. The unit consists of the compressor, motors, control, panel, fans (air coolers) and refrigerant circuits with all necessary accessories for trouble-free and automatic operation, factory assembled on an integral structural steel base, tested and wired.

The number and capacity of compressors depends on the total required cooling capacity. The compressor shall be of the semi-hermetic, reciprocating type with suction gas cooled motor for part winding start, with ring-type, suction and discharge valves. The compressor must be provided with removable cylinder heads and crank case access opening. The lubrication system includes self-reversing oil-pump, oil-strainers, sight glass and electrical crank case heater. The motor is protected by a winding thermostat and an overload must be mounted on spring anti-vibration isolators fixed to the base frame.

(iv) Evaporator Unit

The evaporator shall be made of welded steel, steel tube plate drilled and reamed to accommodate tubes, smooth seamless copper tubes expanded into the tube plates, draining devices at the bottom. The evaporator must be insulated with flexible, closes-cell polyvinylchloride material. The unit shall be located directly in the rooms to be conditioned.

(v) Refrigerant Circuit and Accessories

All refrigerant pipe work shall be constructed from copper tubing, deoxidized and dehydrated prior to charging. The refrigerant pipes shall be insulated. The circuit shall include at least the following components:

- a. Liquid line shut -off valve
- b. Charging connection
- c. Thermostatic expansion valve
- d. Liquid line solenoid valve
- e. Flexible pipe connections for suction and discharge of the compressor for vibration reduce
- f. Mufflers for noise reduction
- g. Anti-vibration mountings
- h. Armaflex insulation with sheet cladding of 1.0 mm minimum

The refrigerant circuit shall be factory pressure tested evaporated, dehydrated, charged with refrigerant and oil and sealed.

(vi) Control and Starter Panel

All control and motor starter equipment must be mounted in waterproof compartments and factory wired. Separate compartments must be provided for the motor starter and control panel. The panel must be accessible through hinged doors. Starter section contains compressor part-winding starter and overload relay, time delay relay, pump down relay and terminal, power fuse breaker with pre-cut contact and contact against single phase working. The control panel shall contain all necessary safety, supervision and control devices for automatic operation as:

- a. High and low pressure and oil pressure safety switches for each refrigerant circuit
- b. High pressure gauges for each refrigerant circuit
- c. Potential-free contacts for air-cooled condenser control
- d. Motor overload reset push button
- e. Indication lamps for each compressor and power supply
- f. Potential-free contacts for remote operation command and indication for each compressor

(vii) Direct Expansion Cooling Coil

Air-cooler for direct expansion made of seamless copper tubes mechanically expanded to fix copper fins, fully tin-plated, thermostatically control expansion valve and drip pan. The air-cooler shall be pressure tested with 16 bar. The cooler shall be equipped with an installation frame made of stainless steel.

The frame construction shall be designed in consideration of the thermal expansion of the heat exchanger using a slide track within the mounting frame to compensate the expansion effect. In case of outside air cooling, the air-cooler shall be designed in consideration of full load operation under most unfavorable ambient conditions, as specified.

(3) Fans

(a) Axial Fan

All axial fans shall be designed and constructed in consideration of all possible operating, start-up and shut-down conditions under all foreseeable ambient conditions and as well the maximum absorbed load the fan can generate in the adjustment of the impeller blades at the rated speed, and consisting of a cylindrical casing made of continuously welded sheet steel, reinforced and stiffened with connecting flanges.

All axial fans shall be included a direct driven impeller with profiled aero-foils for high tenuously adjustable at stoppage, and completely made of silumin alloy statically and dynamically balanced, including a vaned diffuser with radial arranged discharge vanes for high efficiency, made of continuously welded sheet steel, and combined with flexible and non-rottable canvas connections, spring or rubber vibration mountings, an electrical motor designed for maximum power consumption of the fan's characteristic curve, there immediate starts one after another, and a minimum of 10 % power reserve.

And also it shall be included a separate water-tight and dust roof terminal box fastened to the outside of the fan casing and connected with the motor terminal box by a cable with outside protection tube, and completed with an intake-air cone, combined with a wire-mesh, as specified.

(4) Duct Works

(a) Materials

All duct materials shall be in accordance with the following.

Description	Material	Size	Material Specification	Coating Designation
Sheet	Galvanized Steel	1.5 mm thick and lighter 1.9 mm thick and heavier	ASTM A527 ASTM A526	ASTM A525 G-120
Stiffeners, Hanger and Support	Carbon Steel, Hot Dipped Galvanized	60 X 60 X 6 mm and smaller 75 x 75 x 6 mm and larger	ASTM A575, Grade M-1020 ASTM A36	ASTM A123
Bolts	Galvanized Steel	All	ASTM A307	ASTM A153 Class D, Commercial Coating
Rivets	Galvanized Steel	All	ASTM A152	
Sheet Metal Screws	Galvanized Steel	All	ASTM A548 Screws	

(b) Galvanized Steel Duct Construction

(i) Rectangular Ducts (all applications)

- a. All galvanized steel rectangular ductwork shall be constructed of the thickness and with stiffeners as given in the following table.

Largest Duct Dimension, (mm)	Minimum Thickness	Angle Stiffeners or Hangers at Point of Support	
		Minimum Size, (mm)	Minimum Spacing, (mm)
Up to 600	0.76 mm	25 x 25 x 3	1200
625 to 900	0.90 mm	40 x 40 x 4	900
Plenum	1.90 mm or as specified	50 x 50 x 5 or as specified	600 or as specified

b. Seams and joints

Longitudinal seams for ducts less than 1.5 mm thick shall be double-locked, groove type. Ducts 1.6 mm thick and heavier shall have welded longitudinal seams. Any seams prepared in the field must meet design and quality standards of shop prepared seams.

Duct 1.2 mm thick and heavier shall have companion angle flanged joints with sealant or gasket. Duct shall be formed over angle flanges such that the two duct surfaces with gasket form the seal. Flanges shall be the same size as angle stiffeners, but not less than 40 x 40 x 3 mm, or the size of the hanger angle, if the hanger is used for the joint flange. Flanges shall be 25 mm stitch-welded over flange, angles shall be seal welded to the duct. Flanges shall be bolted together with 10 mm diameter bolts on not less than 150 mm centers.

- c. The Contractor shall provide stiffeners and reinforcements, so that the ducts will be free from excessive deflection, vibration, or noise. Additional stiffeners shall be provided without charge if in the opinion of the Engineer, they are required to eliminate excessive deflection, vibration or noise. Angle iron stiffeners shall be 25 mm stitch-welded to the ductwork on not greater than 225 mm centers.

d. Hangers and Supporting Systems:

Rectangular ducts shall be supported on not less than 2.5 m intervals. Hangers and supports shall be angle iron of size not less than that used for duct stiffening. The use of straphangers will not be permitted. Contractor shall furnish and install all hangers, supports, and braces as required for the entire duct systems and do all necessary bolting and welding for such hangers and supports. The most suitable location for each hanger or support, and the use of available supporting structures shall be determined by the Contractor at the site.

Transverse welding across flanges will not be permitted. Any additional structural steel members not in place, which may be necessary to properly hang and support the

duct systems, shall be furnished and installed by Contractor. Ducts shall be supported with hangers to suit the construction in accordance with the SMACNA High Velocity Duct Standards.

(c) Penetration Seals

All sealant and gaskets utilized by Contractor shall be suitable for the respective location and environment to which the sealant materials will be subjected. The Contractor shall furnish and install galvanized flashing on all insulated vertical risers, penetrating floors.

(d) Flexible Connections

Connections between the ductwork and vibrating equipment, such as fans and air handling units, shall be made with flexible material.

(e) Grilles and Diffusers

Supply and Return Grilles:

Supply and return grilles shall be provided for air distribution systems installed visibly in plant rooms, etc. as specified. All supply and return grilles shall be designed with regard to high induction and low noise level. All supply and return air grilles shall comprise a front section consisting of a frame with individual adjustable aero-foil blades and made of pre-phosphates sheet steel with stove enameled finish, including rear built-in flow regulating device, made of common adjustable and contra-rotating coupled blades or adjustable baffle plate. Supply air grilles shall be equipped with vertical front blades, additional rear built-in horizontal blades, and individual adjustable and contra-rotating flow regulating device. Return air grilles shall be equipped with horizontal front blades and baffle flow regulating device. Supply and return air grilles made of rigid PVC shall be designed likewise.

6904 Testing and Functional Guarantees

The work shall be tested, adjusted and balanced to Engineer complete satisfaction prior to acceptance. In service testing shall be performed by Contractor in accordance with the intent and requirements of this specification. Any deficiencies brought out during testing and the Contractor at no expense shall promptly remedy balancing.

Contractor shall provide experienced personnel, including all crafts, to assist for whatever periods required by job conditions, in the preliminary testing and starting of all operating equipment installed by Contractor. Throughout erection and during testing, Engineer will carefully inspect the equipment. The Contractor's general superintendent, together with such additional men as may be required, shall remain at the site of the Work, until Contractor has placed the equipment in complete operation.

Contractor shall do any modifications, changes, adjustments or corrections, which may be necessary in the opinion of the Engineer. This corrective work shall relate only to corrections of erection defects based upon the original design of the equipment and shall be done without additional cost.

6905 Electrical Requirements

The ventilation and air-conditioning (VAC) electrical motor and control equipment and installation shall comply with the requirements of Technical Electrical Motor Specifications. The Contractor shall provide a local control panel for air conditioning units at the each respective building. The control panel shall have a "Hand-Off-Auto" selector switch and associated indicating lights for each air-conditioning unit.

When in Auto position the operating units shall be controlled by the thermostat. An alarm shall be annunciated at the Air conditioning Control Panel should one of the operating units fail. The ventilating fans for electrical equipment rooms shall be provided with locally mounted control stations. Each control station shall have an On-Off switch and indicating lights for fan operating status and clogged or dirty filter. The fan failure and clogged filter shall be annunciated at the Air Conditioning Control Panel.

Enclosures for local control stations shall meet the requirements of IP 55 as defined by IEC 529.

Group fault annunciation of air conditioning and ventilating fans shall be provided at the Air Conditioning Control Panel.

6906 Measurement and Payment

Measurement and payment for ventilation and air-conditioning works shall be based on the number of ventilation and air-conditioning equipment provided include all wall openings, penetrations, ducts and electrical facilities or the works.