SECTION K - WATER SUPPLY PLUMBING, SANITARY AND RAINWATER GOODS INSTALLATION

1. Water Supply Plumbing

1.1 General

1.1.1 The whole of the water supply plumbing and installation shall be executed by a licensed plumber having valid and relevant license issued by the relevant state water authority. The Contractor shall at his own cost be responsible for employing the licensed plumber, and shall be responsible for all the work performed by the licensed plumber.

1.1.2 All water supply plumbing and installation shall be executed in accordance with the relevant state water supply rules and to the approval of the state water authority, notwithstanding any approval given by the S.O.

1.1.3 All pipes, fittings and equipment used for water supply plumbing and installation shall be of the type and make approved by the relevant state water authority.

1.2 Pipework

1.2.1 Pipework for water supply plumbing shall be to the dimensions shown or as specified hereinafter and shall be complete with all bends, tees, sockets, plugs, reducers, brackets, supports and everything else necessary to complete the installation.

1.2.2 Unless otherwise shown or stated in the Drawings, the unplasticed polyvinyl chloride (uPVC) pipes and fittings used in cold water supply pipework in distribution pipes above ground, below ground or concealed, shall be executed in approved Class 7 of MS 762 for sizes 50mm and below. For sizes greater than 50mm, a minimum pressure rating of approved Class ‘E’ of MS 628 (PN 15) (equivalent to 12 bar derated at 30oC) shall be used. Both Class 7 of MS 762 and Class ‘E’ of MS 628 uPVC pipes and fittings shall comply with BS 6920 or MS1583 on their effects on drinking water quality. Solvent cement used for both types of pipes and fittings shall be approved in accordance with MS 628. All uPVC pipes, fittings and solvent cement shall be supplied by the same manufacturers.

1.2.3 Where polyethylene (PE) pipe is shown or stated in the Drawings, the PE pipes and fittings used in cold water supply pipework in distribution pipes above ground, below ground or concealed, unless otherwise stated or shown in the Drawings, shall have a minimum wall thickness and pressure rating of PN 12.5 at 20oC (equivalent to 10 Bar derated working pressure at 30oC) and manufactured to MS 1058 or EN 12201. All PE pipes used shall be marked with SIRIM certification numbers. All metal fittings moulded integrally shall be dezincified brass with BSP threads to CZ132 of BS 2872 or BS 2874 and Nickel & Chromium plated to BS 1224, service condition No. 2, classification number Cu/Ni 10b Crr.

1.2.4 Where Acrylonitrile Butadiene Styrene (ABS) pipe (for cold water applications only) is stated or shown, ABS pipes and fittings used in the water supply pipework in distribution pipes above ground, below ground or concealed, unless otherwise stated or shown in the drawing, shall have a minimum wall thickness

and pressure rating of class 9 to MS 1419 or PN 10 to EN 15493.

1.2.5 Where polybutylene (PB) pipe (for cold and hot water applications) is stated or shown, PB pipes and fittings used in the water supply pipework in distribution pipes above ground, below ground or concealed, unless otherwise shown or stated in the Drawings, shall have a minimum wall thickness and pressure rating of PN 12.5 at 20oC (equivalent to 10 Bar derated working pressure at 30oC) and manufactured to EN 12319 or AS/NZS 2642. All metal fittings (in contact with water) moulded integrally shall be dezincified brass with BSP threads to CZ132 of BS 2872 or BS 2874 and Nickel & Chromium plated to BS 1224, service condition No.2, classification number Cu/Ni 10b Crr.

1.2.6 Where polypropylene random co-polymer (PP-R) Type 3 pipe and fitting (for cold and hot water applications) is stated or shown, PP-R Type 3 pipes and fittings used in the water supply pipework in distribution pipes above ground, below ground or concealed, unless otherwise shown or stated in the Drawings, shall have a minimum wall thickness and pressure rating of PN 16 or SDR 7.4 at 20oC, designed for 10 Bar working pressure at 60oC for a minimum operational life of 50 years and manufactured to DIN 8077, DIN 8078 and DIN 16962 Part 58. All metal fittings moulded integrally shall be dezincified brass with BSP threads to CZ132 of BS 2872 or BS 2874 and Nickel & Chromium plated to BS 1224, service condition No. 2, classification number Cu/Ni 10b Crr. The minimum wall thickness and pressure rating for cold water system, unless otherwise stated or shown in the Drawings is PN 10 or SDR 11 according to DIN 8077.

1.2.7 Where stainless steel pipe (suitable for cold and hot water) is stated or shown, all service pipes, pump delivery pipe works, plumbing works below and above ground level shall be welded austenitic stainless steel pipes (using Schedule 40S pipes for sizes ranging ½" to 2" diameter and threaded, and Schedule 10S pipes for 2" to 8" Diameter pipes by way of welding) manufactured according to ASTM A312/A312M together with stainless steel butt-welding fittings manufactured according to ASTM A403/A403M or stainless steel screwed fittings manufactured according to ASTM A351/A351M.

However for pipe work in plumbing above ground level (which include service pipes, pump delivery pipe works), as an option, stainless steel tubes manufactured according to BS4127 specification for light gauge stainless steel tube, primarily for water application, may be used. It shall be made of stainless steel material grade 304 S15 of BS 1449 Part 2. Compression fittings and capillary fittings made in accordance with the following standards shall be used with stainless steel tubes conforming to BS 4127:

(i) Copper alloy to BS 864
(ii) Stainless steel to BS 4368 or ISO 8434

1.2.8 Where copper pipe is shown, it shall be to BS EN 1057. Fittings to be used for joining copper pipe shall be to BS 864.

1.2.9 Unless otherwise shown or stated in the Drawings, service pipes and distribution pipes except those buried under ground level, shall be concealed. The Contractor shall execute the work in such a manner so as to avoid cutting into finished work in walls, aprons, beams, etc. where practicable as the work proceeds. Pipework to be buried or concealed shall not be covered or plastered before they are examined, tested and approved by the state water authority, notwithstanding any approval given by the S.O.

1.2.10 Unless otherwise shown or stated in the Drawings, final branches to fittings shall be 12mm diameters and the sizes of feeders from which these branches are taken shall be as follows: -

No. of Fittings Served	Diameter of Feeders
1	12mm
2	20mm
3, 4	25mm
5, 6, 7	30mm
8, 9,10,11,12	40mm
13, 14, 15,16,17,18	50mm

1.2.11 The installation and construction of all pipework to storage tanks shall be carried in such a manner that where necessary, flexible rubber joints of approved standards shall be used for connection next to the panel to avoid stress. Mechanical joints shall also be used for connection between the flexible rubber joints and the pipework.

1.2.12 Flange joints (nozzles) used for the inlet, outlet and scour of storage tanks shall be made of hot dipped galvanised mild steel externally and stainless steel grade 304 or polymeric coated hot-dipped galvanised mild steel internally. Joint gaskets shall be of 5mm thick, medium rubber reinforced with two-ply flexible fabric and complying with BS 5292, or approved silica sealant used in the Glass Reinforced Polyester Panel (GRP) tanks. All bolts, nuts and washers used for flange nozzles shall be made of stainless steel grade 304 or polymeric coated hot-dipped galvanised mild steel.

1.2.13 The Contractor shall provide all the necessary flexible rubber joints and mechanical joints for the proper installation and construction of the pipework to the tank.

1.3 Storage Tank

1.3.1 Storage tank for water supply shall be of the type and capacity shown or stated in the Drawings. The storage tank shall be watertight and properly supported. The storage tank shall be provided with dust and mosquito-proof cover. The cover shall be so constructed that it shall not be airtight. The storage tank shall be provided with a high pressure ball valve to BS 1212 on the inlet and of the same size as inlet pipe. Overflow/ warning pipe, scour pipe and outlet tapping shall be in accordance with the relevant state water supply rules. The scour and overflow/warning pipe shall discharge outside the building or to a point shown or stated in the Drawings.

1.3.2 Storage tanks of pressed steel sections shall be of approved type and shall comply with BS 1564 and shall be hot-dipped galvanised to MS 740.
Either one of the following liner systems is acceptable:

(A) Hot-dipped Galvanised Pressed Steel Tank With HDPE Liner
The internal surfaces of the storage tank shall be lined with an approved non-toxic potable water quality grade high density polyethylene (HDPE) liner of minimum thickness of 2 mm. All internal cleats and bracings to tank plates, bolts, nuts, washers and internal ladders shall be of

stainless steel grade 304 or polymeric coated (cold-applied epoxy AWWA C210 or equivalent) hot-dipped galvanised mild steel. Roof covers and trusses to tank shall be fully hot-dipped galvanised mild steel and polymeric coated internally.

(B) Hot-dipped Galvanised Pressed Steel Tank With Epoxy Resin Liner
The internal surfaces of the storage tank together with the roof covers and trusses shall be treated with a suitable etch primer before applying 2 coats of solvent free, high solid epoxy resin with an approved nontoxic potable water certificate. The overall film thickness shall be not less than 500 microns. All internal cleats and bracings to tank plates, bolts, nuts, washers and internal ladders shall be of stainless steel grade 304.

Application requirement for Epoxy Resin Liner:

i) The new galvanised pressed steel shall be cleaned with a suitable degreaser to remove grease and other contaminates. The Etch Primer shall be applied by airless spray at a dry film thickness of 15-20 microns. The 2 part epoxy resin liner must be thoroughly mixed at the prescribed ratio with each coat giving a dry film of average 250 microns. Precaution must be taken to prevent contamination between coats.

ii) The minimum bond strength of the coating shall be 1.5 N/mm2 to be determined by using an Elcometer adhesion testing machine. The testing requirement is one (1) pull-off test per every 100 m2 of tank lining and one (1) pull-off test for tank lining less than 100 m2

Any damage to the coating shall be rectified by following the original method statement. For both the liner systems, beads of non-toxic elastomeric sealant shall be applied to cover all gasket joints. All external bolts, nuts and washers to tank plates, tank support, steel I beams and external ladders shall be hot-dipped galvanised mild steel.

The Contractor shall provide the tank manufacturer's guarantee for the new hot-dipped galvanised pressed steel water tank with any one of the above liner systems for a period of ten (10) years from the date of completion against leakages and all manufacturing, installation and liner's defects.

1.3.3 Storage tanks of stainless steel shall be of approved type and shall be made of stainless steel grade 304 and manufactured to JKR Standard Specification for Stainless Steel Water Tanks No.20200-0041-99.

1.3.4 Storage tanks of fibre glass (FRP) shall be of approved type and shall comply with MS 1241.

1.3.5 Storage tanks of high density polyethylene (HDPE) shall be of approved type and shall comply with MS 1225.

1.3.6 Storage tanks of glass reinforced polyester (GRP) panels shall be of approved type and shall comply with MS 1390.

1.4 Tank Components and Accessories

Unless otherwise shown or stated in the Drawings, the installation of storage tanks shall include the provision and installation of the following accessories and fittings to the tanks:

i) Openings for piping connection for inlet, outlet, overflow and drainage pipe connections with positions approved by the S.O.

ii) Access manholes with cover, the number, locations and details of which shall be approved by S.O.

iii) Air vents to the tank cover at the positions and as per details approved by the S.O.

iv) Water tanks of two metres depth or more shall be provided with internal and external ladders. The internal ladder shall be made of aluminium or of stainless steel grade 304 or polymeric coated (cold-applied epoxy AWWA C210: 1994 or equivalent) hot-dipped galvanised mild steel. The external ladder shall be made of hot dipped galvanised mild steel in accordance with MS 740. The ladder width shall not be less than 300 mm and the length shall be suitable for the tank specified.

v) Suitable type water level indicators and scales graduated in metres to suit the depth of the panel tank.

vi) All internal cleats and bracings to tank plates, bolts, nuts, washers in contact with water shall be of stainless steel grade 304 or polymeric coated (cold-applied epoxy AWWA C210 or equivalent) hot-dipped galvanised mild steel. All external bolts, nuts and washers shall be of hot dipped galvanised steel. The diameter of all bolts in accordance with BS 4190, shall not be less than 10 mm.

vii) Sealing material shall be nontoxic and chemically resistant to the water stored. The sealants shall also be able to withstand the prevailing environmental conditions during service.

viii) The internal supports and reinforcement members for the panels shall be chemically resistant to the water stored. They shall be made of stainless steel. The exterior reinforcement metal parts shall be fabricated from hot dipped galvanised mild steel.

ix) The exterior of the water storage tanks for the purpose of firefighting shall be painted as required by Jabatan Bomba dan Penyelamat.

1.5 Storage Tank Foundation

i) Unless otherwise shown in the Drawings, the Contractor shall construct foundations to provide continuous support to all base panel joints in one direction at 1000 mm nominal centres according to panel size. The concrete foundation shall have a width of at least 300 mm and height of at least 500 mm.

ii) If continuous foundations are used, dwarf walls or steel beams shall be placed between the tank and the base level to allow a minimum clearance of 500 mm to enable ease of tank installation and subsequent bolts tightening and adjustments after installation.

iii) Whenever recommended by the tank manufacturer, the steel skid base shall be designed and constructed in accordance with the manufacturer's instructions,

details and BS 5950 or equivalent. In such cases, the continuous support can be spaced at greater than 1000mm nominal centres as recommended by the manufacturer.

iv) The steel skid base shall be joined by welding neatly and uniformly flushed with each other to enable the base of tank plate to be placed and sit properly on the skid base. Uneven surfaces of the skid base will be rejected. The skid base shall be rust free.

1.6 Stop Valves

1.6.1 High pressure full way brass screw-down stop valves of the same diameter as the pipe shall be provided and fixed for control in the following positions:

i) On the service pipe before it enters the building.
ii) On each branch of the service pipe.
iii) On the inlet to each storage or feed cistern.
iv) On the inlet to each flushing cistern.
v) On the outlet of each storage or feed cistern.
vi) In other positions on the pipe as shown or indicated, other than on overflow/warning pipe.

1.6.2 All stop valves shall be of the type approved and complied with MS 1022.

1.7 Examination, Test and Approval of Water Supply Plumbing

1.7.1 On completion of all the water supply plumbing and fittings installation, the Contractor shall notify the relevant state water authority that they are ready for examination and test and the Contractor shall carry out the test as required by the state water authority.

1.7.2 Test for water tightness and chlorination of storage tank

i) After completion, the tank shall be filled with water to the maximum operating capacity level and the level of water surfaces shall be fully recorded. The tank shall be accepted as satisfactory if after a period of 48 hours there is:

a) No measurable reduction in water level, due allowance being made for evaporation.

b) No visible signs of leakage from any parts of the tank and

c) No deformation of any part of the structure.

ii) If the test results do not satisfy the above conditions of tests, the Contractor shall proceed to locate and rectify all defects and leakages and the test shall be repeated as often as necessary until the structure satisfies the stipulated conditions. The Contractor shall bear all costs and expenses for all tests and remedial works.

iii) On completion of the water tightness test, the Contractor is required to chlorinate the water in the tank to the satisfaction of the S.O.

1.7.3 Testing of Pipework

i) The testing of pipework shall be carried out before the pipework are covered up or plastered.

ii) The Contractor shall at his own cost provide complete plant, including portable hydraulic pumps, blank flanges, "test-end" units fitted with caps or plugs, pressure gauges, all pipe connections and other fittings necessary for the testing of the pipework. All pipes attached to the tank shall be tested to the maximum head which they will attain under normal operating conditions. Only a closed end test shall be required for the valves.

iii) Pressure Testing

When a pressure test is carried out, it may be necessary to disconnect and cap the water service to isolate it from the water main, fixtures and appliances which may be damaged by the test pressure.

a) For Plastic Pipes (uPVC pipes, PE pipes, ABS pipes, PB pipes, PPR-R Type 3 pipes etc), the pipework shall be filled with water and the system shall be charged to a hydrostatic pressure of 15 bar at embient temperature 27 ± 2oC.

For accurate testing, the installation must be filled slowly and be fully ventilated. Calibrated measurement devices, which show pressure changes in steps of 0.1 bar, shall be used for the test. It shall be noted that a temperature change of 10oC causes a pressure change of up to 2 bar, depending on the size of the system.

The pressure test shall be carried out in two stages: i.e. a preliminary test and a main test.

Pressure Testing may take place
• for compression joint, immediately after the last joint has been made.
• for fusion joint, no earlier than 1 hour after the last fusion joint.
• for solvent weld joint, no earlier than 24 hours after the last joint made.

Preliminary test:

The duration of the preliminary test depends on the size of the system, but usually requires about one hour and includes the following activities.

1) Measurement devices shall be installed at the lowest point of the piping system, if possible.
2) The piping system shall be filled with potable water, thoroughly ventilated and separated from the mains supply.
3) Increase pressure with a pressure pump to 15 bar (a) (refer to Pressure Test Diagram in Appendix K/2-1 and Log Sheet in Appendix K/2-2.)

4) Repeat pumping back up to 15 bar, 2 more times over the next 30 minutes (b) at an interval of 10 minutes.
5) After a testing period of another 30 minutes, the test pressure shall not have decreased by more than 0.6 bar (c).
The preliminary test is considered successfully completed when there are no leaks and the pressure drop in the last half hour of the preliminary test does not exceed 0.6 bar.
Main test:
6) The main test shall be carried out immediately following the preliminary test. Its duration is two (2) hours. The test pressure after the preliminary test at point (c) shall be recorded.
7) The main test is considered successfully completed, if the test pressure does not drop more than 0.2 bar (d) from the beginning of the main test and if no leakage is detected.
If the pressure drop is more than 0.2 bar during the main test, then the whole test must be repeated. There must not be any leakage in the system.
The results of the pressure test shall be recorded on a log sheet (see Appendix K/2-2). The test shall be accepted as satisfactory if there are no signs of leakage and pressure drops within the acceptable tolerances in the system. The Contractor shall make good all leakages, replace any defective parts and retest the whole system all at his own expense to the approval of the state water authority.

b) For Metal Pipes (stainless steel pipes, copper pipes etc), the pipework shall be filled with water and the system shall be charged to a hydrostatic pressure of 15 bar and maintained for a period of not less than 30 minutes. The results of the pressure test shall be recorded on a log sheet (see Appendix K/2-2). The test shall be accepted as satisfactory if there are no signs of leakage and pressure drop in the system. The Contractor shall make good all leakages, replace any defective parts and retest the whole system to the approval of the state water authority all at his own expense.

1.7.4 The Contractor shall obtain a written certification from the relevant state water authority to prove that the examination and test have been satisfactorily concluded. Where the installation is proven to be unsatisfactory, the Contractor shall rectify the works in accordance with written notice of the state water authority all at his own expense. The repair or replacement of a faulty pipe or fitting shall be reported by the Contractor to the relevant state water authority within one week.

1.8 Meter Chamber

Where meter chambers are required, these shall be to the details shown in the Drawings. Unless otherwise shown or stated in the Drawings, connection to the meter, supply of meters and all communication pipes up to the meter point shall be done by the relevant state water authority.

2. Sanitary Installation

2.1 Fittings

2.1.1 Unless otherwise shown or specified in the Drawings, all fittings including all necessary brackets and accessories shall be as scheduled in Appendix K/1 hereinafter. The Contractor shall be responsible for determining the type of trap required for each fitting. All necessary concrete backing shall be provided to fittings secured to floors.

2.1.2 Vanity Top

Where shown in the Drawings, vanity tops of approved manufacture and colour shall be installed in accordance with the manufacturer's instructions. It shall be moulded as one solid piece with it's top sloping gently towards the wash hand basin and having a slight upturn or kerb as it's outer edges. It shall be manufactured from non-porous composite product composed of polyester resin and calcium carbonate marble dust with the permanence of stone and an aesthetic appeal of natural marble or granite. The slab surface shall have a glossy finish, and protected by suitable polymer to ensure durability and impermeability. It shall be stain and chemical resistant, and UV stabilised.

2.2 Water Supply Plumbing for Low Pressure W/C Flush Valve and Low Pressure W/C Flushing Cistern

2.2.1 Plumbing for Low Pressure W/C Flush Valve
A separate internal plumbing system shall be provided for low pressure w/c flush valves to have adequate dynamic pressure and flow, to ensure effective operation of each flush valve, i.e. for hydraulics of water closet to function properly, as shown in Appendix K/3.

Alternatively water supply to flush valves for w/c pan shall be derived from a feeder tank which is isolated from the potable water supply main and is not connected in any way with all other fittings serving to basins, sinks, heaters etc. in the building.

The following requirement for each low pressure w/c flush valve as in Table A1 shall be followed in the design of internal plumbing for flush valve system.

Table A1 – Low Pressure W/C Flush Valve

Requirement	**W/C Flush Valve**
a) Dynamic/ operating head at the inlet of flush valve	3.25 m
b) Flow rate	1.8 litres/ sec

2.2.2 Plumbing for Low Pressure W/C Flushing Cistern

An internal plumbing system shall be provided for low pressure w/c flushing cistern, w/c taps, taps for toilet wash hand basins and urinal flush valves as shown in Appendix K/4.

The following requirement for each low pressure w/c cistern, urinal cistern and

urinal flush valve as in Table A2 shall be followed in the design of internal plumbing.

Table A2: Low Pressure W/C Cistern, Urinal Cistern and Urinal Flush Valve

Requirement Low Pressure	W/C Cistern	Urinal Cistern	Urinal FlushValve
a) Dynamic/ operating head at the inlet of cistern/ valv	3.2 m	2.0m	2.0m
b) Flow rate	0.1 litres/ sec	0.1 litres/ sec	0.1 litres/ sec

2.2.3 Materials for Pipes, Fittings and Isolating Valves In Pipeworks

a) Pipes and Fittings For Internal Plumbing, Concealed and Buried Pipework

Pipework for water supply plumbing shall be to the dimensions shown or as specified in the Drawings and shall be complete with all bends, tees, sockets, plugs, reducers, brackets, supports and everything else necessary to complete the installation. All the pipes and fittings mentioned in clause 1.2 are suitable for internal plumbing. Galvanised iron pipes and fittings shall not be used for internal plumbing.

b) Pipes and Fittings for Exposed External Pipework
ASTM A312 Schedule 40S stainless steel pipes and ASTM A351 stainless steel pipe fittings or BS 143 & 1256 brass threaded fittings for external pipework shall be used. High strength composite plastic/ metal pipes and fittings may be allowed with the S.O's approval. Galvanised iron pipes and fittings shall not be used for external pipework.

c) Isolation Valves for Internal Plumbing and External Pipework
Valves used for isolating the water supply system shall be of approved full bore brass gate valves (BS5154) or Type B ductile iron gate valves (JKR Standard Specification 20200-0083-00), brass ball valves (BS 6675:1986 or BS 1552:1995) shall be used. All fittings used shall be made of brass, stainless steel or other approved non-corrodible material. Stop valves (stop cocks with reduced flow areas) shall not be used for external pipework and internal plumbing systems for w/c flush valves and flushing cistern.

2.2.4 Operating/ Dynamic Pressure More Than 30 Metres

Unless otherwise instructed by the S.O, air vents and pressure reducing valves of approved type (JKR Standard Specification 20200-0114-01), shall be installed at 30 meters intervals along downpipes in order to restrict the pressure sustained by the fittings to prevent water hammer and other effects.

2.3 uPVC Soil, Waste and Vent Pipes

2.3.1 Unless otherwise shown or specified in the Drawings, approved uPVC soil, waste and vent pipes shall be provided.

2.3.2 uPVC pipes shall conform to MS 978 and MS 1063. The pipes shall be provided,

fixed and connected to fittings and sanitary installation complete with all necessary bends, tees, sockets, branches, offsets, inspection pieces, hopper heads, holder bats etc. Pipes shall be joined with approved solvent cement in accordance with the manufacturer's instructions.

2.3.3 Expansion joints (expansion couplings for uPVC pipes)
Where pipework is constructed using solvent welded joints, expansion joints shall be provided to compensate for the linear thermal expansion of uPVC pipes which have a coefficient of linear expansion of 7x10-5 mm/mmoC(e.g. for a difference of 10 oC, linear expansion of 3 m length uPVC pipe =10 x 3000x 7x 10-5 =2.1mm). Expansion joints must not be placed below ground level. All expansion joints shall be installed with the proper fittings in accordance with the manufacturer’s instructions.

2.3.3.1 Expansion joints shall be provided at a maximum spacing of 6 meters for cold water pipelines and 4 meters for hot water pipelines (e.g. kitchen or etc.) or wherever specified

2.3.3.2 The permissible maximum length of pipelines between fixed points without an expansion joint or provision for movement is 2 meters for cold water pipelines and 1 meter for hot water pipelines. A fixed point is one at which longitudinal movement of the pipe or fitting is restrained.

2.3.3.3 An expansion joint shall be constructed with a device or a definite means to ensure the provision of the desired gap for thermal expansion between the two pipes during installation.

2.3.3.4 Any expansion joint provided shall incorporate a permanent shield to provide protection to the sliding surfaces and rubber ring seal from ingression of dust particles.