JKR 20500-0010-10

KERAJAAN MALAYSIA
JABATAN KERJA RAYA

SPESIFIKASI TEKNIKAL PIAWAI

SISTEM BEKALAN AIR SEJUK DALAMAN DAN PERPAIPAN SANITARI

CAWANGAN KEJURUTERAAN MEKANIKAL,
IBU PEJABAT JKR MALAYSIA,
CENTREPOINT NORTH,
THE BOULEVARD MID VALLEY CITY,
LINGKARAN SYED PUTRA,
59200 KUALA LUMPUR.

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1.0 SCOPE OF WORK

The work to be performed under this contract shall comprise, but not limited to the supply, delivery, installation, testing and commissioning and maintenance of the following principal services and the associated minors works and items:

a) Internal Cold Water System

i) Internal Piping system complete with all bends, tees, sockets, valves, plugs, reducers, brackets, supports and other necessary accessories to complete the installation.

ii) Water Tank (Suction and Storage Tank)

iii) Booster Pumps and/or Hydro pneumatic pump (if applicable)

b) Internal Sanitary Plumbing System

i) Internal piping complete with all necessary bends, tees, sockets, branches, offsets, and other necessary accessories to complete the installation.

ii) Internal inspection chamber, gully trap and grease trap.

iii) Pump sump complete with submersible pump (if applicable).

The Contractor shall prepare and submit working drawings to the S.O for approval within thirty (30) days from the date of acceptance of tender. In preparing these working drawings, the Contractor shall coordinate with the building layout and constructional details of the architectural, structural and electrical drawings.

The drawing shall be fully dimensioned and show all the precise locations, arrangement and loading of the equipment. The drawings shall also indicate location and details of all foundation, supports, chases, core holes, opening in partitions wall, floors and roof and any other information required for works or services to be provided by others.

The drawings submitted shall be modified as necessary and, if requested by S.O., re-submitted for final approval. Six (6) sets of drawings shall then be submitted for distribution to all parties concerned.

The Contractor shall also be responsible for co-ordination with Licensed Plumber during construction work.

The contractor shall submit samples of materials or execute samples of workmanship (mock-up) for S.O approval, and for further samples as required until the samples submitted or executed are, in accordance with this specification. Samples, after approval, shall indicate the standard of materials and workmanship to be maintained in the execution of the works.

The bursting test for pipe shall be carried out according to pipe's nominal pressure (PN) at the factory prior to installation.

After connection work is done, the Contractor shall ensure that all system to be tested, commissioned and operated as required.

The Contractor shall service and maintain the above-mentioned cold water and sanitary plumbing system during Defect Liability Period (DLP) from the date of Certificate of Practical Completion (CPC) in good operating condition until Certificate of Making Good Defect (CMGD).

The Contractor shall submit the as-built drawing, operation and maintenance manual (OMM) complete with Schedule of Maintenance before handing over.

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1.1 INTERNAL COLD WATER SUPPLY SYSTEM

1.1.1 GENERAL

The whole of the water supply plumbing and installation shall be executed by a licensed plumber with valid and relevant license issued by relevant state water authority / Suruhanjaya Perkhidmatan Air Negara (SPAN). The contractor shall at his own cost be responsible for employing the licensed plumber, and shall be responsible for all work performed by the licensed plumber.

The contractor shall at his own cost be responsible to appoint qualified person who are recognized by SPAN for the submission, supervision, construction and certification of the completed works.

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 / SPAN notwithstanding any approval given by the S.O.

The Contractor shall submit method statement of installation recommended by manufacturer.

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 / SPAN / S.O.

The standards stated in this specification shall comply with their latest edition issued or relevant standards approved by SPAN.

1.1.2 PIPEWORK (MATERIAL PIPES STANDARDS)

1.1.2.1 General

Pipe work for water supply plumbing shall be to the dimensions shown in the Tender Drawings or as specified hereinafter and shall be complete with all bends, tees, sockets, plugs, reducers, brackets, supports and other accessories to complete the installation.

1.1.2.2 Standards

The following standards in their latest edition shall apply:-

Item	Standard
ABS Pipes	MS 1419: Part 1, 1997 - Pipes MS 1419: Part 2, 1997 - Fittings MS 1419: Part 3, 1997 - Solvent
Stainless Steel	BS EN 10312 or JIS G 3448 or ASTM A312 / A312M
HDPE Pipe Class PN 15	MS 1058: Part 2
Copper	BS EN 1057 or ASTM B88

1.1.2.3 Internal Piping

Type of pipe	Minimum wall thickness & pressure rating	Pipe	Fitting
High Density Polyethylene (HDPE)	PN 12.5 at 20°C (equivalent to 10 bar derated working pressure at 30°C)	MS 1058: Part 2 or BS EN 12201; and marked with SIRIM certification numbers	Moulded integrally dezincified brass with BSP threads of BS EN 12420 or BS EN 12165. Nickel and Chromium plated to BS 1224 service condition No. 2.
Acrylonitrile Butadiene Styrene (ABS)	Class 12-15 to MS 1419: Part 1 : 1997	MS 1419 : Part 1 : 1997	MS 1419: Part 2, 1997 - Fitting MS 1419: Part 3, 1997 - Solvent cement. All ABS pipes, fittings and solvent cement shall be supplied by the same manufacturers.
Polybutylene (PB)	PN 15 at 20°C (equivalent to 15 bar derated working pressure at 30°C)	EN 12319 or AS/NZS 2642	Moulded integrally dezincified brass with BSP threads of BS EN 12420 or BS EN 12165. Nickel and Chromium plated to BS 1224 service condition No. 2.
Polypropylene random co-polymer (PP-R)	More than 10 bar working pressure: PN 16 or SDR 7.4 at 20°C Less than 10 bar working pressure: PN 10 or SDR 11	DIN 8077, DIN 8078, DIN 16962 or EN ISO 15874	Moulded integrally dezincified brass with BSP threads of BS EN 12420 or BS EN 12165. Nickel and Chromium plated to BS 1224 service condition No. 2.
Stainless Steel (SS)	BS EN 10312 <Ø 12mm → Series 1 ≥Ø 12mm → Series 1 or Series 2 or ASTM A312/A312M: Ø ½'' – Ø 2'' → Schedule 40S (Threaded) Ø 2½'' – Ø 8'' → Schedule 10S (Welded)	BS EN 10312 or JIS G 3448 or ASTM A312 / A312M	Press fittings according to SAS 322 Ø ½'' – Ø 2'' → (Schedule 40S) Threaded & screw fittings according to ISO 4144:2003 Ø 2½'' – Ø 8'' → (Schedule 10S) Butt weld fittings according to ASTM A403 / A403M
Copper tubing	Type K	BS EN 1057 or ASTM B88	Brazing according to BS EN 1254: Part 1 Compression joint or 'push fit' fittings according to BS EN 1254: Part 2

1.1.3 PIPE INSTALLATION

Pipes and fittings shall be cleaned and free from manufacturing burrs and site debris.

1.1.3.1 Internal Piping

All installation shall be done according to the approved working drawings and pipe manufacturer's recommendation. Licensed Plumber shall be competent in various type of installation. Special care shall be taken in the arrangement of piping to ensure a neat finishing and alignment.

Services pipes and distribution pipes except those buried under ground level shall be concealed in wall, ceilings, boxed up or laid within the common trench, services ducts, etc provided where possible. All work shall be executed in such a manner so as to avoid cutting into finished work in walls, aprons, beam, etc. where practicable as the work proceeds. Pipe work to be buried or concealed shall not be covered or plastered before they are examined, tested and approved by the state water authority / SPAN, notwithstanding any approval given by S.O.

Installation of valves and fittings shall be grouped where this will not affect their operation, to reduce the number of joints to a minimum.

All necessary isolating valves, check valves and other fittings as required are as shown in the Tender Drawings. Every section of major branch supply piping shall be controlled by a stop valve at the point of connection to the supply.

Minimum diameter for internal water plumbing system shall be 20mm except for flush valve system where minimum diameter shall be 25mm. Final branches to fittings shall be 20mm diameters and the sizes of feeders from which theses branches are taken shall be as follows :-

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

The pipes shall be adequately protected against damage during transit. Each delivery of pipes shall be accompanied by the manufacturer's testing certificate.

1.1.3.2 Threaded Joints

Threaded end connections for ABS/PE/PB pipes shall have tapered thread forms complying with AS 1722.1 or equivalent approved standard in accordance with manufacturer's instruction.

Where threaded joint is to be made between ABS/PE/PB pipes and metal, the ABS/PE/PB pipes should be the male component of the joint.

All screwed joints shall be made by using Teflon tape or approved jointing compound.

1.1.3.3 Flanged Joints

Flanging or other suitable methods used shall be in accordance with the manufacturer's instructions and comply with the relevant state water authority / SPAN / S.O.

1.1.3.4 Bends

Bends of all piping shall have a radius of not less than 5 times the diameter and shall be of standard type.

1.1.4 PIPE SUPPORTS

Pipe supports, hangers, anchors, guides etc. shall be supplied and installed for proper support.

Vertical riser shall be supported at each floor with galvanized iron (G.I) riser clamps or other material to S.O approval.

Horizontal pipe runs shall be supported on hangers of split ring adjustable type or clevis type. Where pipelines run along walls, columns or ceilings, brackets or clamps may be used.

Piping at all equipment, valve positions and at main junctions, shall be adequately supported to prevent any distortion or transmission of strain to connected equipment or valves.

Where pipe lines run in a common group, they shall be supported from a common hanger bar as indicated in the Tender Drawings.

Pipe supports and hangers shall be spaced at intervals not exceeding the following:-

1.1.4.1 Horizontal Position

Pipe Size (mm)	Recommended Maximum Spacing of Support (m)	
	Non-metal	Metal
10	0.6	1.5
15	0.7	1.5
20	0.7	1.5
25	0.75	1.8
32	1.0	2.1
40	1.0	2.4
50	1.0	2.4
80	1.3	3.0
100	1.5	3.7
150	1.8	4.3
200	1.9	4.9

***Water temperature should not exceed 60^{O}C**

1.1.4.2 Vertical Position

Pipe Size (mm)	Recommended Maximum Spacing of Support (m)	
	Non-metal	Metal
10	0.7	NA
15	0.9	3.0
20	1.0	3.0
25	1.0	3.0
32	1.2	3.7
40	1.2	3.7
50	1.3	4.6
80	1.6	4.6
100	1.9	5.5
150	2.1	NA
200	2.4	NA

***Water temperature should not exceed 60^{O}C**

Vertical pipes shall be supported at least at the top and bottom of each riser, at each floor level, and at each isolating valve. In addition, a further support shall be provided between floor levels for pipes smaller than 32mm.

1.1.5 PIPE SLEEVE AND COVER PLATE

Where pipes are required to be laid through structural beams or slabs, G.I/ uPVC pipe sleeves shall be provided as indicated in the Tender Drawing. All pipes shall be properly secured in place with brackets.

All exposed piping within occupied rooms shall be boxed up to S.O approval.

Where pipe past through fire break walls or other partitions, clearance between pipes and sleeves shall be tightly pegged with suitable fire rated material to form a sound and fire barrier.

1.1.6 VALVES AND FITTING

All valves and fittings necessary for the correct control, operation and maintenance of all services shall be provided and installed to the satisfaction of the S.O. Samples shall be submitted for S.O approval before installation. Valves shall be installed where they are easily accessible for maintenance and operating purposes.

Each valve shall be of the same nominal size as the line in which it is installed, except for control, pressure reducing and similar valves which shall be correctly sized for the duty concerned. Connection between each valve and adjacent piping or equipment shall be made either flange or treaded joints may be applicable.

Before installation, every valve shall be blown out with air to remove any foreign matter lodged in the valve.

All valves shall be of SPAN approved, manufactured and generally constructed in accordance with relevant standard. All valves shall be suitable for system operating pressure.

1.1.6.1 Stop Valves / Gate Valves

Stop valves / gate valves are generally used as isolation valves.

Full bore copper alloy screw-down stop valves / gate valves of the same diameter as the pipe shall be provided and fixed for control in the following positions:

a) On the service pipe before it enters the building.
b) On each branch of the service pipe.
c) On the inlet to each storage or feed cistern.
d) On the inlet to each flushing cistern.
e) On the outlet of each storage tank or feeder cistern.
f) In other position on the pipe as shown or indicated, other than on overflow/warning pipe.
g) For system with pressure reducing valve (PRV), location of the gate valves shall be as indicated in the Tender Drawing.

Stop valve of 25mm and below shall be of copper alloy type screwed end complied with BS EN 1213.

Gate valve of 50mm and below shall be of copper alloy type screwed end complied with BS EN 12288.

Gate valves above 100mm shall be of ductile iron flanged end gate valve complied with BS 5163, BS EN 1074 or BS EN 1171.

Gate valve sized from 65mm to 100mm shall be either screwed or flanged end complied with above mentioned standards.

Stop valves with reduced flow areas (stop cocks) shall not be used for water closet flush valves and flushing cistern.

All valves shall have hand-wheel with externally screwed bronze or stainless steel spindle.

1.1.6.2 Pressure Gauges

Dial type with 3-way gauge cock shall be supplied and installed where indicated in the drawings.

Pressure gauges shall be minimum 100 mm diameter dial face type and having ranges suitable for the service pressure encountered. The maximum range of the gauge should be double the operating pressure.

The gauges shall be industrial type shock proof, oil filled, stainless steel casing and IP 65 Ingress Protection Rating.

1.1.6.3 Pressure Reducing Valve (PRV)

Air vent and pressure reducing valve 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 effect.

1.1.6.4 Non-Return Valves

Where shown on the accompanying drawings, non-slam-type non-return valves shall be supplied and fitted.

Valves shall be selected in relation to the velocity of the water in the pipe. In all cases the valve is required to operate silently on reversal of water flow and if necessary valves of the double or articulated clack type or the spring assisted type shall be fitted.

1.1.6.5 Water Meter

Suitable water meter approved by SPAN shall be supplied and installed as required.

1.1.7 WATER TANK

1.1.7.1 Water Tank Material

All water tanks for water supply shall be of the type and capacity shown or stated in the drawings. The water tanks shall be watertight and properly supported.

1.1.7.1.1 Fibreglass Reinforced Polyster (FRP) Domestic Water Tank

General

The tanks shall be scribbled down and flushed out with clean water and sterilized with chemical containing chlorine before being put into use.

Water tank design shall comply with the following standards:

a) MS 1241 - FRP Water Tank
b) MS 1390 – FRP Sectional Water Tank
c) Any other standards approved by SPAN

Materials for the construction of panels shall conform to MS 1241. The surface of FRP panels shall be manufactured with built-in stabilizer against embrittlement due to ultra-violet radiation.

The panel shall be of hot press moulded and fabricated from fiberglass reinforced plastic (FRP) of dimension 1M x 1M square with maximum tolerance of 1.5mm. Each FRP panel will be manufactured with flanges at a right angle of 90 to all sides of each panel. The thickness of the flange for the side wall and base plates will not be less than 10mm and the landed width of each flange will not be less than 70mm for base and side panels.

Physical Properties

Parameter	Results
Tensile strength	124 MN/M²
Bending strength	152 MN/ M²
Elastic modulus in bend	6,700 MN/ M²
Hardness	52 Barcol
Glass content	>30%
Water absorption	0.09%
Heat distortion temperature	182°C
Opacity	100%

Jointing Material

The jointing material shall be synthetic rubber as sealant with stainless steel washer, nuts and bolts.
The holes for the bolts will be 12mm± 1.5 to 2.0mm in diameter, suitable for M12 bolts and nuts.

Connections

All holes and pipe connection made in wall, top and bottom of tanks shall be factory fabricated before delivery of tank to site. The positions and type pipe connections shall be carried out strictly in accordance with the manufacturer's recommendations.

Painting

The internal face of the water tank shall be given 2 coats of non-toxic non corrosive paint and external one coat primer and two coats of non-corrosive paint to S.O approval.

1.1.7.1.2 High Density Polyethylene (HDPE) Tank

The HDPE tanks shall be constructed of physiologically safe, non toxic, inert, visor-elastic, UV-resistant high density polyethylene of one-piece moulded seamless construction to BS 4213 or MS 1225 and SIRIM certified without welding or joint. The tanks shall be manufactured from 100% virgin food grade resins without the additional recycled or reworked material. The resin used must be certified by the resin manufacturer to be food grade compliance and suited for the potable water.

The tanks and all piping connections shall be installed strictly in accordance to manufacturer's instructions and specification and the installation shall be supervised and verified by the manufacturer's technician.

The tanks shall come with a minimum 10 years warranty against defect in materials, manufacture and workmanship by the tank manufacturer. The warranty certificate shall be submitted to the S.O. before handing over.

1.1.7.1.3 Stainless Steel Tank

Stainless steel tank design shall comply with the following standards:

Type of water tank	Standard
Spherical shape, flat top & flat bottom, flat / round bottom	JKR 20200-0041-99
Pressed steel sectional (composite)	BS 1564

Spherical shape, flat top & flat bottom, flat / round bottom water tank

Material used in the fabrication of this tank shall be of Grade 304 stainless steel ASTM Designation: A240/A240M-94a or equivalent standards and supported by the respective mill certificates.

The finished surface of the materials used shall be of BA (bright annealed) and/or 2B (non-shining) finished.

The tank shall be manufactured inclusive of the following components:

a) Top cap
b) Top cover
c) Tank body
d) Bottom cover
e) Stand (for round bottom & spherical types only)

The stands (except for flat bottom type), fittings and accessories such as internal and external ladder, tank cover, screw nut, etc. of the tank shall be made of similar stainless steel materials of the above grade.

Each tank shall be marked / labeled on the external upper part of the tank body according to the following information:

a) Manufacturer's name and/or trade mark
b) The number and date of JKR standard
c) Serial number and model
d) Capacity

Pressed steel sectional water tank (composite)

Material for the pressed steel sectional water tank shall be manufactured from 1mm thickness Grade 304 stainless steel plate inner surface composite with 5mm external surface of mild steel plate.

The reinforcement for pressed steel sectional water tank shall be reinforced using suitable support. Detail calculation for internal / external reinforcement design shall be submitted to S.O for approval.

All bolts, nuts and washers in contact with water shall be of stainless steel Grade 304. All external bolts, nuts and washers in contact with water shall be of hot dipped galvanized mild steel.

The cover for pressed steel sectional water tank shall be constructed 1.2m x 1.2m / 1m x 1m from 1.2m thickness Grade 316 stainless steel plate.

Non-toxic PVC foam shall be used for jointing between flanges.

1.1.7.2 Tank Components and Accessories

The installation of storage / domestic tanks shall include but not limited to the following accessories and fitting to the tanks:

a) Overflow / warning pipe, outlet tapping and scour pipes shall discharge outside the building or to a point shown or stated in the drawing.

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

c) Dust and mosquito-proof air vents to the tank cover at the positions and as per details approved by S.O.

d) Water tanks of two (2) metres depth or more shall be provided with internal and external ladders. The internal ladder shall be made of stainless steel grade 304 unless otherwise specified. The external ladder shall be made of hot-dipped galvanized mild steel in accordance with MS 7140. The ladder width shall not be less than 300 mm and the length shall be suitable for the tank specified.

e) Water level indicators and scales graduated in metres to suit the depth of the tank as shown in the drawing.

f) Float Operated / Ball Valves

   Float operated valve shall comply with BS 1212. The combination of body pattern, seat number and size of float to suit the required pressure zone shall be as per standard.

All ball valves shall be supplied and fitted complete with back nuts, ball float, arm, etc. Ball floats may be of soldered copper or brass or alternatively polythene PVC.

g) Drain Cocks

Gunmetal drain cocks shall be provided as necessary to ensure that all sections of the pipework and plant can be effectively drained. The sizes of drain cocks shall be as follows:-

i)	Tanks, plant and pipes above 6" diameter not less than 1" diameter.		
ii)	Pipes 3" to 5" diameter	-	0.75" diameter
iii)	Pipes up to 2.5" diameter	-	0.5" diameter

1.1.7.3 Water Tank Foundation

1.1.7.3.1 Panel Tank

Unless otherwise shown in the drawings, the foundations shall be constructed to provide continuous support to all base panel joints in one direction at 1000 mm nominal centres according to panel sizes. The concrete foundation shall have a width of at least 300 mm and height of at least 600 mm. All foundations shall be constructed according to JKR standard specifications.

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 tighten and adjustments after installation.
Whenever recommended by the tank manufacturer, the steel skid base shall be designed and constructed in accordance with manufacturer's instructions, and details. In such cases, the continuous support can be spaced at greater than 1000 mm nominal centers as recommended by the manufacturer.

1.1.7.3.2 Round Tank

The concrete plinth shall have minimum of 100 mm height complete with 5 mm MS base plate as per tank size.

1.1.7.4 Flange Joint (Nozzle)

Flange joint used for the inlet, outlet and scour of storage tanks shall be made of stainless steel grade 304 externally and internally. Joint gaskets shall be of 5 mm thick, medium rubber reinforced with two-ply flexible fabric and complying with BS 6956, or approved silica sealant used in the Fibreglass Reinforced Polyester Panel (FRP) tanks. All bolts, nuts and washer used for flange nozzles shall be made of stainless steel grade 304.

1.1.8 CLEANING, PAINTING AND IDENTIFICATION

1.1.8.1 Cleaning of Pipework

All pipes, fittings, etc. shall be kept closed against moisture and foreign matters when stored on site.

All pipes, fittings, valves and accessories shall be thoroughly cleaned internally and externally before their installation and again where necessary before closing up.

After installation and before putting into service all pipeworks including fittings, valves shall be thoroughly cleaned internally.

1.1.8.2 Painting And Identification

All pumping equipments shall be factory painted according to the manufacturer's recommendations.
All thermoplastic pipes, fittings, valves, etc exposed directly to sunlight shall be painted with water based exterior-grade latex paint.

All surfaces to be painted shall be first thoroughly cleaned to remove dirt, scales, grease spots etc. Surface shall be completely dry before painting.

All surfaces shall have minimum one coat primer and two coats finish subject to S.O approval.

1.1.8.2.1 Pipework Identification

All pipes installed shall be identified in accordance with their relevant standards.

1.1.8.2.2 Labels for Valves and Controls

All control valves, relays, switches and instrumentation shall be identified by black or white engraved laminated plastic labels, securely attached to the item of equipment, or when such equipment is installed on or within panels or cubicle, the labels shall be located immediately below the equipment.

Directional arrows shall be painted on the pipework in the plant rooms, tank room and vertical risers.

---------- END OF SECTION 1.1 ----------

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1.2 SANITARY PLUMBING SYSTEM

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1.2 SANITARY PLUMBING SYSTEM

1.2.1 RULES AND REGULATION BY LAW

All the workmanship and material for the supply, installation, testing & commissioning of all equipment and accessories shall comply with the following rules and regulation requirements:

a) Drainage, Sanitation and Sanitary Plumbing By-Laws of the proposed Street, Drainage and Building Act. 1974; and

b) Gravity Drainage Systems Inside Buildings, BS EN 12056:

- Part 1 - General and Performance Requirements.
- Part 2 - Sanitary Pipework, Layout and Calculation.
- Part 5 - Installation and Testing, Instructions for Operation, Maintenance and Use.

c) Code of Practice for Design and Installation of Sewerage System, MS 1228:1991.

d) Local Authority By-Laws in force at time of installation.

e) Other relevant standards.

1.2.1.1 Material Standard

The following standards in their latest Edition shall apply:-

Item	Standard
Cast Iron Pipes	BS 416 for heavy grade pipes BS 437 for spigot / socket drain
Galvanized Iron	BS EN 10255 “Heavy”
Unplasticized polyvynil chloride (PVC-U)	MS 1063 or BS EN 1329: Pt. 1, BS 4514 (∅82mm only)
Unplasticized polyvynil chloride (PVC-U) (Underground)	MS 979: Part 1 (∅100mm & ∅155mm) MS 979: Part 2 (∅200mm and above) or BS EN 1401: Part 1, BS 4660 (fitting of ∅110mm & ∅160mm only).

The standard stated in this specification shall comply to their latest edition issued or relevant standards approved by SIRIM / SPAN / Local Authority.

1.2.2 DEFINITION OF SANITARY PIPE

1.2.2.1 Soil (Black Water) Pipe

Pipes attached to a building and designed to convey sewage or waste matter from any water closet (W.C) or urinal.

1.2.2.2 Waste (Grey Water) Pipe

A separate waste pipe shall be provided for the following:-

a) Dirty water from baths, basins, wash troughs and other waste containing a small proportion of soap and /or dirt; and

b) Greasy water from kitchen sinks and equipment where grease traps or interceptors are required.

1.2.3 SANITARY DISCHARGE SYSTEM

All main stacks shall be minimum 150mm diameter or subject to S.O approval.

The discharge system can be classified as follows:

1.2.3.1 Single Pipe System

In this system all appliances discharge separately into a single discharge stack. All traps are unventilated and those on pipes 50mm and below must have 75mm seals. The stack is directly connected to the manhole.

Where more than one fitting is connected to the stack, each branch shall be ventilated with a self-syphonage stack.

1.2.3.2 Fully Ventilated One-Pipe System

All appliances are directly discharged to a common stack and essential features of this system are the provision of 75mm deep seal traps on baths, basins and sinks also the provision of a ventilating pipe to which every appliance connected.

1.2.3.3 The Modified One-Pipe System

The modified One–Pipe system basically similar to the one pipe system, with the exception that the W.C.'s only are ventilated direct to the main ventilating pipe.

The depth of the water seal to all appliances, except W.C's shall 75mm.

The depth of the water seal to W.C's shall be 50mm to the main discharge stack.

1.2.3.4 Two–Pipe System

The discharge from W.C.'s, urinal and other soil appliances are conveyed via a main discharge soil (soil pipe) and finally to the sewer line.

A separate waste pipe conveys the discharge from waste basins, baths, sinks to the waste water drain through a trapped gully.

1.2.4 PIPEWORK MATERIAL

1.2.4.1 PVC-U Soil, Waste and Vent Pipes

All pipes shall run in accordance with layout sizes shown in the approved working drawings. 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.

Pipes, fittings and the system of unplasticized polyvinyl chloride (PVC-U) piping systems shall comply to MS 1063; or BS EN 1329: Part 1, or BS 4514 (size ∅82mm only)

- For soil, ventilation and waste discharge (low and high temperature) inside buildings (marked with "B")
- For soil and waste discharge systems buried in ground within the building structure (marked with "D")
- For soil, ventilation and waste discharge for both inside buildings and buried in building structure (marked with "BD")

The pipes and the fittings shall be coloured through the wall. The colour of pipes and fittings shall be as follows:

- "B" code - white
- "D" code - brown
- "BD" code - white

All underground sewerage pipe and fittings of ∅ 4" (100mm) diameter and ∅ 6" (155mm) diameter shall be of PVC-U Brown complied to MS 979: Part 1, and for size ∅ 200mm and above complied to MS 979: Part 2; or BS EN 1401: Part 1, or BS 4660 (fitting of nominal size 110mm and 160mm only).

Main soil, waste and vent pipes shall be carried up to the roof level and protected by vent cowl and weather apron as per tender drawing.

All Pipes shall be fixed in straight runs and all horizontal runs shall be laid to gradients in accordance with BS EN 12056: Part 2 and in any event not less than 18mm/m unless otherwise instructed.

1.2.4.1.1 PVC-U Waste, Vent and Soil System (Inside building, buried in building structure and buried in ground within building structure)

The PVC-U pipes, fittings and system shall comply in all respects with the requirements of MS 1063 or other relevant standard certified by SIRIM.

Pipes shall be supplied in plain-ended lengths and the minimum acceptable wall thickness of pipe and fittings shall be:-

Nominal Sizes (mm)	Wall Thickness (mm)		
	Pipes (mm)	Fittings (mm)	Sockets (mm)
32	3.0	3.0	2.0
40	3.0	3.0	2.0
50	3.0	3.0	2.0
63	3.0	3.0	2.0
75	3.0	3.0	2.0
80	3.0	3.0	2.3
82	3.0	3.0	2.3
90	3.0	3.0	2.3
100	3.0	3.0	2.3
110	3.2	3.2	2.4
125	3.2	3.2	2.4
140	3.2	3.2 / 3.5*	2.4 / 2.6*
160	3.2	3.2 / 4.0*	2.4 / 3.0*
180	3.6 / 4.4*	3.6 / 4.4*	2.7 / 3.3*
200	3.9 / 4.9*	3.9 / 4.9*	2.9 / 3.7*
250	4.9 / 6.2*	4.9 / 6.2*	3.7 / 4.7*
315	6.2 / 7.7*	6.2 / 7.7*	4.7 / 5.8*

* For soil and waste discharge systems buried in ground within the building structure, "D" and for soil, ventilation and waste discharge for both inside buildings and buried in building structure, "BD".

The method of jointing to be employed shall be that solvent welding using the manufacturer's approved cement. Seal ring fittings shall be used where necessary to accommodate thermal movement or the sockets of standard fittings shall be converted to seal ring adaptor.

Access shall be provided where necessary either by means of an integrally moulded door in an access fitting with an externally fitted rubber seal and secured with two piece clamp type door fitted into the pipe run.

1.2.4.1.2 Underground PVC-U Sewerage Pipes and Fittings

The underground PVC-U sewerage pipes and fittings shall comply in all respects with the requirement of MS 979: Part 1 (∅100mm and ∅155mm) and MS 979: Part 2 (∅200mm and above) or other relevant standard certified by SIRIM.

Pipes shall be supplied in plain-ended lengths. The minimum acceptable wall thickness of pipes and fittings shall be:-

Nominal Sizes (mm)	Wall Thickness (mm)		
	Pipes	Fittings	Junctions
100	3.2	3.4	3.4
155	4.1	4.1	4.1
200	4.9	4.9	4.9
250	6.1	6.1	6.1

The method of jointing to be employed shall be strictly to manufacturer's recommendation.

1.2.4.1.3 Expansion Joints (Expansion Coupling for PVC-U Pipes)

Where pipework is constructed using solvent welded joints, expansion joints for PVC-U pipes shall be carried out in accordance with the manufacture's recommendations.

Expansion joints shall be provided at a maximum of 4 meter centers for soil, 2 meter centers for waste and between fixed points over 1 meter centers.

1.2.4.1.4 Cast Iron/Galvanized Iron Pipe

Where shown or stated in the drawing, 100mm diameter cast iron soil and vent pipes internally coated with anti-corrosive bituminous coating shall be provided, fixed and connected to the fittings and sanitary system.

All main and branch soil pipe and fittings shall be cast iron to BS 416 Heavy grade coated with an approved tar-based composition.

Main and branch vent pipe and fittings shall be cast iron to BS 416 Heavy grade factory coated with an approved certificate tar-based composition.

Branch vent pipe of 2" (50mm) diameter and below shall be galvanized to BS 1387: Heavy grade.

Waste pipe from sink or wash basin shall be galvanized iron pipe to BS 1387: Heavy grade.

Cast iron pipes shall be jointed with an approved certificate resin with molten lead and well caulked. All necessary bends, tees, sockets, branches, offsets, inspection pieces, hopper heads, holder bats shall be provided where necessary.

1.2.4.1.5 Other Material

All material not specifically mentioned above shall conform to the latest edition of their respective British Standard and/or Malaysian Standard or equivalent specification and shall be to the approval of the relevant Authority.

1.2.5 WORKMANSHIP & PIPE SUPPORT

The installation, method of jointing and fixing shall comply in all respects to the manufacturer's recommendation and comply with latest relevant standards.

All soil, waste and vent pipes, pipe hooks clamps and clips shall be placed tight up against the head or underside of the collar. Extension clips shall be used where it is necessary to run the pipe clear of the wall.

Maximum intervals between pipe supports shall be: -

1.2.5.1 Horizontal Position

Pipe Size (mm)	Recommended Maximum Spacing of Support (m)	
	Non-metal	Metal
10	0.6	1.5
15	0.7	1.5
20	0.7	1.5
25	0.75	1.8
32	1.0	2.1
40	1.0	2.4
50	1.0	2.4
80	1.3	3.0
100	1.5	3.7
150	1.8	4.3
200	1.9	4.9

***Water temperature should not exceed 60^{O}C**

1.2.5.2 Vertical Position

Pipe Size (mm)	Recommended Maximum Spacing of Support (m)	
	Non-metal	Metal
10	0.7	NA
15	0.9	3.0
20	1.0	3.0
25	1.0	3.0
32	1.2	3.7
40	1.2	3.7
50	1.3	4.6
80	1.6	4.6
100	1.9	5.5
150	2.1	NA
200	2.4	NA

***Water temperature should not exceed 60^{O}C**

The work shall be inspected and tested during installation at agreed stages.

All work, which will be concealed, shall be tested before it is finally enclosed.

A final test shall be made upon completion for soundness and performance is accordance with BS EN 12056: Part 2 - Gravity Drainage Systems Inside Buildings: Sanitary Pipework, Layout and Calculation.

1.2.6 VENTILATING PIPE

Main ventilating stack pipe shall be discharge to the open air or connected to the discharge stack above the spillover level of the highest appliance on the stack. (Soil pipe or one pipe system shall in all cases be vented by upward extension of the soil or combined pipe).

The upward vent pipe shall be straight and free from any bends or angles except where unavoidable. It shall be extended through the roof to the required height with the open end protected by means of copper wire globe or approved cowl .The distance of outlet is not less than 900mm from the roof level or any window or other opening.

All vent and branch vent pipes shall be graded 18mm/m (minimum 1^{o}) so as to drip back to the soil or waste pipe by gravity. A branch vent must rise vertically or at an angle of not more than 45˚ from the vertical to a point 150mm above the fixture it is venting before running horizontally.

Main ventilating pipe shall not be less than 50mm dia. or 2/3 of the diameter of the main soil/waste pipe whichever the larger diameter is.

1.2.7 ANTI-SYPHONAGE

An anti-syphonage pipe shall be carried up from each fixture to the branch or main vent pipe above the level of the fixture to prevent the loss of the water seal in traps.

No fixture shall be connected to the soil, waste or combined pipe at any point between the trap and the anti-syphonage pipe, which it serves.

In special cases and with the approval of the authority, anti-syphonage vent pipe could be connected to the waste, combined pipe or soil pipe on the opposite site of the water seal to the fixture at a point, which should be between 75mm to 300mm from the crown of the trap. In the case of bath and closet pan, the vent pipe shall not exceed 1.2m from the crown of the trap.

Before connecting to the main vent pipe all anti-syphonage pipework shall rise above the floor level of the sanitary appliances.

Anti-syphonage pipework shall not be less than 32mm diameter.

1.2.8 TRAPS

Each sanitary appliance shall be fitted with a trap either as an integral part of the appliance or attached to and immediately beneath its outlet. All traps shall be accessible and provided with adequate facility for cleaning. The internal surface of the trap shall be smooth throughout. Generally the trap shall be of the same material as the soil/waste pipe.

1.2.9 FLOOR TRAPS

Floor trap in all areas, unless otherwise specified, shall be 100mm diameter similar materials to the pipe traps complete with grating and self-tapping screw.

1.2.10 TESTING TEES

Testing tees shall be located on the vertical stacks between floors to enable each floor to be tested independently as specified hereafter. Upon completion of testing, the tees shall be sealed up with lead joint or solvent joint where PVC-U pipe is specified.

1.2.11 GREASE INTERCEPTORS/WASTE DRAIN TRAP (WHERE SPECIFIED)

The body of the interceptor and baffles shall be made of Stainless Steel material Grade 316. The baffles shall be of removable type.

Grease interceptors shall be certified by relevant authority. It shall be of floor mounted or fully recessed manual type complete with extension collar or extension piece to suit the structural requirement where required.

1.2.12 REDUCING FITTING

Wherever reduction in pipe sizes takes place, reducing fitting shall be used. Bushings will not be permitted unless with prior permission from the Superintending Officer (S.O).

1.2.13 CLEANING EYES AND INSPECTION OPENING

To provide access for the proper inspection, cleaning and testing of the entire length of pipe, inspection openings and cleaning eyes shall be provided on all soil, waste and combined pipes at:-

a) Each change of direction of piping; and
b) Based of each soil, waste or vent stack.

1.2.14 TEMPORARY CLOSING OF PIPEWORKS (INGRESS OF CONTAMINANTS)

As soon as pipes have been installed, all openings shall be capped or plugged to prevent the entrance of materials that would obstruct or choke the pipes. It is the responsibility of the Contractor to ensure that caps and plugs are left in place until removal is necessary for completion of installation.

1.2.15 INSPECTION CHAMBER

The works shall include the construction of all inspection chambers generally as shown in the tender/construction/working drawings.

Each inspection chamber shall be constructed with at least 6” thick concrete base which carries 9” brick walls. The bricks shall be in clay engineering bricks Class ‘B’ conforming to relevant British Standard. Bricks shall be laid in 1: 3 cement mortar with English Bonds.

The inside of the manhole shall be rendered with 0.75” thick rendering with 1 part of high Alumina cement to two part sand and smooth finished to the Local Authorities requirements.

Salt-glazed ware half round channel straights or bend to BS 65 shall be laid to the bottom of the manholes. The main channel shall be laid straight and shall be same diameter as the outlet pipe and other channels shall be of the same diameter as the pipes discharge into them.

Bench up to channels with 1:2:4 by 3/4 “ concrete rising vertically from the edge of the channel to a height not less than that of the soffit of the outgoing drain and sloping upwards from there to meet the side of the smooth hard surface with ½“ coat of high alumina cement mortar.

A cast iron frame with cover shall be set on top of each manhole, level with the ground and lid fitted on to it. The frame shall be properly bedded and fixed. The two sides of the cover and frame shall be coated with bitumastic paint before fixing in position. Airtight gasket shall be provided wherever necessary. The cast iron covers shall be either medium or heavy duty as shown on the drawings.

In the case where the manhole is positioned within the building, the cover shall be of double sealed type and shall have copper (or stainless steel) lined rims on both frame and cover for floor finishing.

All inverts for the manhole shall be formed with glazed pipes, or approved equivalent, with properly formed branches.

1.2.15.1 Heavy and Medium Duty Manhole Covers and Frames

Heavy duty cast steel cover and frame shall weight not less than 41/2 cwt. Medium duty cast iron cover and frame shall weight not less than 21/4 cwt.

Generally, heavy duty cover and frame shall be installed for manholes situated in roads and backlanes which are affected by vehicular traffic. Medium duty at backlanes and other areas which are not affected by vehicular traffic.

1.2.15.2 Light Duty Manhole Cover

Light duty covers shall weight not less than 3/4 cwt or shall be approved type 18" x 24" cast iron covers and frames.

1.2.16 UNDERGROUND/BURIED PIPE (FOR SANITARY)

All underground/buried pipes shall be carefully laid on beddings free from rocks, stones and other broken materials. Unless otherwise stated, all direct buried pipework shall be installed in open trench.

1.2.16.1 Excavation and Trenching for Piping

The Contractor shall perform all excavation to the depths indicated in the drawings or as specified in conformance with local authority requirements.

All excess excavation materials shall be removed from the site. The contractor shall prevent surface water from flowing into trenches or the excavations by using sheeting and shoring method thus ensuring the safety of personnel. Any water accumulating therein shall be removed.

1.2.16.2 Trench Excavation

Trenches shall be of necessary width for the proper laying of the pipe, and the banks shall be as nearly vertical as practicable. The bottoms of the trenches shall be accurately graded to provide uniform bearing and supports for each section of the pipe on undisturbed soil at every point along its entire length, or may be over excavated 100mm below depth indicated and filled with well tamped salt free coarse sand or other approved materials. Layers or brick, concrete base and angle blocks shall be used support for the laying of piping.

Pipe Diameter Inches	Trenches Width Inches
3 and under	15 - 24
4 - 6	18 - 28
8	20 - 30

1.2.16.3 Depth of Trench's Cover

The minimum depth of trenches covered with concrete slab shall be 450mm from top of pipe to finished ground level and trenches without concrete slab shall be 750mm.

1.2.16.4 Protection of Existing Utilities

Existing utility lines or other completed utility lines if damaged by the Contractor shall be repaired at his own expense.

When connecting to existing utility lines, no section of the existing piping shall be abandoned unless it is specifically indicated on the drawings.

1.2.16.5 Backfilling of Trenches

Trenches shall not be backfilled until all required pressure and other tests have been performed. Backfill and compaction shall comply to Civil & Structural Engineer's requirements.

---------- END OF SECTION 1.2 ----------

SECTION 1 - TECHNICAL SPECIFICATIONS

1.3 PUMPING SYSTEM (IF APPLICABLE)

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1.3 PUMPING SYSTEM (IF APPLICABLE)

The pumping system divided into two types:
a) Booster pump system
b) Hydropneumatic system

1.3.1 Booster Pump System

The system shall comprise but not limited to the following components;
a) Pump
b) Controller and devices
c) Pipes, fittings and valves
d) Support base

The system shall be provided with minimum two (2) numbers booster pumps as shown in the drawings. These shall comprise of two (2) numbers electrically driven pumpsets for duty and standby operation.

The duty and standby pumpset shall be alternated to maintain even wear and tear.

Pumps provided shall be single/multi-stage centrifugal type pumps. The pumps shall operate at constant/variable speed with the pump motor coupled directly to the pump and the whole mounted on a common base plate bolted onto a concrete plinth.

The pumps shall be selected to suit the type of service encountered. End covers, body rings, bearing housing and casing generally be of cast iron constructions. Impeller shall be of bronze or gunmetal and shafts of stainless steel. For pump speed of 2,900 rpm, the impeller shall be of stainless steel grade 316, shaft of stainless steel and the casing of high grade close grained cast iron or stainless steel.

The pump seal shall be integral with the casing and shall be of mechanical seal type. The mechanical seal material shall be silicon carbide, carbon or ceramic type and suitable for fluid media operation.

The plinth shall be provided to suit the manufacturer's requirements and shall raise the pumps to at least 6 inch (150mm). Mounting of the pumpsets to the plinth shall be complete with vibration isolators.

The pumps shall be fitted with air cocks and two lubricators/nipples at suction and delivery branch flange.

Proper drainage shall be provided for all points around the pumpset mounting.

1.3.1.1 Automatic Switches And Controls

Single tank

The automatic controls shall be of no-float type using stainless steel electrodes provided at (i) Suction tank and (ii) Storage/elevated tank; and shall be able to perform the following automatic actions:-

a) When the water level drops below L.W.L. in the Storage/elevated tank, the pump shall be switched on and shall remain until the water level reaches T.W.L.

b) When the water level in the Storage/elevated tank reaches T.W.L. the pump shall be switched off and shall be prevented from being switched on again until the water level falls to L.W.L.

c) When the water level is at or below the L.W.L. in the suction tank, the pump shall be switched off and shall be prevented from being switched on again until the water level rises to T.W.L.

d) The L.W.L. and T.W.L. in the suction tank and Storage/elevated tank shall be provided subjected to the S.O approval.

An auto-manual change-over switch shall be provided. Each pump shall have a pressure gauge fitted on the delivery branch with shut-off cock. Flexible coupling shall be provided at the suction and delivery pipes to prevent transmission of Vibration.

Multiple tank

Each pump shall be automatically activated by water level sensors/pressure of no float electrode type located in the gravity tanks which are set at predetermined levels.

This control arrangement shall not prevent any individual pump to operate should any one of the pumps in the set fail to function. For multiple gravity tank installation, each independent tank shall be fitted with its own no float electrodes. Pneumatic pumping systems with pressure switch controls may be considered as an alternative to the above system.

The operation of all automatic control equipment shall be so arranged that on power failure and / or partial or complete shut down during routine maintenance or repair, all systems and components shall 'fail safe'.

Water Level Control - Pressurized Mains System

All water tanks shall be incorporated with no float type high and low water level sensors, electrode, electrical solenoid on-off valve, and by pass line with normally closed valve. The electrical solenoid valve shall open on low water level and close on high water level.

1.3.2 Hydropneumatic System

The system shall comprise but not limited to the following components;
a) Pump
b) Pneumatic tank
c) Controller and devices
d) Pipes, fittings and valves
e) Support base

The system shall be provided with pumps as shown in the tender drawings.

Pump casing shall be constructed of high grade close grained cast iron or stainless steel. The pump casing shall be of adequate strength to withstand 1.5 times the maximum operating pressure of the system or a minimum of 150 psi. The plinth shall be provided to suit the manufacturer's requirements and shall raise the pumps to at least 6 in (150mm) Mounting of the pumpsets to the plinth shall be complete with vibration isolators.

The pumps shall be selected to suit the type of service encountered. End covers, body rings, bearing housing and casing generally be of cast iron or stainless steel constructions. Impeller shall be of bronze or gunmetal and shafts of stainless steel. Case sealing rings, intermediated bushes and water lubricated journal bearings shall be phosphor bronze material.

Each pump shall be fitted with an air valve grease lubricator water seal connection, copper gland drain fitting and tappings in the pump head casing for discharge pressure gauge. Proper drainage shall be provided for all points around the pumpset mounting.

1.3.3 Pressure Vessel (If Necessary)

The pressure vessel shall be pre-charged type and shall be designed for 1.5 times of its maximum working pressure or not less than 10bar and shall be so arranged that the water is wholly contained with a removable bladder type. The bladder shall be able to withstand a maximum temperature 82^{o}C without impairing performance.

The vessel shall constructed of welded mild steel plate to ASME Section VIII for unfired vessel and shall be epoxy coated inside and painted outside. The vessel shall comply to the requirements of the local authorities.

The vessel shall be fitted with pressure switches and gauges, lifting lugs, gauges, safety valves and air valve, drain cock and inspection opening.

1.3.4 Pipes, Valves And Fittings

Pipework shall include all pipes, bends, tees, flanges, brackets, belts, nuts, valves, etc. from and including the connection at the suction tank up to the pumps and from the pumps up to and including the connection as specified in the tender drawing.

All pipes and fittings shall be galvanised mild steel tubes conforming to BS 1387:1985 and BS 21:1985, Class C. Pipe flanges shall be to BS 10.1962 Table E.

The non-return valves shall be of design and quality as will prevent slamming by rebounding water column in the system.

Isolation valve shall be installed at pumps outlet and inlet, pressure reducing valve (PRV) and every distribution pipe for maintenance purpose.

Vibration isolators shall be of wire and fibre moulded high pressure rubber type. The flange shall be integral with the fittings and shall be clamped in place using split steel flanges for sizes 2" diameter and above, and for size below 2" diameter, a similar hose shall be used for connection.

Strainers shall be installed up stream of all pumps. On lines 2" diameter and below, the strainers shall be screwed steel or bronze body type. Otherwise, the strainers shall be of the flanged type. All strainers shall be of flanged steel body type and shall be fitted with permanents magnets and removable bronze screens.

1.3.5 Pump Operation

All the pumps shall be wired for alternate operation, i.e. automatic changeover between and/or amongst the pumps in every cycle of operation.

---------- END OF SECTION 1.3 ----------

SECTION 1 - TECHNICAL SPECIFICATIONS

1.4 ELECTRICAL WORKS (IF APPLICABLE)

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1.4 ELECTRICAL WORKS (IF APPLICABLE)

1.4.1 GENERAL

The Contractor shall carry out all electrical work necessary for the efficient, safe and satisfactory operation of the plant detailed elsewhere in the specification and shall supply, install and connect all motors, switchboards, switchgears and all necessary equipment and materials except where it is stated in the specification that materials are to be supplied or work is to be carried out by others.

All electrical equipment supplied shall be of the first grade as regards design and fully competent electrician of appropriate grades shall only carry out manufacture and installation.

The Contractor shall provide the following electrical equipment and services: -

(a) All electric motors, starters, isolators, cable boxes and isolating switches for the cold water supply and sanitary plumbing system.

(b) Conduit, cable tray, cabling and control wiring from the electrical isolator in the sub-switchboards to the pump switchboards (control panels).

(c) Conduit, cable tray, cabling and control wiring from the pump switchboards (control panels) to the various items.

(d) All control equipment, control wiring and associated works.

(e) Conduit and wiring including control switches and fused spare outlets as indicated in the tender drawings.

The Contractor shall be required on completion of the electrical installation to provide in a glazed frame a complete "as installed" wiring diagram identifying all the control circuit and the various color-coding.

The following works shall be carried out under other specialist work: -

(a) Supply, installation and connection of the sub-mains to main plant pump switchboard and to the isolators in the sub-switchboards.

(b) Lighting and power socket outlets in the plant rooms.

Unless specified elsewhere, all equipment, switchgears, apparatus, appliances and accessories for low voltage electrical installation shall be rated for operation on a 240/415 V (within the tolerance as defined in MS IEC 60038 : 230/400V +10%, -6%), 3 phase, 4 wire, 50 Hz. system with solidly earthed neutral.

All standard shall conform to the latest MS, MS IEC, IEC, BS EN, BS and/or EN standard.

1.4.2 PUMP SWITCHBOARDS

1.4.2.1 Types of Pump Switchboard

The types of switchboard shall be as specified in the Drawings and/or and Schedule of Design Requirements shall be of the following types: -

(a) Self-contained, floor mounted, flush fronted, metal-clad cubicle type suitable for front and rear access;

(b) Self-contained, floor mounted, flush fronted, metal-clad cubicle type suitable for front access;

(c) Wall mounted metal-clad type suitable for front access.

The switchboards shall house their air circuit breakers, moulded case circuit breakers, fuse switches, switch fuses, isolators, contactors, busbars, meters, protective relays, selector switches, indicating lamps, current transformers, cable terminating boxes, cable glands, anti-condensation heaters complete with automatic thermostats and isolators and all other necessary items of equipment whether specified hereinafter or in the Drawings or not, suitable for operation on a 415/240 V (+10%, -6%), 3 phase, 4 wire, 50 Hz. system with solidly earthed neutral.

Unless otherwise specified elsewhere, the switchboards shall be capable of withstanding fault condition of not less than 50 kA at 415 V for 1 s as defined in IEC 60439-1. The switchboards shall comply with IEC 60439-1 and the degree of protection shall be IP41 in accordance to MS IEC 60529. Outdoor switchboard shall also comply with MS IEC 60439-5 with protection degree of IP54 in accordance to MS IEC 60529.

Type testing for switchboard:-

Table 2A: Type testing for switchboard as per categorization

Category	Current Rating	Registration & Type Test Report
I	I ≤ 600A	Suruhanjaya Tenaga
II	600A < I ≤ 2000A	Suruhanjaya Tenaga & Partial Type Test accordance with MS IEC 60439-1 (i) Short Circuit Test (Clause:80203) (ii) Temperature Rise Test (Clause:8.2.1)
III	I > 2000A	Suruhanjaya Tenaga & Full Type Test accordance with MS IEC 60439-1

Routine tests on the switchboard shall be carried out before delivery to site. The main circuits and the auxiliary circuits shall be tested to verify dielectric properties with power-frequency test voltage of 2500 V*ac* for 1 minute and insulation resistance under test voltage of 1000 V. Routine tests shall include inspection and checking of wiring, electrical continuity of the protective circuits, connections and effectiveness of mechanical actuating elements and interlock. **Test Results or Certificate duly certified by Competent Person as in Electricity Regulations 1994 shall be issued for every switchboard supplied and installed.**

1.4.3 ENCLOSURES

1.4.3.1 Self-Contained Floor Mounted Cubicle Switchboards

The framework of the switchboard shall be fabricated from rolled steel sections of thickness not less than 2.5 mm and shall be self-supporting when assembled, uniform in height and depth from front to back. The rigid construction shall be designed to withstand without any sag, deformation or warping, the loads likely to be experienced during normal operating, maintenance or maximum fault condition.

The front shall be provided with covers/doors of box formation. The rear shall be provided with hinged removable doors of box formation. The rear doors shall be of double-leaf type with rebated edges and each leaf should preferably not be wider than 450 mm. Each leaf of door shall have 2 pairs of approved hinges. The door shall be fitted with approved type of surface-mounted espagnolette or cremone bolts complete with approved locking device operated by a satin chrome lever handle at the centre fixing.

The top and sides shall be of removable panels. Cover plates with openings for cable entry shall be provided at the base of the switchboard. All panels, covers and doors shall be fabricated from sheet steel of thickness not less than 2.0 mm and so constructed as to provide a clear, flush and pleasing appearance. The panels, covers and front doors shall be secured to the enclosure by means of chromed type of screws with cylindrical knurled head complete with retaining clips. Welded cross struts shall not be used.

The switchboard shall be dust and vermin proof. All covers and doors shall be provided with grommets and dust seals to exclude dust and dirt. Louvres or ventilation vent with filter shall be provided at the sides and back for adequate ventilation. Precaution shall be taken to prevent overheating due to hysteresis and eddy current using non-ferrous plate (for single core cable). All edges shall be rounded. Serrated star washers shall be fitted to ensure satisfactory earthing of the front cover. The switchboards shall be of Form 2b and comply with MS IEC 60439-1.

All indicating instrument which need to be read by the operator shall not be located higher than 2 m above the base of the switchboard. All operating devices such as handle, push buttons, etc., shall be located at such a height that they can easily be operated, and in general, the centreline shall not be higher than 2 m above the base of the switchboard. In the case where building automation devices, transducers and relays are provided, they shall be separately housed in a compartment of the section of the switchboard. All wiring from the devices, transducers and relays shall be neatly arranged and connected to the terminal blocks with removal links mounted on rail. Terminals shall be identified and labelled in accordance with IEC 60445.

A lockable tool compartment with keys and opening handle shall be provided at the lowest subsection of the switchboard. The switchboard shall undergo de-rusting treatment, anti-rust treatment with the exterior finished with epoxy dry-powder and oven baked semi-gloss beige colour and interior finished matt white. The switchboard shall be bolted to mild steel channel base or over concrete trench. The channel shall be anti-rusted and painted with a primer. There shall be a readily installed cable tray on the interior at both side panels for outgoing cable. All cables shall be rigidly secured using cable support bracket of non-rotting material, before termination.

1.4.3.2 Wall Mounted Switchboards

The switchboard shall be fabricated from sheet steel of thickness not less than 2.0 mm. The enclosure shall be of all welded construction with sheets bent where possible so as to minimise the number of welded joints. The four sides of the enclosure shall be returned at the front to facilitate fixing of front cover plates. The front cover plates or doors shall be of box formation and flanged to facilitate fixing to the enclosure.

The front cover of the switchboard shall be provided with grummets and dust seal to exclude dust and dirt. Meshed louvre or ventilation vent with filter shall be provided at both sides for ventilation. All edges shall be rounded. Serrated star washers shall be fitted to ensure satisfactory earthing of the front cover. The switchboard shall undergo de-rusting treatment, anti-rust treatment and be finished with epoxy dry-powder and oven baked semi-gloss beige colour.

The switchboard shall not be mounted directly to the wall structure. It shall be firmly bolted/ welded on to galvanized C-channel brackets which in turn shall be bolted to the wall or structure by means of bolts and nuts. The top of the switchboard shall not be higher than 2100mm and the bottom shall not be lower than 900mm from the floor.

1.4.4 ASSOCIATED COMPONENT

Busbars shall be of hard drawn high conductivity copper of adequate rectangular cross section to carry continuously the specified current without overheating and also coloured in accordance with the latest applicable British Standards.

An earthen busbars of suitable cross section shall be run the full length at the base of the main switchboard.

Connections from busbars to the circuit breakers, switch fuses and fuse switches shall be affected by means of copper bars or rods securely clamped to the busbars and identified by means of coloured plastic sleeve to indicate the phase colours.

All relays provided shall be heavy-duty pattern, unaffected by external vibration and capable of operation in any position. All meters and relays shall be fully tropicalised.

Earth fault/over current relays with the delay characteristics shall be provided to trip circuit breakers as specified. Earth fault relay shall incorporate drop flag indicator with hand-reset contacts.

All contactors and starters, relays and controllers shall be fitted on insulated panels. All incoming and outgoing circuit and in ring shall be brought to the contactors, starters, relays and controllers, via insulated terminal strips mounted within the metal cubicles, and all wiring between terminal strip and electrical equipment inside the control panel shall be neatly run and taped in accordance with the requirements of the Suruhanjaya Tenaga (ST).

1.4.5 OTHERS

All secondary wiring shall be of not less than 1.5 sq. mm. sections insulated with PVC and shall be fixed securely without strain by cleats of the compression type. All screws, locknuts, washers, bolts etc. shall be of copper alloy type.

Indicating light shall be long life coloured LED type. All indicating light shall be adequately ventilated and easily be replaced from the front of the panel without the use of extractors.

Instruments, meters, relays, protective fuses etc. located on the front of the switchboard shall be so positioned that as far as possible, each instrument, meter, relay, protective fuse etc. is adjacent to the unit which it is associated. All relays shall be of heavy duty type, unaffected by external vibration and capable of operation in any position. All instruments, meters, relays, equipment etc. shall be fully tropicalised.

One number approved anti-condensation heater shall be installed for every two sections at the switchboards. Each heater shall be complete with automatic thermostat control, ON-OFF switch and indicating lamp.

Engraved labels with white lettering on a black background shall be fastened or riveted on the front panels of each switchgear and item of equipment. The wording shall be approved by the S.O.'s Representative. Engraved name plate showing the relevant earth fault setting, overcurrent setting, current transformer ratio, fuse rating, name of the circuit to which it is connected, etc. shall be fixed to switchgear panels to which it refers.

1.4.6 AIR CIRCUIT BREAKERS (ACB)

ACB shall be of withdrawable metal-clad, flush mounted, horizontal drawout isolation and air break type suitable for installing on cubicle type of switchboard. They shall be three or four poles type as specified and shall comply fully with IEC 60947-1 and 60947-2. They shall be ASTA or KEMA or other accredited laboratories certified for minimum rupturing capacity, rated short time withstand current, (I_{cw}) of 50 kA at 415 V for 1 second or otherwise specified.

They shall consist of quick-make, quick-break, mechanically and electrically trip free mechanism arranged to give double break in all poles simultaneously. The closing mechanism shall be of stored energy type, either manually or electrically charged. Mechanical `ON' and `OFF' or ‘|’ and ‘0’ indicators shall be provided. The tripping

mechanism shall be equipped with push button for independent manual tripping and shall be stable and not being opened by shocks.

Each pole of the circuit breaker shall be provided with an arc chute to extinguish the arc drawn between the breaker contacts each time a breaker interrupts current, and interpole barriers to reduce arcing time for rapid deionization of the arc and guard against flash over. The contacts shall be renewable type.

The operating mechanism and carriage shall have the following positions: -

(a) Service - In this position the main and control contacts are engaged.

(b) Test - In this position the main contacts are isolated but the control contacts are still engaged. It shall be possible to check the correct operation of the control circuits without energising the main circuit.

(c) Isolated - Both main and control contacts are isolated.

They shall be provided with marking to show the breaker positions with facility for padlocking the carriage in the Test and Isolated positions. They shall be equipped with the following interlock devices: -

(a) Prevent withdrawal of breaker while the breaker is in closed position.

(b) Prevent closure of breaker while the carriage is in any position between `fully isolated' and `fully home'.

The arrangement of the busbar connections shall be such that with the circuit breaker withdrawn, the life parts shall be protected, either by suitable shrouding or lockable shutters.

Minimum four numbers (2-Normally-Open, 2-Normally-Close) double break type auxiliary contacts shall be provided.

Mechanical interlocks and/or electrical interlocks, where specified, shall be provided. Mechanical interlock shall be of code key type, arranged to mechanically operate the trip mechanism latch so that the breaker can only be closed when the key is trapped in the lock. Electrical interlock shall be controlled by means of operation of auxiliary switches of another breaker designed to cut out the closing coils and mechanism of the parent breaker.

Where used as bus-coupler, they shall be of 4 pole type and provided with electrical and/or mechanical interlocks as required so that it is not possible for the coupler to close with its associated main incoming supply breakers closed.

Where used as incoming feeder from supply source (either from transformer, generator set or coupler), they shall be of 4 pole type.

The neutral of the 4 pole type ACB terminals shall be of the same size as the phase.

The frame of ACB shall be bonded to the switchboard earthing bar using of 3 mm x 25 mm tinned copper tape.

1.4.7 MOULDED CASE CIRCUIT BREAKERS (MCCB)

MCCB shall comply with MS IEC 60947-2. They shall be fully tropicalised and suitable to be used up to an ambient temperature of 40 ºC, enclosed in glass-reinforced polyester moulded case and suitable for use on 240/415 V, 50 Hz. a.c. supply system.

They shall be of the quick-make, quick-break type having manually operable toggle type handle. Permanent position indicators shall be provided to show status of the breaker. When tripping occurs, the handle shall be in the trip position midway between the 'ON' and 'OFF' or 'I' and 'O' position so as to provide positive indication of automatic interruption. The operating mechanism shall be non-tamperable. The MCCB shall have trip-free feature to prevent the breaker from being closed against fault conditions. Multipole MCCB shall have common-trip operating mechanism for simultaneous operation of all poles.

The tripping units shall be one of the following types: -

(a) Thermal-magnetic type with bimetallic elements for inverse time-delay overload protection and magnetic elements for short circuit protection.

(b) Solid state trip unit with adjustable overload protection and adjustable short circuit protection with or without adjustable time-delay.

An arc extinguisher shall be incorporated to confine, divide and extinguish the arc drawn between the breaker contacts each time a breaker interrupts current. The contacts shall be of non-welding type.

Unless otherwise specified in the Drawings and/or and Schedule of Design Requirements, the minimum rated ultimate short circuit breaking capacity (I_{cu}) of the MCCB shall be 50 kA rms at 415V for switchboards connected to transformer or Supply Authority's or Licensee's incomer and 25 kA for the subsequent switchboards.

The rated services short-circuit breaking capacity (I_{cs}) shall be 100% of the rated ultimate short-circuit breaking capacity (I_{cu}) at 415 volts for incoming feeder, and for all outgoing feeder I_{cs} shall be 50% of I_{cu}.

Unless otherwise specified the rated ultimate short circuit breaking capacity (I_{cu}) for MCCB at Distribution Board shall be not less than 10kA at 240/415V (+10%, -6%) and I_{cs} shall not be less than 50% I_{cu} at 240/415V (+10%, -6%).

If current limiting types of MCCB are used, they shall be equipped with current limiting device of either permanent self-resetting power fuse type or magnetic repulsion moving contact type.

The current limiting device shall coordinate with the normal trip mechanism so that all fault and overload currents occurring within the safe capability of the MCCB shall cause the MCCB to open, and all currents occurring beyond the capability of the MCCB shall cause the current limiting devices to operate.

If required, the MCCB shall have facilities for shunt trip, under-voltage/no-volt trip, externally connected earth fault protection, externally connected overcurrent protection etc.. They shall also have auxiliary contacts, accessories etc. for indication, alarm and interlocking purposes if necessary. In area where is specified, and door interlocking facilities to prevent the panel door from being opened to access to the MCCB in closed position, shall be provided.

Where used as incoming feeder from supply source (either from transformer and/or generator set), they shall be of 4 pole type.

1.4.8 MINIATURE CIRCUIT BREAKERS (MCB)

MCB shall be of type approved by Suruhanjaya Tenaga and JKR.

Unless otherwise indicated in the Drawings and/or Schedule of Design Requirements, MCB shall have breaking capacity not less than 6kA (rms) and of C-type with class 3 energy limiting characteristics. They shall comply with MS IEC 60898-1 and/or MS IEC

60898-2, fully tropicalised and suitable for use on a 240/415 V, 50Hz. a.c. system and up to an ambient temperature of 40 ^{0}C.

They shall be quick-make, quick-break and trip free type complete with de-ion arc interrupters. The tripping elements shall be of thermal magnetic type with inverse time delay overcurrent and instantaneous short circuit characteristic. The respond to overload shall be independent of variations in ambient temperature.

They shall be manually operated by means of toggle type handles having visual indication of whether the breaker is opened, closed or tripped. Multipole MCB shall be of all pole protected type and provided with common-trip mechanism for simultaneous operation of all the poles.

Where used as incomer, they shall be of 2 or 4 pole type.

1.4.9 FUSESWITCHGEARS

Fuse-switch disconnector and switch-fuse disconnector shall be of totally enclosed flush or surface mounting, double air break, quick-make and quick-break type complete with phase barriers and fully comply with MS IEC 60947-1 and MS IEC 60947-3. They shall be of utilization category AC-23A. They shall be equipped with operating handle, position ON-OFF indicator and mechanical door interlock to prevent the cover from being opened. However this interlock shall be able to be defeated by competent person for maintenance purpose. The terminals and fuses shall be minimum IP20. The doors shall be provided with dust seal.

They shall be equipped with replaceable HRC fuses. The fuse holder shall have shrouded base contact with provision for busbar mounting and front wiring. The fuse links and fuse carrier shall comply with relevant parts of MS IEC 60269. Suitable knockouts shall be provided for cable entry.

1.4.10 ISOLATING SWITCHES

Isolating switches or switch-disconnector shall be of metal-clad or high impact insulating material (e.g. polycarbonate) type. They shall fully comply with MS IEC 60947-1 and MS IEC 60947-3. The degree of protection shall be IP54 for indoor installation and IP65 for outdoor installation. They shall be able to operate continuously at full current rating without de-rating, capable of making and breaking currents under normal condition and when in open position, providing isolation from source of electrical energy for reasons of safety.

They shall be quick-make, quick-break type suitable for use on 240/415 V, 50Hz. a.c. system. They shall be provided with removable top and bottom end plates or knockouts for cable entry. The enclosure, the isolating mechanism and all other accessories shall be from the same manufacturer.

The enclosure for metal-clad type shall comprise of heavy gouge steel plates rust protected and finished grey stove enamel. Front access doors for metal-clad type, which is detachable, shall be fitted with dust-excluding gasket and shall be interlocked to prevent opening when the switch is ‘On’. However this interlock shall be able to be defeated by competent person for maintenance purpose. It shall be provided with, if required, facilities for lock-on and lock-off the operating handle.

1.4.11 CONTACTORS

Contactors shall comply with IEC 60947-1 and 60947-4-1. They shall be fully tropicalised, suitable to be used up to an ambient temperature of 40ºC and suitable for use on 240/415V (+10%, -6%) 50Hz. A.c. supply system.

The contacts shall be of quick-make and quick-brake type, dust-proof and rust protected. They shall be utilisation category as per Table 4A.

Table 4A – IEC Utilization Categories

Current	Utilization Category	Typical Applications
AC	AC-1	Non Inductive or slightly inductive loads, resistance furnaces, heaters.
	AC-2	Slip-ring motors : switching off
	AC-3	Squirrel-cage motors: starting, switching off motors during running Most *typical industrial application*
	AC-4	Squirrel-cage motors: starting, plugging[1], inching[2]
	AC-5a	Switching of electric discharge lamps
	AC-5b	Switching of incandescent lamps
	AC-6a	Switching of transformers
	AC-6b	Switching of capacitor banks
	AC-7a	Slightly inductive loads in household appliances: mixes, blenders
	AC-7b	Motor-loads for household applications: fans, central vacuum
	AC-8a	Hermetic refrigerant compressor motor control with manual resetting overloads
	AC-8c	Hermetic refrigerant compressor motor control with automatic resetting overloads

(1) Plugging – Stopping a motor rapidly by reversing the primary power connection.

(2) Inching – Energizing a motor repeatedly for short periods to obtain small incremental movements.

The contactor shall have multiple contacts and unless otherwise specified shall be normally-open.

1.4.12 PROTECTION RELAYS

The protection device shall be of the type acceptable to the Supply Authority or Licensee and JKR. The protection relays shall be of panel flush mounting type. All relays shall comply with relevant parts of IEC 60255.

Overcurrent and earth fault protection shall be provided by externally connected current transformers.

Unless specified in the Drawing and/or Schedule of Design Requirements, electromechanical overcurrent and earth fault relay shall be of Inverse Definite Minimum Time (IDMT) type.

For overcurrent relay of IDMT induction disc type, current settings shall be from 50% to 200% adjustable in seven equal steps and time multiplier settings from 0.1 to 1.0 seconds adjustable continuously.

Earth fault relay of IDMT induction disc type shall have current settings from 10% to 40% or rated current adjustable in seven equal steps time multiplier settings ranging from 0.1 to 1.0 adjustable continuously.

Earth leakage relay (ELR) shall be of the type suitable for use on a 240/415 V,50 Hz. a.c. system and up to ambient temperature of 40ºC ELR shall be provided with test button for simulation of a fault, earth leakage LED indicator a reset button, protection against nuisance tripping due to transient voltage and d.c. sensitive. Unless otherwise specified in the Drawings and/or Schedule of Design Requirements, ELR shall be of adjustable current sensitivity and adjustable time delay type.

The selectivity range for current sensitivity shall be 0.03A to 10A and the time delay selectivity range of 0 second to 1 second. ELR shall incorporate with matching balanced core current transformer and shunt trip coil for the circuit breaker to which it controls the tripping shall also be provided.

Unless specified in the Drawings and/or Schedule of Design Requirements, the microprocessor based protection relays shall be rated at 240V/415V and operating voltage shall be in a range from 90V to 250V. The relays shall be housed in robust panel flush mounting case to IP 54 and shall be fully tropicalised and suitable to be used up to an ambient temperature of 50ºC and relative humidity of 95%.

Unless otherwise specified, the microprocessor based protection relays shall be of combined three phase over-current and earth-fault protection with instantaneous, definite time and inverse-time characteristics. Time / current characteristic of IDMT overcurrent and earth fault relays shall be of standard inverse curve (3/10).

The microprocessor based protection relays shall give numerical digital readout of set values, actual measured values and recorded values. The relays shall include a serial communication port for external connection to facilitate external reading, setting and recording of relay data and parameters by a personal computer (PC). PC connecting cable and parameter reading/setting/recording PC program shall be provided.

The microprocessor based protection relays shall incorporate with built-in self-supervision system with auto-diagnosis. The self-supervision system shall continuously monitor the relay microprocessor programs. If a permanent fault is detected, an alarm indication shall be given. A 240V/5A alarm contact for connection to external alarm shall be provided.

If current and voltage measurements are specified, the microprocessor based protection relays shall make available these measurements for local display. The measurements shall include three phase currents, phase-to-phase voltages and three phase-to neutral voltages.
The microprocessor based protection relays shall comply with relevant parts IEC 60255 and shall also comply with relevant parts of IEC 61000 on electromagnetic compatibility.

1.4.13 MEASURING INSTRUMENT AND ACCESSORIES

Measuring instrument and accessories shall comply with the relevant IEC Standards. They shall meet the requirement as specified in the Drawings and/or Schedule of Design Requirements.

1.4.14 MEASURING INSTRUMENT

Measuring instrument shall be of panel flush mounting type with square escutcheon plate finished matt black and pressed steel case. They shall be of industrial grade type

adequately shielded against stray magnetic fields, conform to the measuring scales and arrangements as shown in the Drawings and calibrated for correct readings. They shall comply with MS 925 and relevant parts of IEC 60051. External zero adjustment shall be provided for ammeters and voltmeters.

Ammeters, unless otherwise specified, shall be of moving iron type having continuous overload capacity of 120% of rated value and full scale value accuracy of ± 2%. They shall be provided with maximum demand indicator, if specified.

Voltmeters shall be of moving iron type having overload capacity of 200% of rated value and full scale value accuracy of ± 1.5%.

Kilowatt-hour meter shall be of 6 numbers wheel cyclometer aluminium type with both the current and voltage coils on laminated cover fabricated from high quality silicon steel strip. They shall have overload capacity of 200% of rated value and accuracy of ± 0.5% at the supply voltage and frequency characteristic.

Power factor meters shall be of balanced type using ferrodynamic, cross-coiled mechanism with measuring range from 0.5 lagging to 0.5 leading. Full scale value accuracy shall be ± 1.5%.

Frequency meters shall be of reed type with frequency range from 45 Hz. to 55Hz. and accuracy of ± 5%.If specified in the Drawings and/or Schedule of Design Requirements, the microprocessor based power meter shall be rated at 240V/415V and operating voltage shall be in arrange from 90V to 265V.

The meters shall be housed in robust panel flush mounting case to IP 54 and shall be fully tropicalised and suitable to be used up to an ambient temperature of 50 0C and relative humidity of 95%.The meters shall give direct numerical digital readout of actual measured values and recorded values. The meters shall include one serial communication port for external connection to facilitate external reading and recording of meter data and parameters.

The measurements and their accuracy of the microprocessor-based meters shall be: -

Parameters / measurements	Accuracy
Volts (V): line-line / line-neutral	0.5% of reading ± 2 digit
Currents (A): per phase	0.5% of reading ± 2 digit
Frequency (Hz)	0.1 Hz ± 1 digit
Power Factor: total	1% of reading ± 2 digit
Active Power (kW): total	1% of reading ± 2 digit
Reactive Power (kVAr): total	1% of reading ± 2 digit
Apparent Power (kVA): total	1% of reading ± 2 digit
Active Energy (kWh): total	1% of reading
Reactive Energy (kVArh): total	1% of reading
Maximum Demands (A, W, VA): total	1% of reading ± 2 digit

If harmonics content measurement is specified, individual and total harmonics distortion on the current and voltage up to 30th harmonic shall be measured with the accuracy of 1% of reading.

There shall be a custom display screen, which can be programmed to display customised specific parameter requirements.

All data shall be continuously and concurrently logged, recorded and stored in internal non-volatile memory. All time base logged-in data can be retrieved and downloaded to a personal computer (PC) using serial communication port. PC connecting cable and data retrieving PC program shall be provided

The meters shall comply with IEC 60359 and IEC 60688. The meters shall also comply with relevant parts of IEC 61000 on electromagnetic compatibility.

1.4.15 CURRENT TRANSFORMERS

Current transformers shall comply fully with MS 1202 and IEC 60044-1 and shall have short time rating not less than that of the switchboard in which they are incorporated. The secondary shall be rated for 5A. They shall be adequately rated in VA to carry the summation of all VA burdens of the connected loads but in any case, the rating shall not be less than 15VA. They shall be capable of withstanding, without damage, on open circuit secondary with full primary current.

They shall be constructed from high quality silicon steel or resin encapsulated steel core. They shall be installed inside the switchboard in such a way that it is easily accessible for maintenance purpose. Identification labels shall be fitted giving type, ratio, rating, output and serial numbers.

Unless otherwise specified, current transformers used for measuring and metering shall be of Class 1.0 accuracy and those used for protection shall be of Class 10P10 accuracy.

1.4.16 SURGE PROTECTION DEVICE

The surge protective devices (SPDs) shall be one-port type compatible with the 240/415V (+10%, -6%), 3 phase, 4 wire, 50Hz with solidly earthed neutral supply system it is protecting. The SPDs shall be of the type complying with MS IEC 61643-1, MS IEC 61643-12 and IEE Std C62.41.2 and in accordance with recommendations of MS IEC 62305 and the relevant parts and section of MS IEC 60364.

If the specifications conflict in any way, with any or all of the above/ standards, the specification shall have precedence and shall govern.

The SPDs shall be designed for the average isoceraunic level of approximately 200 thunder-days per year.

The SPDs modes of protection shall be each phase-to-neutral (L-N), each phase-to-earth (L-E) and neutral-to-earth (N-E) for either single phase or three phase supply system.

The SPDs shall be of voltage limiting type with metal oxide varistors (MOVs), or voltage switching type with gas discharge tube (GDT)/spark gap, or combination type with MOVs and GDT/spark gap. MOVs and GDT shall comply with MS IEC 61643-331 and MS IEC 61643-311 respectively.

The maximum continuous operating voltage (U_c) of SPDs shall be minimum 175V for SPDs connected between L-N and (L-E). When SPDs connected between (N-E), the rating of Uc shall be minimum 240V. The continuous operating current (I_c) for each mode of protection shall not exceed 3mA. In the case where the MOVs are used, the SPDs shall be provided with integrated thermal protection to avoid thermal runaway due to degradation.

The SPDs to be installed with respect to the location of category shall be as in Table 7A. The maximum discharge current (I_{max}) of SPDs shall be declared by the SPD manufacturer by submitting the V-I characteristic of a MOVs / GDT / spark gap.

The SPDs shall be equipped with visual indicator showing the protection status of the SPDs. Unless otherwise specified, SPDs shall be provided with auxiliary contact for connection to remote monitoring of SPDs protection status. A durable label with red lettering on a white background with words as stated below shall be fastened externally on the front cover of the SPDs compartment.

AMARAN

1. Pemasangan ini dilindungi oleh Surge Protective (SPD).
2. SPD tidak lagi berfungsi apabila 'petunjuk' bertukar warna/ tidak menyala.
3. Slia buat pemeriksaan pada SPD secara bulanan.
4. Sila hubungi 'orang kompeten' untuk penggantian SPD.
5. Pastikan juga 'circuit breaker' ke SPD sentiasa berada dalam keadaan ON (I).

The size of connecting conductors shall be as recommended by the SPD manufacturer. The connecting conductors shall be as short as possible (preferably not exceeding 0.5m for the total length) and shall be tightly bound together throughout the whole length with cable-ties or other approved means. Either a or a fuse of rating as recommended by the SPD manufacturer shall be provided for disconnecting the SPDs from the system in the event of SPDs failure or for maintenance. In the case where an MCCB is used, the breaking capacity of the MCCB shall comply with the rated ultimate short circuit breaking capacity (I_{cu}) for the switchboards and DB respectively. The I_{cs} shall be 50% of the I_{cu}.

Location Category	**1.2/50µs (U_{oc}) Voltage Generator**	**8/20 µs (I_{sc}) Current Generator**	**Voltage Protection Level (Up)**	**Maximum Discharge Current, Imax (8/20 µs) per mode**
Main Switchboard (MSB)	≥ 20 kV	≥ 10 kA	≥ 1800 V	≥ 65 kA
Sub-Switchboard (SSB) receiving energy from MSB located in the same building	≥ 10 kV	≥ 5 kA	≥ 1500 V	≥ 40 kA
SSB receiving energy from MSB located in other building	≥ 20 kV	≥ 10 kA	≥ 1800 V	≥ 65 kA
Distribution Board (DB) receiving energy from SSB located in the same building (*for cases where the SSB located in other building with MSB)*	≥ 6 kV	≥ 3 kA	≥ 1200 V	≥ 20 kA
Distribution Board (DB) receiving energy from SSB located in the same building (*for cases where the SSB located in other building with MSB)*	≥ 10 kV	≥ 5 kA	≥ 1500 V	≥ 40 kA
DB receiving energy from the licensee or MSB/SSB located in other building	≥ 20 kV	≥ 10kA	≥ 1500 V	≥ 40 kA
Socket Outlet or Terminal Equipment	≥ 2 kV	≥ 1 kA	≥ 500 V	≥ 10 kA

1.4.17 SYSTEM OF WIRING

The system of wiring shall be surface wiring, concealed wiring, surface conduit wiring or concealed conduit wiring as indicated in the Drawings and/or Schedule of Design Requirements. The wiring systems shall comply with MS IEC 60364-5-52.

All wiring shall be run neatly and in an orderly manner. They shall be routed parallel to building wall and column lines in a coordinated manner with other services. The wiring throughout shall be on the 'looping-in system' and no 'tee' or other types of joints are allowed. No reductions of the strands forming the conductors are allowed at all terminals. All strands shall be effectively secured by approved means.

Wiring which are not embedded in concrete or concealed behind plaster shall be run in an accessible manner on the beams, underside of slabs or below pipes, ducts, and down drops shall be run on the surface of columns or walls. Concealed wiring shall be installed in such a way that plaster can be applied over their thickness without being subjected to spalling or cracking. Cables serving different operating voltages and functions shall be segregated.

All cables shall be legibly marked on the external surface with at least the following elements; Manufacturer's identification, Voltage designation, Nominal area of conductor and Standard Numbers. Standard colour coded cable shall be used for three phase circuit to identify the phase conductors, neutral conductor and protective conductor respectively.

Opening on floor, wall or partition through which cable, trunking, conduit or other wiring passes through shall be sealed according to the appropriate degree of fire resistance after the installation.

Chipping and cutting of concrete are not allowed unless otherwise approved by the S.O.'s Representative. The Contractor is required to work in conjunction with the building contractor for the provision of openings, trenches, core-holes, chases etc. as the building concreting work progresses.

In steel frame structures, the wiring system shall be rigidly and securely supported and fastened in place onto the structural steel beams, purlins and columns by fasteners such as clamps, clips, anchors, straps, hangers, supports or similar fittings. The fasteners shall be designed and installed as not to damage either to steel structures or wiring system.

The fasteners shall be installed at intervals not exceeding 1000 mm, and within 300 mm of every outlet box, junction box, device box, cabinet or fitting. Fasteners shall be of spring steel and/or galvanised steel, and where wires, rods or threaded rods are used with fasteners, they shall be of rolled carbon steel. The fasteners shall be finished with zinc coatings to resist rusting. Samples for the fasteners used shall be submitted to S.O.'s Representative for approval before they are used.

Unless otherwise approved by S.O.'s Representative, no welding on and/or drilling holes into any members or components of the steel frame structures for the installation of fasteners are allowed.

1.4.18 TYPES OF CABLE

1.4.18.1 PVC Insulated PVC Sheathed Cable

PVC insulated PVC sheathed cables of300/500 V grade to MS 136 and 600/1000 V grade to MS 274. The conductors shall be of stranded plain annealed copper to MS 69 and MS 280.The insulation shall be suitable for continuous operation at a maximum cable temperature of 70oC and comply with MS 138.

1.4.18.2 PVC Insulated Cable

PVC insulated cable of 450/750 V grade to MS 136 and 600/1000 V grade to MS 274. The conductors shall be of stranded plain annealed copper to MS 69 and MS 280. The insulation shall be suitable for continuous operation at a maximum cable temperature of 70^0C and comply with MS 138.

1.4.18.3 XLPE/PVC Cable

Cable shall be manufactured and tested in accordance to BS 5467 or IEC 60502 and shall have high conductivity plain copper stranded conductors, insulated with cross-linked polyethylene (XLPE), suitable for a voltage of 600/1000V laid together and bedded with extruded PVC and sheathed with PVC.

1.4.18.4 Armoured Cable

(a) PVC/SWA/PVC Cable – Cable shall be manufactured and tested in accordance with MS 274 or BS 6346 and shall have high conductivity plain copper stranded conductors insulated with PVC suitable for a voltage of 600/1000V laid together and bedded with PVC, armoured with galvanized steel wires and sheathed with PVC.

(b) XLPE/SWA/PVC Cable – Cable shall be manufactured and tested in accordance to BS 5467 or IEC 60502 and shall have high conductivity plain copper stranded conductors, insulated with cross-linked polyethylene (XLPE), suitable for a voltage of 600/1000V laid together and bedded with extruded PVC, armoured with galvanized steel wires and sheathed with PVC.

(c) XLPE/AWA/PVC Cable – Cable shall be manufactured and tested in accordance to BS 5467 or IEC 60502 and shall have high conductivity plain copper stranded conductors, insulated with cross-linked polyethylene (XLPE), suitable for a voltage of 600/1000V laid together and bedded with extruded PVC, armoured with aluminium wires and sheathed with PVC.

1.4.18.5 Mineral-Insulated Cables

Mineral-insulated cables shall be manufactured complying with IEC 60702, IEC 60331 and BS 6387 Category C, W and Z for electrical circuit integrity in case of fire. The cables shall have been tested to comply with IEC 60332-1 and 60332-3 for flame retardance, and IEC 61034 for smoke obscuration. The cables shall be halogen free with low organic content and do not release any corrosive emission when subject to fire conforming to IEC 60754-2. The cables shall be able to withstand a short circuit temperature of 280°C for 5 seconds. For general lighting and power points final circuits, unless otherwise specified, cables of 600V insulation grade may be used.

For main circuits and major power points, the cables used shall be of 1000 volt insulation grade. They shall be installed strictly in accordance with the manufacturer's recommendation and instruction. The mineral-insulated cables shall be as specified:

(a) Mineral-insulated copper sheathed copper conductor (MICC) cables comprise of pressure packed magnesium oxide insulation contained within a solid drawn ductile seamless copper sheath with solid high conductivity copper conductors; or

(b) Mineral-insulated mineral sheathed copper conductor (MIMS) cables comprise of multi stranded high conductivity copper conductors wrapped with layers of glass mica composite tape flame barrier and be insulated with a non-melt cross linked mineral insulation and mineral sheathed.

Cables installed on walls shall be fixed by means of copper clips or copper saddles at appropriate spacing. The clips or saddles shall be secured by means of brass screws. Where cables are installed on cable trays, they shall be clipped at appropriate spacing by means of copper saddles. The saddles shall be secured by means of brass bolts and nuts. Where single core cables are used on multi-phase distribution work, the cables shall be laid on their phase groups whether flat or trefoil.

Where single core cables pass through ferrous or other magnetic materials, the area surrounding the cables shall be replaced with non-ferrous plate of appropriate dimensions. Adequate bonding shall be provided where cables break formation to enter terminating positions. Minimum bending radius shall be not less than six times the cable diameter and saddle spacing not more than 60 times the cable diameter or 500 mm whichever is less.

Connection to motors, generators, transformers and other similar equipment shall be by one of the two methods listed below: -

(a) The cable shall be clipped at the appropriate spacing up to a point adjacent to the equipment and an unsupported anti-vibration loop shall be left in the cable.

(b) The cable shall be glanded into a suitable terminal box adjacent to the equipment and connection to the equipment being effected by means of mechanically protected flexible cable of adequate cross sectional area.

For mineral-insulated copper sheathed copper conductor (MICC) cables, termination shall be of cold seal type. Silicon rubber sleeve insulation shall be used to replace copper sheath stripped off near the termination for temperature not exceeding 150oC. For temperature exceeding 150oC, varnished glass sleeve insulation shall be used. Insulation and continuity tests shall be carried out before and after the cable is terminated. The insulation test reading shall be ‘infinity’. A blow lamp may be used for drying out cable ends.

If it is impracticable to cut to waste, in which event the cable should be brought to cherry red heat at about 600 mm from the end and moisture driven carefully towards the cut end. It is absolutely essential that great care shall be taken to maintain earth continuity when terminating the cables. Dirt and metallic particles in the compound and any loose traces of dielectric left at face of the sheath after stripping shall be removed prior to sealing. Cold sealing compound shall be forced down one side of the pot only until slightly overfilling in order to avoid trapping of air at the base of the pot and to ensure that when the sealing disc is entered before crimping a completely solid insulation barrier is affected.

All other necessary accessories such as tap-off units, joint boxes, brass compress ring glands, screw-on brass pots, earth tail seals, coloured sleeving for phase identification, cone shape beads, fibre disc, brass locknuts etc. required for the proper installation work, unless otherwise approved by the S.O.'s Representative, shall be of the type manufactured by the cable manufacturer.

For mineral-insulated mineral sheathed copper conductor (MIMS) cables, termination shall be metal gland or close fitting metal bush of crimping type. All other necessary accessories such as tap-off units, joint boxes including termination kits etc. required for the proper installation work, unless otherwise approved by the S.O.'s Representative, shall be of the type manufactured by the cable manufacturer.

1.4.19 WIRING IN CONDUIT/TRUNKING (SURFACE OR CONCEALED)

The cables used in conduit wiring, unless otherwise specified shall be similar to that described above. Unless otherwise specified in the Drawings and/or Schedule of Design

Requirements, the conduits shall be of galvanized steel and conduit fittings shall be of galvanized steel or alloy materials. Cables above false ceiling shall be run in conduit or trunking.

The conduit shall generally be run on the underside of the floor slabs by mild steel brackets or suspenders. The trunking shall be suspended from the floor slabs or mounted against the wall by mild steel brackets. The mild steel brackets shall be anti-rust treated, painted with a primer and finished in orange enamel. The suspension structure shall be robust in constructions and adequately installed such that the conduit/trunking will not sag.

Conduit for lighting point shall be terminated in a junction box complete with die-cast cone-shaped metal cover so that downdrop to luminaire shall be carried out through flexible steel conduit up to luminaire. Ceiling fan points shall be run in the similar way. Flexible conduit shall be used for termination to equipment, which is subjected to movement or vibration. However, the length of this flexible conduit shall not exceed 400mm unless approved by the S.O.'s representative.

1.4.20 METALLIC CONDUITS

Steel conduits shall be of galvanised, heavy gauge, screwed type complying with MS 275-1, MS 1534:PT.1, MS 1534:PT.2:Sec1, IEC 60423, IEC 61386-1 and IEC 61386-21. All steel conduit fittings shall comply with MS 275-2, MS 1534:PT.1, MS 1534:PT.2:Sec1, IEC 61035-1, IEC61035-2-1, IEC 61386-1 and IEC 61386-21. The steel conduits shall be fitted with brass bushes at the free ends and expansion devices at appropriate intervals. The ends of each length of steel conduit shall be properly reamed. The termination to the distribution boards, consumer units, switchgears and outlet boxes shall be effected by brass type smooth-bore bushes. All steel conduits shall be effectively earthed.

For laying underground steel conduit shall be used and buried at a minimum depth of 450 mm below ground level or 100 mm below floor slab or hard standing. Junction boxes, outlet boxes etc. shall be of galvanised sheet steel or alloy material or malleable cast iron. The covers shall be galvanised sheet steel or alloy material with thickness not less than 1.2 mm. Accessories such as junction boxes down dropping to luminaires shall have die-cast cone-shaped metal cover.

1.4.21 CABLE TRUNKING

Cable trunkings shall comply with IEC 61084. They shall be fabricated from galvanised sheet steel and finished with two coats of standard enamel paint. They shall be equipped with removable covers at suitable intervals. They shall be supplied in lengths to suit the installation and shall have the following minimum wall thickness: -

NOMINAL SIZE (mm x mm)	MINIMUM WALL THICKNESS (mm)
50 x 50 and below	1.0
75 x 50 to 100 x 100	1.2
150 x 50 to 300 x 150	1.6
Above 300 x 150	2.0

All trunking elbows, offset and combination elbows, adaptors and tees shall be of same thickness as the straight trunking and shall be the type manufactured and supplied by the same trunking manufacturer.

The trunking shall be supported by fixing brackets so that the trunking will not be in contact with the walls or floor slabs. The brackets shall be installed at intervals not greater than 1500 mm for vertical runs and not greater than 1000 mm for horizontal runs. The brackets shall be derusted, finished in a primer and coated with standard enamel paint.

Wherever the trunking passes through a floor or a fire resistant wall, fire-resisting barrier shall be provided. At these positions the cables shall be sealed with non-hygroscopic fire resisting material of minimum 2-hour fire rating. In addition, the floor openings and wall openings shall be sealed with similar type of compound.

Cables running in the trunking shall carry conductor identification colours and shall be supported by split hard wood racks securely fixed at the base of the trunking and spaced not more than 600 mm apart.

Cables for each final circuit shall be properly bunched together and labelled. Where conduit is tapped off from the trunking, suitable brass type smoothbore bushes shall be fitted at all conduit termination. Unless otherwise specified, all trunkings shall have either tinned copper tape of dimension not less than 25 mm x 3 mm as circuit protective conductor or earth cable of appropriate size. In the latter case, all trunking joints shall be bridged by means of tinned copper tape of dimension not less than 25 mm x 3 mm.

1.4.22 CABLE TRAYS

Cable trays system shall comply with MS IEC 61537 and shall be fabricated from perforated galvanised sheet steel complete with all necessary bends, tee pieces, adaptors and other accessories. The minimum thickness of the sheet steel shall be 1.5 mm for cable trays with widths up to and including 300 mm and 2.0 mm for cable trays with width exceeding 300 mm. However minimum thickness for the sheet steel of the perforated hot dipped galvanised cable trays shall be 2.0 mm. Cable trays may either be suspended from floor slabs by hangers or mounted on walls or vertical structure by brackets at 600 mm intervals.

However where the above methods of installation are not feasible or practical, suitable floor mounted mild steel structures shall be provided. All supports, hangers and structures shall be robust in construction and adequately installed to cater for the weights of the cables and trays supported on them so that cable trays and cables will not sag. All supports, hangers, bracket and structures shall be anti-rusted, finished in primer and coated with standard enamel paint.

All supports, hangers, bracket and structure for the perforated hot dipped galvanised cable trays shall also be of hot dipped galvanised type. Fixing clips and cleats for cables on trays shall be installed by means of bolts, washers and nuts.

All tees, intersection units, adaptor units etc. shall be the type manufactured by the cable tray manufacturer unless otherwise approved by the S.O.'s Representative. Wherever cable tray pass through a floor or a fire resistant wall, fire-resisting barrier as mentioned above shall be provided.

1.4.23 CABLE LADDER

Cable ladder system shall comply with MS IEC 61537 and fabricated from mild steel and finished in hot-dipped galvanised or epoxy powder coat complete with all necessary horizontal elbow, horizontal tee, horizontal cross, reducer straight, outside riser, inside riser, reducer left, reducer right, cable clamp, cantilever arm, hold down clip/clamp, hanger bar, vertical splice plate and horizontal splice plate for welded type and screwed type. The minimum thickness of the sheet steel shall be 2.0 mm.

Cable ladder may either be suspended from floor slabs by hangers or mounted on walls or vertical structure by cantilever arm. Cable ladder shall be supported rigidly and adequately by external spring hangers mounted on channel base. The cable ladder shall be supported at maximum intervals of 3000mm for in contact with the wall or floor slab surfaces. The spring hangers shall be supplied by the cable ladder manufacturer. All supports, hangers, and structures shall be robust in construction and adequately installed to cater for the weights of the cables and ladder supported on them so that cable ladder and cables will not sag.

Rungs shall be spaced at 300mm nominal centres, welded to the rail sections by approved welding procedures. All rungs shall be perforated in accordance to the manufacturer's design.

The cable ladders shall be supplied fully assembled with preparations for connections to straight sections or accessories using splice plates mechanically bolted together. Allowance shall be provided for longitudinal adjustments and expansion. The cable ladders when completed shall be smooth, free from all sharp edges and shall be capable of discharging any water that may be retained due to normal weathering.

All accessories shah be the type manufactured by the cable ladder manufacturer unless otherwise approved by the S.O.'s representative. Wherever cable ladder pass through a floor or a fire resistant wall, fire-resisting barrier as mentioned above shall be provided.

1.4.24 MOUNTING HEIGHTS

Mounting heights listed below shall be measured from the underside of the fitting to the finished floor level. Unless otherwise specified or directed on site by the S.O.'s Representative, heights of fixing shall be as follows: -

Type of Fitting	Mounting Height (mm)
Suspended ceiling luminaries and ceiling fans	2400
Wall mounted luminaries and wall bracket fans	2050
Switches, and fan and regulators	1450
Socket outlets (for surface wiring), and those in the kitchen and washing areas (for concealed wiring)	1450
Socket outlets (for concealed wiring)	300
Isolator points	1450
Window unit air conditioner switches and starters	1450
Cooker points	1450
Water heater outlet points.	1450
Distribution boards (in service duct)	1450
Distribution boards (other than in service duct)	2050

1.4.25 EARTHING

All motors and equipment earthing shall comply with Electricity Regulations 1994 and relevant parts of MS IEC 60364.

All protective conductors, copper tapes and earth electrode shall comply with BS EN 13601.

1.4.26 LABELLING

Labels shall be fitted on the outside of all switchboards by means of non-corrodable screws or rivet or any other method approved by the S.O.'s Representative. The labels shall be of laminated plastic with engraved lettering with details such as type of equipment, rating, setting, to/from where it is connected etc.

The exact wording of the labels shall be agreed with the S.O.'s Representative. Single line mimic schematic circuit diagram shall be provided at the facial of the switchboards showing the relevant connection. The single line diagram shall be encased in perspex sheet and riveted on the outside front cover of the switchboard.

1.4.27 STARTERS

The starters for each motor shall comply with regulation of ST or Local Authority. Unless otherwise specified or indicated, the Contractor shall provide the following type of starters: -

kW	PHASE	CONSTRUCTION	STARTER
Below 0.75	1	-	Capacitor start induction run
0.75 to 2.25	3	Squirrel Cage	Direct on Line
2.25 to 7.5	3	Squirrel Cage	Soft Starter Type
Above 7.5	3	Wound Rotor	Soft Starter Type

All soft starters shall be of reliable brand instead of conventional star-delta or auto-transformer starter and designed only for building services application and the power factor shall remain unity at any condition. Soft starter designed for general purpose shall not be used.

---------- END OF SECTION 1.4 ----------

SECTION 2:
SPECIFICATION FOR TESTING AND COMMISSIONING (T&C)

SECTION 2 - SPECIFICATION FOR TESTING AND COMMISSIONING (T&C)

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SECTION 2 - SPECIFICATION FOR TESTING AND COMMISSIONING (T&C)

2.1 INTERNAL COLD WATER SUPPLY SYSTEM

The inspection, testing and approval of the cold water supply by state water authorities shall be the responsibility of the Contractor. Any fee in respect of testing and approval shall be borne by the Contractor. The Contractor shall allow for the cost of all tests to the plumbing system to the satisfaction of the S.O. The completed system shall be tested for water and the plumbing system shall be tested for hydraulic performance.

The cost for providing all testing and measuring equipment, all materials and consumables such as fuel, electricity, water etc. shall be borne by the Contractor.

All pipework which is to be encased or concealed shall be tested and approved before it is finally enclosed.

The Contractor shall give the S.O a full seven day's notice of his readiness to carry out acceptance tests and shall submit for his approval a complete and detailed schedule of the tests to be carried out.

Before the commencement of acceptance tests the Contractor shall have brought the installation to a state of practical completion and shall have completed all of his preliminary testing and adjusted the equipment to its proper running order.

During the testing period no modification, adjustment or other work on the installation shall be carried out without the permission of the S.O. Should there be any contravention of this requirement the results of all tests completed may be rejected and a retest carried out.

No acceptance test shall be carried out except in the presence of the S.O the Local Authority's representative and the Contractor or their respective representative appointed for the purpose.

Should the installation fail to perform in accordance with the requirements of the Specification, the S.O may reject the whole or any part of it. The Contractor shall bear all costs and expenses for all retests and remedial works.

2.1.1 Testing of Internal Pipework

2.1.1.1 Pressure Test

Internal reticulation and main distribution pipes shall be slowly and carefully charged with water in order that all air is expelled from the system. The system shall be allowed to stand full for 24 hours. An air relief valve should be provided at the highest point in the system to bleed off any air that is present.

A test pressure of 1.5 times the maximum working pressure measured at the lowest point or 100 psig measured at the lowest point, whichever imposes the higher pressure on the system, shall be applied for 24 hours. After correction for ambient temperature the pressure drop shall not exceed 5% of the test pressure.

Should any signs of leakage occur in the tanks or pipe-work, their positions shall be marked and the Contractor shall carry out remedial measures. The pressure tests procedure shall be repeated until the whole water system passes.

No pipe-work shall be covered or concealed until it has been tested to the satisfaction of the S.O. Where arrangement of work makes necessary, the piping system shall be tested by sections but final overall test shall be carried out to prove joints between sections.

All equipment not designed to withstand test pressure shall be disconnected during test, but shall be reconnected and tested under actual working pressure.

2.1.1.2 Flow Test

Upon completion of pressure tests on all risers, all pumps shall be run with all valves fully open. During test running, the following data shall be recorded:-

a) Flow at outlet into tank to which water is pumped
b) Head at pump discharge outlet
c) Current consumed, and
d) Voltage

The permanently installed pumps shall not be used for pressure testing of the water system.

2.1.1.3 Flushing/Sterilization of Cold Water System

After completion of the pressure tests to the satisfaction of the S.O and the State Water Authority, the whole system shall be thoroughly flushed with clean mains water to remove any debris within the system.

The Contractor, at his own expense, shall use public water supply for cleaning and flushing out of all the plumbing system that he had installed in this Contract.

Control valves and all equipment liable to damage, shall be disconnected before cleaning out. All strainers shall be thoroughly cleaned out during and at the completion of the cleaning out operation.

2.1.1.4 Balancing

Prior to balancing, all isolation/gate valves shall be checked to be in the fully open position.

The balancing shall be carried out on a floor by floor basis. All water appliances on the floor to be balanced shall be turn on.

2.1.1.5 Records

All pressure, flow and balancing tests shall be recorded and certified by Contractor and S.O.

The S.O reserves the rights to order a re-test should the Contractor fail to produce authentic test record.

2.1.2 Testing of Storage Water Tank

After complete installation of the tank, it shall be thoroughly sterilized and flushed with mix water and chloride of lime with concentration of 1.0 ppm. After flushing, the tank shall be filled with water to maximum operating capacity level and the level of water surface shall be carefully recorded. The tank shall be accepted as satisfactory if after a period of 48 hours there is:-

a) No measured reduction in water level, due allowance being made for evaporation from the surface of water
b) No visible sign of leakage from any part of tank: and
c) No deformation of any part of the surface

If the test results do not satisfy the above conditions of test, the Contractor shall locate and rectify all defects and leakages and the test shall be repeated. The Contractor shall bear all costs and expenses for all tests and remedial works.

2.1.3 Testing of Pump (If Applicable)

All pumps and motors shall be checked for flow rates, pressures and RPM. The input signal device sensors and controllers shall be checked to ensure the pumps cut-in and cut-out at predetermined water levels.

2.1.4 Post Occupancy Testing and Commissioning

Further adjustments to the system controls such as re-balancing, re-tuning, re-checking and re-adjustment etc. shall be made whilst the building is occupied and the installation is in use during the defects liability period. The cost of the adjustment shall be included in the tender.

2.2 SANITARY PLUMBING SYSTEM

The Superintending Officer reserves the right to request for water or air or smoke tests as well as for hydraulic performance to be performed by the Contractor at his expense including the furnishing of the necessary equipment. The testing procedure shall in accordance with BS EN 12056-2.

2.2.1 Water Test

Water test shall be performed before the appliances are connected and may be carried out in sections so as to limit the static head to 4.6 m.

All openings affected by test shall be hermetically sealed and the system shall be filled with water.

The water level shall be maintained by the system at its filled height for a period of thirty (30) minutes by the addition of water.

The quantity of water added to maintain the original water level must not exceed 13.6 litres for every fifty (50) joints in the section tested or of equivalent proportion.

Every joint shall be carefully examined for leaks while system is filled with water.

The soil, waste and ventilation pipework is designed for a gravity system and the maximum test pressure applied shall not exceed 4.6 m.

Once a section of pipework to be tested is filled with water, it shall stand for 30 minutes to absorb any pockets of air. Top up with water, if necessary and add no further water for 30 minutes.

Permissible water loss shall be as tabulated: -

Nominal Pipe Size (mm)	Loss (Volume)
100	0.5 litres/meter
150	0.8 litres/meter
200	1.2 litres/meter

2.2.2 Air Test

Air test may be performed by inserting expanding rubber testing plugs in the lower and upper ends of the main soil pipe and main ventilating pipes and sealing the plugs with water necessary. The water seals of all sanitary appliances shall be fully charged.
The testing plug at the upper end of the ventilation pipe should be fitted with a tee-piece with cock on each branch. A flexible tube manometer should be fixed to one branch while air pressure is being introduced into the system through the other branch until the desired pressure is indicated on the manometer scale.

The air test applied shall be 2.4 mbar (38 mm water gauge) in period not less than 3 minutes without loss.

2.2.3 Smoke Test

Smoke can be introduced into the system by a small machine under the source pressure as for the air test.

The whole system shall be filled with smoke before the openings are sealed with plugs.

The pressure on the smoke shall be maintained for three (3) minutes after the last opening has been sealed.

Smoke test is not recommended if UPVC pipe material is adopted.

Smoke testing shall normally only be used instead of air test when an undetectable leak in the system occurs.

2.2.4 Leak Detection Using Soap Solution

Should the system or section of the system fail the air test or the smoke machine test, as described, soap solution shall be applied to the pipes and joints to detect leakage by the information of bubbles.

2.2.5 Hydraulic Performance

Hydraulic performance discharge tests shall be made from all appliances singly and correctively. Obstruction in any of the pipe lines shall be traced and the whole system examined for proper hydraulic performance including the retention of an adequate water seal in each trap.

---------- END OF SECTION 2 ----------

SECTION 3:
SPECIFICATION FOR SERVICE AND MAINTENANCE

SECTION 3 - SPECIFICATION FOR COMPREHENSIVE SERVICE AND MAINTENANCE FOR INTERNAL COLD WATER AND SANITARY PLUMBING SYSTEMS

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SECTION 3 - SPECIFICATION FOR COMPREHENSIVE SERVICE AND MAINTENANCE FOR INTERNAL COLD WATER AND SANITARY PLUMBING SYSTEMS

3.0 GENERAL

All work to be performed under this Specification shall be in accordance with this specification shall in accordance with the commercial practice and must be in strict accordance with this specification.

3.1 WORKMANSHIP AND MATERIALS

The work described in this Specification shall be performed by workmen skilled in the service, maintenance and repair of the internal cold water and sanitary plumbing system and shall be executed in accordance with the best commercial practice.

All materials to be supplied in connection with work under this Specification shall be new and unused, and shall generally be of the best quality as regards manufacture and performance.

3.2 SUPERVISION

The Contractor shall have a Plumber in charge of the service, maintenance and repair work to be carried out under this Specification. This Plumber must be thoroughly competent in supervising the service, maintenance and repair of internal cold water and sanitary plumbing system of all types and shall be in the direct employ of the Contractor, and acceptable to the Superintending Officer.

The Contractor shall have in his direct employ workmen who are especially skilled in the service, maintenance and repair of internal cold water and sanitary plumbing system of all types.

3.3 SCOPE OF WORK

The work covered under this Specification is to service and maintain all machinery and equipment comprising the complete internal cold water and sanitary plumbing system. The service and maintenance of the complete internal cold water and sanitary plumbing system shall be in strict accordance with the servicing and maintenance schedule as set out in Clause 5 below.

The Contractor shall advise the Superintending Officer of any defects in any parts of the complete internal cold water and sanitary plumbing system observed during routine inspection and service, and shall repair such defects if required to do so by the Superintending Officer.

The Contractor shall also provide emergency repair service during normal working hours and also during overtime hours if required to do so by the Superintending Officer.

3.4 CONSUMABLE MATERIALS

The Contractor shall include in his service and maintenance contract for the supply of the following consumable materials as and when required.

a) All oils and greases required for the lubrication of motor bearing, packing, pivots and other moving parts.

b) All cotton waste, soap detergent and other cleaning materials required for cleaning purpose.

c) All consumable filter elements.

d) All tap washers.

e) All electric contact poits required to replace worn electric contact poits in switchgears, electric control gears and electric relays.

f) All electric fuses required to replace blown or defective fuses.

g) All indicator lamps required to replace blown lamps.

The cost of these consumable materials shall not be charged for separately, but shall be included in the schedule quoted by the Contractor for the service and maintenance of the complete Cold Water Supply and Sanitary Plumbing.

3.5 SERVICING AND MAINTENANCE SCHEDULE

The Contractor shall inspect and service All machinery and equipment comprising the complete internal cold water and sanitary plumbing system at the above premises periodically as schedule in the check list except where otherwise directed by the Superintending Officer.

The Contractor shall report in writing to the Superintending officer any defect/s observed in any part or parts of the complete internal cold water and sanitary plumbing system. The report shall state the causes of the defects observed, and shall include an estimate of the cost of repairs required.

3.6 CHECK LIST (TO BE DONE MONTHLY)

3.6.1 Pumps (If Applicable)

a) Check all seals, glands and pipe line for leakage

b) Check all pump bearing and lubricate with oil or grease

c) Check the alignment and condition of coupling

d) Check all bolt and nut for tightness

e) Clean pumps casing and shaft

f) Check and record pump running pressure

3.6.2 Electric Motor Pumps (If Applicable)

a) Check motor bearing and lubricate

b) Check carbon brush and slip rings and clean as necessary

c) Check and record motor running amperes and voltages

3.6.3 All Electrical Starters, Electrical Control Gears, and Ancillary Electrical Apparatus (If Applicable)

a) Clean, adjust and lubricate all bearings, pivots and other moving parts as necessary.

b) Clean or renew electric contactors as necessary.

c) Renew electric fuse as necessary.

d) Check the performance of the complete pumping and associated equipment as necessary.

3.6.4 Cold Water Piping

a) Check water leakages in piping and rectify accordingly

b) Check water leakages in valve and rectify accordingly

c) Check excessive vibration of piping during pumping

d) Clean strainer baskets

e) Check all water taps for leakages and replace rubber washer as necessary

f) Check ball float valves and adjust as necessary

g) Check water level control indicator

h) Check water leakage at any part of jointing of panel water tank

3.6.5 Internal Sanitary Plumbing System

a) Check access covers, caps and cleaning eyes

b) Check any water leakage at any part of jointing of internal sanitary pipe system

c) Check discharge pipe systems;
   i) It shall be kept in a clean and sound condition.
   ii) Any blockages shall be removed by using hand operated rods and capable passing through the system without damaging the internal surfaces of pipes and fittings.

3.7 INSPECTION AND RECORDS

a) Inspect and check all other equipment under this Sub-Contract, whether or not these are specifically mentioned in this schedule.

b) Instruct the operators responsible for the operation of the plant and equipment on correct methods of operating the plant and equipment and on the maintenance points to be watched.

c) Report in writing to the Superintending Officer any defects observed in any part or parts of the complete pumping and associated equipment. The report shall state the cause/s of the defect/s observed and shall include an estimate of the cost of repairs required.

3.8 SAMPLING OF STORAGE WATER (IF NECESSARY)

The Contractor shall have deemed to have included the sampling and testing of water in storage tanks.

These samples shall be undertaken by maintenance workman who have been examined and certified by a Health Officer that the workman is free from water borne diseases and shall be approved by Local Water Authority.

The worker shall be capable of obtaining samples of water for analysis by the Chemistry Department. Samples for testing to be performed every three months shall include :

a) Chemical Analysis
b) Bacteriological Analysis

Should the result prove unsatisfactory when submitted to Local Water Authority, the

Contractor shall clean, disinfect the entire tank and piping installation.

The above mentioned tests shall be performed again and results shall be forwarded to Local Water Authority for their approval.

3.9 REPAIRS

The Contractor shall repair defects in the complete cold water supply system and sanitary system and ancillary equipment on the instruction of the Superintending Officer.

The cost of such repairs shall not be included in the fixed monthly rate quoted by the Contractor for the service and maintenance of the complete Cold Water Supply system and Ancillary Equipment.

All repairs on the complete cold water supply system and ancillary equipment shall be guaranteed by the Contractor against defects in workmanship and materials for a period of one year to take effect from date of completion of the repairs. During the guarantee period, the Contractor shall rectify defects in repairs carried out by him with no additional charge to the government.

3.10 SERVICE AND MAINTENANCE RECORDS

The Contractor shall provide a service and maintenance record book for the complete Cold Water Supply system and Ancillary Equipment being serviced and maintained by him. This record book shall be kept in the plant room of Cold Water Supply system and Ancillary Equipment being service and maintained, and brief details of all service, maintenance and repairs carried out on complete Cold Water Supply system and Ancillary Equipment shall be entered by the Contractor into this book for checking purposes. The address and telephone number of the Contractor's service station shall also be entered into this record book to facilitate emergency service call.

The Contractor shall also keep an accurate detailed record in duplicate of all service, maintenance and repair work carried out by him on the complete Cold Water Supply System and Ancillary Equipment. This record shall be in the form of a Maintenance/Repair Sheet, and shall be countersigned by the Superintending Officer each time the Cold Water Supply system and Ancillary Equipment is attended to by the Contractor.

3.11 RATES FOR SERVICE AND MAINTENANCE

The price for the service and maintenance of the complete Cold Water Supply System and Ancillary Equipment shall be stated by the Contractor at the time he submits his tender.

This price shall hold good for the period of **THREE** years commencing from the end of the free maintenance period. The Contractor may be required to enter into the contract for the above period with the Government on the Standard Form of Contract for Service and Maintenance of Cold Water Supply & Sanitary Plumbing System.

3.11.1 SCHEDULE OF RATES FOR THE COMPREHENSIVE SERVICE AND MAINTENANCE

The tenderer is to note that the cost quoted for this shall not be included in the tender price but quoted separately in the table below and it will be binding in the event that the Government decides to accept them immediately after the guarantee period.

This cost should not be subjected to variation for the period of 2 years after guarantee period.

COST BASED ON CONTARCT PERIOD OF TWO YEARS ONLY

For the comprehensive service and maintenance of the complete Cold Water Supply & Sanitary Plumbing System; and all ancillary equipment at the above premises in accordance with the maintenance specification and maintenance schedule in this specification.	Cost per month = RM..... X 24 months = RM.....

Signature of Contractor : _____

Contractor's Chop or Seal : _____

_____

Date : _____

Signature of Witness : _____

Witness's Chop or Seal : _____

_____

Date : _____

---------- END OF SECTION 3 ----------