SECTION 3.1 TECHNICAL SPECIFICATION FOR HOSE REEL SYSTEM

1 WATER STORAGE TANK

1.1 Hot Dipped Galvanised Pressed Steel

The storage tank shall be 5 mm thick hot dipped galvanised pressed steel sectional water tank with hydraulically pressed flanges comply to BS 1564:1975 and treated with two protective coats of paint, including bolting sections together, jointing with approved plates and stiffeners, 5 mm chamfered pressed steel covers and mosquito-proof framed access door.

1.2 Tank Accessories

The tank shall be supplied complete with:

(1) Water level indicator of the float type and scales graduated in metres c/w metal indicator arrow, stainless steel wire rope, etc. as shown in the drawing.

(2) External and internal access ladders shall be of stainless steel.

(3) Overflow pipe (one size larger than the inlet pipe).

(4) Scour pipe complete with drain valve and drain pipe.

(5) Inlet pipe c/w float ball (brass) valve (BS 1968:1953) and gate valve.

(6) Outlet pipe connections to pumps and sized according to the drawings.

(7) Galvanised vent pipe of 75 mm diameter in the form of swan neck and covered with stainless steel insect screen.

(8) One number of 600 mm diameter manholes with hinged cover situated near the water inlet pipes.

(9) Warning pipe.

(10) Stainless steel electrodes shall be provided in the storage water tank for sensing low level condition and shall stop the pumps when the storage tank at low level.

The storage tank shall be installed on concrete plinths. The capacity and location of the storage tank shall be as indicated in the Tender Drawings.

All offers of storage tank shall be supported by copies of the most current test certificates from SIRIM, or other authorities having jurisdiction.

2 PUMPING EQUIPMENT

The total number and the duty of each Fire Hose Reel Pump to be provided are as indicated in the Schedule of Design Requirements and/or Tender Drawings. The Hose Reel Pump System comprises a duplicate set of pumps, one known as the 'Duty Pump' to operate on normal electric power supply and the other a 'Standby Pump' arranged to operate either on emergency power supply or by a diesel engine, in case of mains failure, as indicated in Schedule of Design Requirements and/or Tender Drawings.

All pumps shall comprise of standard heavy duty end suction pump, and shall have a smoothly cast volute, machined and balanced impeller fitted to stainless steel shaft and sleeves, turning in heavy duty ball thrust and roller bearings, with leak proof mechanical

seals. The material of the impeller shall be high grade bronze/stainless steel as indicated in Schedule of Design Requirements. All electric driven pumps shall be direct-coupled to its driving motor by flexible type steel couplings and the whole unit shall be mounted on a common rugged steel base plate.

All pump units shall be mounted on raised concrete plinth and the overall height of the plinth shall be as indicated in Schedule of Design Requirements and/or Tender Drawings. The Contractor shall supply and install the concrete plinth and shall be responsible to ensure smooth running, quiet operation with noise effectively reduced.

Each pump shall be fitted with suction strainer, suction valve, anti-vibration flexible coupling, discharge 'non-slam' check valve, discharge valve, pressure gauges, renewable casing wearing rings, renewable bronze shaft sleeves at the mechanical seal and a priming cock as indicated in the drawings.

All pumps shall be specifically chosen for their particular operation as regards water quantity, operating speed and working head.

All pumps shall be carefully selected and operate on a suitable flow characteristic curve as denoted by the pump characteristics i.e., at operating condition for a given flow rate and head as indicated in Schedule of Design Requirements.

All pumps and motors shall have full load speed not exceeding 2900 rpm.

2.1 Mechanical Seal

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

2.2 Pump Operation

The pumps shall be arranged such that the Duty Pump starts automatically when a fall in pressure occurs in the rising or distribution mains exceeding 20% of the normal static pressure. The Standby Pump shall automatically take over the duty in the event of failure of the Duty Pump. The pump shall stop automatically when the normal static pressure in the riser or distribution mains has been re-established.

2.3 Diesel Engine

The diesel engine shall be for driving the standby Fire Hose Reel Pump and shall be of cold starting, direct injection type, naturally aspirated single cylinder, air-cooled with variable speed governor, fuel and lubricating oil filters and exhaust silencer. The engine shall be of the industrial type suited for continuous heavy duty performance and shall be rated at not more than 2900 rpm under standard atmospheric conditions. The power output shall be as specified in the Schedule of Design Requirements, with all engine accessories driven, or not less than 120 % of power required to drive the pump at design condition.

The engine is to be started directly by an extra heavy duty 12 Volts or 24 Volts electric starter motor, from a bank of batteries. Automatic and manual starting of the engine shall be provided. Manual starting switch shall be placed on the engine instrument panel.

The battery shall be extra heavy duty maintenance free lead acid rechargeable type of sufficient capacity a minimum of not less than as indicated in Schedule of Design Requirements for Hose Reel System in 5 hour rate of discharge, to provide six (6) successive abortive starts of the engine without recharging, and housed in metal box located beside the engine set. The box shall be lockable c/w lock set and have louvers for sufficient ventilation.

A trickle charger shall be supplied with the battery and of the automatic type with two charging rates. Charger instrumentation shall consists of ammeters, voltmeters, indicating lights for "Main On", "Trickle Charge", "Booster Charge" to be incorporated in the pump control panel in the pump room.

The engine and pump set shall be mounted on raised concrete plinth. The overall height of the plinth shall be as indicated in Schedule of Design Requirements and/or Tender Drawings.

The exhaust pipe shall be discharge outside of plant room and wrapped as shown in the Tender Drawings.

2.4 Fuel Tank

The fuel tank must be of welded steel conforming to BS EN 210:2000 for mild steel drums. The tank must be mounted above the inlet to the Engine Fuel Pump to provide a gravity feed. The tank must be fitted with an indicator showing the level of the fuel in the tank. The tank capacity is indicated in Schedule of Design Requirements (Minimum 30 litres (8 gals.)).

Any valve in the fuel feed pipe between the fuel tank and the engine, must be placed adjacent to the tank and it shall be locked in the open position. Pipe joints must be soldered and the plastic tubing must not be used.

The following auxiliary equipment must be provided:

(1) A sludge and a sediment trap.

(2) An inspection and a cleaning hole.

(3) A filter between the fuel tank and fuel pump mounted in an accessible position for cleaning.

(4) Means to enable the entire fuel system to be bled of air.

(5) Screwed plugs for air relief.

3 PIPEWORK

3.1 General

The work involved includes but shall not be limited to the supply and installation of all necessary pipe, valves, fittings, anchors, supports, brackets, insulation etc. unless specifically excluded elsewhere in this Specification.

The pipework shall be carried out by competent person in accordance with the best engineering practice to conform the diagrams and layouts shown in the Tender

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Drawings.

3.2 Regulations

All pipelines shall be constructed in accordance with the relevant Regulations and Standard.

3.3 General Piping Instruction

In general, piping has been shown diagrammatically on the drawings. Care shall be taken to install this piping exactly as shown. Should field condition prevent this installation exactly as shown, this section of the work shall be decided by Superintending Officer (S.O.).Where piping is to be furred in or concealed or buried under ground, the Contractor is to coordinate all the works to maintain lines and levels.

As soon as lines have been installed, all openings shall be capped or plugged to prevent the entrance of the materials that would obstruct the pipe. Caps and plugs shall be left in place until removal is necessary for completion of installation. All piping shall be flushed or blown clean and strainers or line pockets cleared of all foreign materials before putting the lines into service. All piping shall be thoroughly cleaned, free from scale by wire brushing and shall be left in proper condition for painting or insulating.

3.4 Material

All piping shall be galvanised steel to BS EN 10255:2004 Class 'C'.

Square tees and elbows shall not be used. All changes of direction of the pipe run shall be made with standard bends or long turn fittings.

All piping shall be cut with pipe cutters, accurately to dimensions determined on site and worked into position without springing or forcing. Pipe thread shall be cut with threaded dies and ends reamed before assembly. All screwed and socketed pipe joints shall be made using Teflon or an approved propriety jointing compound and fine hemp. Any threaded tubing exposed after jointing shall be painted to prevent corrosion.

A suitable automatic air release valve shall be fitted to each stack of risers or as indicated in the Tender Drawings.

The contractor shall ensure that all joints are tight and drip-proof.

3.5 Underground Piping

All underground pipes shall be galvanised steel to BS EN 10255:2004 Class 'C', pre-insulated factory wrapped externally with bituminous comply to BS 534:1990 and shall be complete with pipe marker at 20' interval.

Pipes run underground shall be laid at least 900 mm below the surface and adequate provision for protection against vehicle movements and corrosion shall be taken. The insulated pipe shall be carefully laid on a sand bed completely free of stones, back-filled with sand around and over the pipe to a minimum depth of 80 mm. The next layer of backfill shall then be 300 mm deep of material free of stones; etc. The trench shall then be filled with available material.

**** For road crossing, please refer to detail drawing.***

All excavation, backfill of underground pipework shall be done by the Contractor. The work shall be supervised for alignment, levels and protection to the piping.

Piping shall be installed in accordance with good commercial practice. Care should be taken to avoid possible restrictions due to foreign matter, faulty fabrication or improper installation.

3.6 Pipe Jointing

3.6.1 Screwed Joint Connections

Pipe joints up to and including 50 mm (2") diameter on galvanised steel piping shall be made by means of screwed connections.

For screwed joints, the sealing compound to be used shall be litharge or glycerin. Plumber's rope or paint will not be allowed for such purpose. Standard reducing pieces shall be used throughout the whole installation.

3.6.2 Selection of pipe jointing type for 65 mm (2½") diameter and above to suit the operational requirements of the specific installation shall be as per Schedule of Design Requirements and specification below:

(1) Welded Connections

For joints 65 mm (2½") and above, on galvanised steel piping shall be made by means of welded connections.

All welded joints shall comply with BS 2633:1987. Pipe ends shall be prepared by machining, grinding or machine gas cutting or hand flame cutting with subsequent grinding. The portion of galvanised pipe zinc coating damaged during welding process shall be touched up with zinc-rich paint or any appropriate cold galvanizing compounds.

Prior to commencement of welding work, the contractor shall submit a copy of approved Welding Procedure Specification (WPS) and competent welder certificate for approval.

Where welded joints are impractical, or flanges are required for erection purposes, or at connections to fittings and at all flanged valves, flanges shall be fitted and welded onto pipes to approval.

All flanged joints shall be flushed and aligned and shall be made with corrugated joining rings, coated on both sides with the recommended joining compound. All bolts and nuts shall be of galvanised steel of approved manufacturer.

(2) Mechanical Joint Coupling

For joints 65 mm (2½") and above, on galvanised steel piping shall be made by means of mechanical joint coupling.

All joint couplings, fittings, valves, and accessories shall be the products of a single manufacturer.

All castings used for coupling housings, fittings, valve bodies, etc., shall be traceable for quality assurance.

Detail of mechanical joint couplings and fittings shall be shown as per drawing.

All mechanical joint couplings shall conform to ASTM A-536 Grade 65-45-12.

Installation of mechanical joint coupling shall be in accordance with the manufacturer's installation instructions. The Contractor shall remove and replace any joints deemed improperly installed.

Where mechanical joints coupling are impractical, or flanges are required for erection purposes, or at connections to fittings and at all flanged valves, flanges shall be fitted and welded onto pipes to approval.

All flanged joints shall be flushed and aligned and shall be made with corrugated joining rings, coated on both sides with the recommended joining compound. All bolts and nuts shall be of galvanised steel of approved manufacturer.

All welded joints shall comply with BS 2633:1987. Pipe ends shall be prepared by machining, grinding or machine gas cutting or hand flame cutting with subsequent grinding.

Prior to commencement of welding work, the contractor shall submit a copy of a competent welder certificate for approval.

3.7 Pipe Supports

All vertical runs of pipe shall be adequately supported with suitable steel clamps. All horizontal runs of pipe shall be hung from ceiling slab or walls with suitable steel hangers. At the lowest point of a vertical riser pipe, proper additional support shall be used to support from the floor level.

All pipe hangers below the roof shall be fixed to steel bar provided by the Main Contractor.

In the case of pipe support is allowed to be hang at roof structural steel, drilling and punching of hole are not allowed for roof structural steel. Steel bracket/ clamps or proper fixing shall be provided.

All pipes shall be adequately supported by approved type steel hangers. The spacing of these supports shall be as follows:-

SCHEDULE 1: Pipe Spacing

Nominal pipe diameter	Maximum spacing	
	Horizontal spacing	Vertical spacing
Up to and including 50 mm (2" diameter) bore	3 m	3.5 m

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65 mm (2½") bore up to and including 150 mm (6") bore	4 m	4 m

SCHEDULE 2: Anchoring

Pipe sizes (Diameter)	Anchor & Rod Size	Hole Diameter	Anchor Length	Hole Depth
25 mm – 50 mm	6 mm	8 mm	25 mm	25 mm
65 mm – 150 mm	9 mm	12 mm	40 mm	40 mm

3.8 Pipe Sleeves

Pipe sleeves shall be fitted for pipes passing through concrete floors and walls (concrete/brick). Pipe sleeves shall be one (1) nominal diameter larger than the service pipe concerned.

Sleeves for galvanised steel pipe shall be of galvanised pipe off-cuts, and sleeves for copper pipe shall be similar but of brass or copper. Pipe sleeves of 100 mm diameter and above maybe constructed from not less than 3 mm galvanised sheet steel.

Pipe sleeves fitted in floors shall generally end 25 mm above the finished floor level, except in plant rooms and other areas where "wet floors" are expected in these cases, the sleeves shall end 50 mm above the finished floor level.

3.8.1 Fire Resistance Sealant or Non-Combustible Fire Stop Material

Any opening or clearances on floor, wall or partition through which pipe and pipe sleeves passes through shall be tightly caulked with fire resistance sealant or non-combustible fire stop material compliance to BS 476 Part 20 with minimum 2 hours fire protection to form acoustic and fire barrier.

The method of installation for the fire resistance sealant or non-combustible fire stop material through any floors, walls or partitions shall in accordance with manufacturer's instruction.

3.9 Pipework Accessories and Fittings

All valves and fittings necessary for correct control, operation and maintenance of all services shall be provided and installed to the satisfaction of the S.O. 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 valve.

(1) Flexible Couplings 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 50 mm diameter and above. For sizes below 50 mm

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diameter, a similar hose shall be used except that hose clips sealed with mastic shall be used for connection.

(2) Strainers shall be installed upstream of all pumps. For 50 mm diameter and below, the strainers shall be bronze body type. All strainers shall be fitted with permanent magnets and removable bronze screens.

(3) Pressure gauges shall be minimum 150 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.

(4) All valves supplied and installed shall conform to the following standards:

(a) Gates Valve

All gate valves shall be of approved full bore type.

All gate valves up to 50 mm (2") shall be of the screw end bronze body with internal spindle and shall comply with BS EN 12288:2003.

All gate valves above 50 mm (2") shall be of the flange end cast iron body with internal spindle and shall comply with BS 5163-1:2004.

(b) Check Valve

All check valves, horizontal or vertical up to 50 mm (2") shall be screw end bronze type spring loader type and shall comply with BS EN 13709:2010.

All check valves above 50mm (2”) shall be wafer type cast iron with stainless steel disc and shall comply with BS EN 13709:2010.

(c) Ball Valve

All ball valves shall be screw end brass type and shall comply with BS EN 13828.

(5) Pressure switches shall have an operating pressure range of 0 – 1 bar or 0.3 bar – 3.5 bar depending on the line pressure of the system, and shall have stainless steel diaphragm, a mercury switch and to operate on 240 volt, 50 Hertz A.C. supply.

(6) All pipe fittings up to and including 50 mm (2") diameter, shall be of malleable cast iron conforming to BS143 and BS1256.

All pipe fittings having 65 mm (21/2") diameter and above, shall be of galvanised steel type conforming to JIS B2311:2117 or equivalent approved standard within the specifications of the relevant piping circuit and shall be of best quality

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manufactured. Each pipe fittings shall have appropriate identification mark embossed or engraved on it and approved by S.O prior to installation.

The Contractor will not be permitted to fabricate any non-standard fittings without prior approval of the S.O.

(7) All flange fittings shall be factory welded and **no welding** shall be carried out at the site. All flange connections shall have their mating faces machined to a true surface square with the centre line pipe axis $\pm$ 3° deflection from the cross-sectional axis of the pipe. Suitable gaskets shall be provided for leak proof connections.

(8) On-site welding operations should be avoided as far as possible, but if unavoidable they shall be carried out in accordance with BS 2971:1991 and should be carried out by qualified welders.

(9) All bends used shall have radius of not less than five (5) times the diameter. If radius is not obtainable, alternative bends of approved type may be used.

(10) Tees in pipes shall be slipped on or other approved leveled end. All tees shall be of approved manufacturer.

(11) Reduction in diameter for through flow pipes shall be made by means of reducing sockets. Eccentric reducing sockets shall be used on horizontal pipes and concentric reducing sockets for vertical pipes only.

(12) Unions 50 mm and under shall be screwed with ground brass seats.
Unions 65 mm and above shall be standard galvanised steel companion flanges. Where the pipe is galvanised , the union and flanges shall be galvanised . Unions of flanged connections shall be provided where necessary, to permit dismantling of piping or removal of valves and equipment.

3.10 Pipe Arrangement

Typical arrangement of pipe shall be as per drawing.

4 HOSE REEL

The hose reel system shall be of the swing universal type and shall consist of but not limited to the following:

(1) A Stop Valve.
(2) Reel.
(3) Hose.
(4) Shut-off nozzle assembly.
(5) Nozzle box/steel cabinet.

and shall be designed as to facilitate swift withdrawal of the hose in any directions with the reel axis horizontal.

4.1 Rubber Hose

The rubber hose shall have 25 mm internal diameter and a working pressure of 10 bars.

The minimum bursting pressure shall be 42 bars.

The rubber hose shall be manufactured with an inner rubber tube lining, a reinforcement of single rayon braid of cotton conforming to BS EN 694:2001 and an abrasion resistant rubber cover.

The length of the rubber hose shall not be less than 30 meter as indicated in the Schedule of Design Requirements. There shall be no joints in the length of the hose.

4.2 Stop Valve

The stop valve shall be complying with BS EN 671-1:2001, 25 mm diameter and threaded 25 mm B.S.P. (British Standard Pipe) parallel. Any indication of the open or shut position shall be fixed or marked on the wheel of the valve, and the body of the valve shall be marked with directional arrow indicating the direction of flow through the valve.

The hose reel waterways connecting the water supply to the hose excluding the stop valve and that part between the stop valve and the hose reel shall be constructed of non-ferrous material or stainless steel.

4.3 Shut-Off Nozzle

The hose shall terminate in a shut-off nozzle which shall give the following control settings:

(1) Shut, and
(2) Spray; and/or
(3) Jet

Note: When both spray and jet are provided, it is recommended that the sequence should be as above with the spray setting between the shut setting and the jet setting.

Any spray discharge shall be in the form of either a sheet of spray or a conical spray.

4.3.1 Marking of control conditions

Rotary operated nozzles shall be marked to show the direction of closing and opening. Lever operated nozzles shall be marked to show the settings for:

(1) Shut; and
(2) Spray; and/or jet.

4.4 Hose Reel

The hose reel shall extend not more than 350 mm from the mounting surface and shall have an overall diameter not greater than 750 mm. The side plate of the hose reel shall have a continuous outer rim and shall be rigid in construction. The diameter of the inner core on which the hose is wound shall not be less than 200 mm. When the full length of the hose is coiled on the hose reel without the use of abnormal tensions, the rims of the side plates of the hose reel shall project at least 15 mm beyond the external diameter of the coiled hose reel. It shall be arranged in such a way that the hose is not restricted or flattened by the application of additional layers.

Every hose reel shall be marked with the following information:

(1) The manufacturer's name, trade name or mark, or the name, trade name or mark of the responsible vendor.

(2) Instructions for operating and use, which shall include the following:

(a) Turn on stop valve to release nozzle.
(b) Run out hose.
(c) Turn on water at nozzle.
(d) The hose shall be fully charged before winding it on to the reel.
(e) Test pressure in bar (lbf/in²).

4.5 Hose Reel Cabinet

The cabinets if required shall be fitted with a door and fitted with a lock. Lockable cabinets shall be provided with an emergency opening device, which may be protected only by transparent frangible material. The hose reel cabinet shall be unlocked with a key, to provide access for inspection and maintenance. The emergency opening device shall not leave jagged or sharp edges when broken.

5 NOISE AND VIBRATION CONTROL

This section of specification specifies the basic requirement that the noise and vibration isolation control for the mechanical equipment which must be satisfied in order to be considered for the installation.

All mechanical plant and services shall be installed in accordance with the methods of installation and precautions stated herein, and such additional precautions as may be necessary to ensure that the operation of the plant does not result in noise levels or vibration amplitudes beyond the specified limits.

5.1 Pumping Equipment

The 9.0 mm minimum thick neoprene pads / natural rubber shall be installed for all pumps shall have a minimum deflection as follow;

(a) When equipment on stable ground minimum deflection is 19 mm.

(b) When equipment on concrete slab above floor level the minimum deflection.

6 ELECTRICAL INSTALLATION WORK

6.1 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 equipments and services: -

(a) All electric motors, starters, isolators, cable boxes and isolating switches for the fire protection services.

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

(c) Conduit, cable tray, cabling and control wiring from the fire protection switchboards (control panels) to the various items of fire protection and ventilation equipments.

(d) All control equipments, 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 colour-coding.

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

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

(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.

6.2 Fire Fighting Switchboards

6.2.1 Types of Fire Fighting 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, metalclad cubicle type suitable for front and rear access.

(b) Self-contained, floor mounted, flush fronted, metalclad cubicle type suitable for front access.

(c) Wall mounted metalclad 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.**

6.2.2 Enclosures

6.2.3 General

Switch operating handles shall be interlocked with the compartment door so that the door may not be opened until the switch is off.

Light shall be clearly visible at a distance on clear day. The following shall be incorporated in Switchboard:

(1) Duty & Standby Electric Pump:

i) Red, Yellow and Blue lights for phase indication in duplicate.

ii) Red flashing light for A/C FAIL and PUMP ON MANUAL.

iii) Green light for PUMP RUN.

iv) Yellow light for PUMP TRIP.

v) START and STOP push button.

vi) Switch off for A/C isolate and AUTO MANUAL selector switch.

vii) An ammeter and voltmeter shall be provided.

viii) MANUAL START push button.

ix) Amber light for AUTO ON, AUTO CRANK ON, MANUAL ON, and AUTO CRANK FAIL.

x) Green light signals shall be provided on single horizontal alignment spaced adequately to show that the supply is normal. They are A.C ON, CHARGER ON, D.C ON.

(2) A relay shall be provided to sound the alarm bell at the ground floor near the pump room and also to the Master Bell at the Fire Alarm Panel on the starting of any pump.

(3) A relay shall be provided in the switchboard to stop the pump when the water level in the water tank is at low water level and prevent from being switch on again until the water level reach start level.

6.2.4 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. Louvers 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.

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.

6.2.5 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 louver 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 galvanised 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.

6.2.6 Associated Components

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, switchfuses and fuseswitches shall be effected by means of copper bars or rods securely clamped to the busbars and identified by means of coloured plastic sleeving 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).

6.2.7 Air Circuit Breakers (ACB)

ACB shall be of withdrawable metalclad, flush mounted, horizontal draw out 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 eathing bar using of 3 mm x 25 mm tinned copper tape.

6.2.8 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 types 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.

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 over current 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.

6.2.9 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°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 over current 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.

6.2.10 Isolating Switches

Isolating switches or switch-disconnector shall be of metalclad 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 metalclad type shall comprise of heavy gouge steel plates rust protected and finished grey stove enamel. Front access doors for metalclad 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.

6.2.11 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.

6.3 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.

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

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

For over current 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 over current 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.

6.4 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.

6.4.1 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 a range 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.

6.4.2 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.

6.5 Surge Protection Device

The surge protective devices (SPDs) shall be one-port type compatible with the 240/415V (+10%, -6%), 3 phases, 4 wires, 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 U_c 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

6.6 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.

6.6.1 Types of Cable

(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.

(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 70ºC and comply with MS 138.

(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.

(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 galvanised 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 galvanised 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.

(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.

6.6.2 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 galvanised steel and conduit fittings shall be of galvanised 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.

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.

6.6.3 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 luminaries shall have die-cast cone-shaped metal cover.

6.6.4 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.

6.6.5 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.

6.6.6 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.

6.6.7 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

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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

6.7 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.

6.8 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.

6.9 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: -

Fractional hp motors shall squirrel cage type with split phase starting:-

kW	PHASE	CONSTRUCTION	STARTER
Below 0.75	1	-	Capacitor start induction run
0.75 to 2.2	3	Squirrel Cage	Direct on Line
3 to 7.5	3	Squirrel Cage	Star Delta/Auto Transformer
Above 7.5	3	Wound Rotor	Primary & Secondary

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			Resistance/Soft starter

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.

6.10 Electric Motors

All electric motors shall be totally enclosed fan-cooled and fully tropicalised, and shall be furnished with Class 'F' insulation to BS EN 60085:2008 and shall be specifically designed for 50 Hz, 400V (+10%, -6%), 3 phase power supply and to comply with the Electricity Supply Act 1990 (Act 447) and Electricity Regulations 1994 regulations. Motors shall be continuously rated and shall have torque characteristics as required by their respective duties.

6.11 Power Factor Requirement

The monthly average power factor of all the equipment supplied shall be not less than 0.85.

The above condition is to be achieved by power factor improvement equipment or devices. However, if the power factor correction is done other than at the load, than the cabling, electrical switching protection devices between the load and the point of correction shall be rated according to the worst power factor condition that they may be subjected to.

Power factor improvement used shall conform to IEC 70/70 standards and shall be suitable for continuous operation at a nominal voltage of 400V (+10%, -6%)/50 Hz/3 phase.

Capacitors used shall be dry type with self-healing properties and discharge devices. Loss shall not exceed 0.5W/kVar.

When automatic power factor correction bank is used, the regulator with the required number of steps should also incorporate no-volt protection relay, anti-hunting relay and a manual and automatic control switch. The regulator should be set to respond to kVar need of the system with no hunting. The regulator shall have LED display to show the number of steps switched on at any one time and settings for the sensitivity value and the desired power factor.

Current transformer to suitable ratio shall be rated at 15VA and minimum accuracy of Class 1.

The Contractor shall be liable to pay any surcharge, or part thereof, levied by the TNB as a consequence of low power factor of the installed equipment.

7 CLEANING, PAINTING AND IDENTIFICATION

The painting works shall include all equipment, piping, fittings, valves, hangers, conduits, framework, switchboard, etc. and all other works exposed to view.

All paints used shall be of approved brand of best quality, low Volatile Organic Compound (VOC) content and ready mixed paint brought to site in unopened containers.

No painting shall be done in unsuitable weather. Each coat of painting shall only be applied when the previous coat is completely dry.

The Contractor shall provide all tarpaulins, sheets and covering to protect the floors, walls and other works belonging to other trades.

All equipment and piping shall be thoroughly cleaned and degreased upon completion on his work before any painting is carried out.

All metal works shall be cleaned and scale shall be free from grease. The surface shall then be prepared with an approved rust inhibitive primer and two (2) high gloss-finishing coats to approved colors and to the approval of the S.O.

All pipelines shall be painted to approved colors in general to match the surroundings. In addition, lettering and the direction of flow must be indicated by painting a black/white arrow on to the pipelines at appropriate intervals. These arrows shall be 3" long on pipes up to 50 mm (2") diameter, 150 mm (6") long for pipes over 50 mm (2") diameter. All items to be painted shall be first cleaned and prime coated. Over this the final colour shall be applied in two coats. The paint shall be gloss-finish type.

The Schedule of Colours shall be as follows unless otherwise decided by the Superintending Officer.

ITEM	COLOUR
Water Tank	Red
Pipes	Red
Landing Valves	Red
Inlet Connections	Red
All Valves	Red
Items exposed to weather	Two coats of aluminium paint
Directional arrows	White

All Fire Fighting System equipment should be as per UBBL clause 248 or as other colours approved by Jabatan Bomba dan Penyelamat Malaysia.

8 NAME PLATES

Supply and install on each of the following, identification nameplates engraved lettering. The plate size and lettering shall be subject to the approval of the S.O. but no limited: -

(1) Fire fighting switchboard and sub switchboard.

All control components nameplates shall bear the system number and the identification of the control function.

(2) All duty and standby pump.

(3) Pressure indication 'Cut In' and 'Cut Off' of pressure switch.

9 TESTING

After each section of the piping system has been installed it shall be blown clear by air or water, pressure tested and any leaks repaired.

After the complete piping system has been installed, the whole system shall be subjected to a hydrostatic pressure test, in the presence of the Superintending Officer or his representatives, to withstand 1½ times the working pressure for 2 hours. During this period, an inspection of the system shall be made to check that no leakage of water is taking place at any part of the pipe joints or valves.

The four highest and most remote hose reels shall be discharged simultaneously until the duty pump cuts in automatically. With one being led to waste, the other shall be directed into a receptacle of sufficient capacity to determine the flow rate. Alternatively, a flow meter/gauge may be used. The flow rate and distance of jet produced shall be recorded to the satisfaction of the S.O.

The test shall be repeated with a simulated mechanical or electrical failure of duty pump, and the ability of the standby pump to come into service automatically and to maintain the required outputs shall be determined.

The Contractor shall be responsible to arrange, set out and pay all fees in connection to these testing.

10 SAMPLE OF MATERIAL FOR SUBMISSION AND APPROVAL

The Contractor shall prepare sample board of typical material proposed to use in the work and/or samples of workmanship (mock up) to the approval of the S.O, prior to commencement of the installation work. The sample board and/or samples of workmanship (mock up) shall comprise of but not limited to pipes, pipe fittings, pipe hanger and support, shut-off nozzle, automatic air release valve, cables and etc.

The cost of the sample board or samples of workmanship (mock up) is deemed to be included in the Contract.

---------- END OF SECTION 3.1 ----------