

PROPOSED ADDITIONS AND ALTERATIONS WORKS FOR OFFICE OF FOOTBALL ASSOCIATION OF SINGAPORE @ 100 TYRWHITT ROAD, JALAN BESAR STADIUM, SINGAPORE 207542

TECHNICAL SPECIFICATION OF MECHANICAL & ELECTRICAL WORKS

2.0 FIRE PROTECTION INSTALLATION

2.1 PIPEWORK - GENERAL

a. General

All pipework, fittings and supports necessary for the proper functioning of the work, whether or not specifically shown on the drawings and/or called for in the Specification, shall be supplied and installed in full co-ordination with other services. The intent of this Clause is that, whereas all minor and incidental works are not necessarily shown and/or specified but are necessary for the completeness of the work, such items shall be provided within the Tender Price. Allowances shall be made in the Tender Price for all offsets and adjustments to pipe runs, etc. needed to overcome the obstructions of the building and other services despite the fact that they may not be shown in detail on the Drawings.

All pipe sizes shown in the Drawings are the nominal bore of the pipe.

In the case of internally lined pipe (e.g. cement, PVC, etc.) the pipe bore diameter shall be not less than the Nominal Bore (NB) diameter specified in the Drawings. Where necessary a larger pipe NB shall be provided and is deemed to be included without further clarification. No additional time or cost will be allowable to this subcontract for compliance with this requirement.

b. Cleanliness

All pipes and fittings shall be thoroughly clean before erection and be free of scale, burrs, obstructions and other deleterious matter and their coatings shall be completely intact.

c. Installation

All piping shall be machine or hacksaw cut. No flame cutting is permitted except with the express permission of the Engineer. All burrs on the inside of pipes shall be removed. Changes in direction shall not be made by bending pipes (except for 25mm diameter or smaller pipes) nor by fabricated bends. All piping shall be installed to avoid other services. Allowances shall be made for all minor adjustments to pipe runs etc., needed to overcome the obstructions of the building and other services, despite the fact that they may not be shown in detail on the Drawings.

d.. Vents and Drains

Pipes shall be vented at high points with B.S.P. plugs and shall be provided with plugged drain connections at the low points. For installations designed to comply with NFPA and/or Factory Mutual, 50mm dia. gate valve at the end points of all lateral branch pipework shall be provided.

e. Reducers

Eccentric reducers shall be used in all horizontal locations installed so that in liquid services the top is level and in gaseous service the bottom is level.

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f. Welding

All welding shall be done by welders appropriately qualified for the particular service in question, using welded materials of size and type recommended for the work involved. All residual scale, weld spatter and slag shall be removed from the piping.

The Engineer reserves the right to select up to 2 % of welds and request an appropriate destructive or non-destructive test to confirm the integrity of the weld. If there is any evidence suggesting that the welding/brazing is unsatisfactory. The testing scope shall be expanded and the Engineer may order any number of tests at no additional cost.

The welding of galvanized pipework after galvanizing process is not permitted. Any welding of steel pipe shall be carried out prior to galvanizing.

g. Provisions for Expansion

Piping shall be installed so that it is free to expand and contract without imposing undue stresses on any branch connection or piece of equipment.

h. Supports

Where supports are not detailed on the Drawings, ensure that the strengths and sizes of all pipe supports are adequate in all respects. Supports shall be arranged so that the piping loads are shared by the supports so that no fixing is over-stressed. Pipe clamps, bands, saddles and the like shall be of 3mm minimum thickness. Light gauge galvanized steel straps shall not be used. Provision shall be made for an expansion and contraction allowance of plus and minus 0.3mm/m of wet system pipework in order to avoid damage.

Spacing of supports horizontally and vertically shall not be greater than shown in the following table (all sizes in millimeters):

Spacing(mm)				
Pipe Size	Stainless Steel, Copper	Steel	Ductile Iron	Hanger Size
15	1200			10
20	1800	2400		10
25	2100	2400		10
35	2400	2700		10
40	2700	3000		10
50	3000	3300		10
65	3300	3600	3000	12
80	3600	3900	3000	12
100		4500	4000	16
150		5400	4000	20
200		7500	4000	2 X 20*

* One hanger each side

** Subject to approval

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Pipe supports shall be located not more than 600mm from each change of direction.

Ductile iron pipes shall have a minimum of two supports per length.

Attachment to Steel Structure

No welding to or drilling of structural steelwork is permitted. Holes may be drilled through the back of purlins to support pipes 50mm and smaller but other means must be used to support larger pipes. Methods of connecting to the structure must be acceptable to the Structural Engineer for the project.

Attachment to Concrete Structure

All pipes larger than $\varnothing 150\text{mm}$ that are suspension supported shall hang from supports cast into the structure during construction. Allow for the cost of supplying all supports of an adequate size and quantity. Provide a drawing clearly indicating location of all such supports prior to formwork being placed and allow for the cost of fixing. Check that all supports are correctly located before concrete is placed. Methods of connecting to the structure must be acceptable to the Structural Engineer for the project.

i. Sleeves

All piping passing through a wall or floor shall be sleeved to allow freedom for expansion and contraction and other movement.

Galvanized steel pipe sleeves shall be used. For floor penetration it shall end 50mm nominal proud from floor. For wall penetration, it shall be flush with wall. The sleeve shall be filled with suitable ceramic fibre fireproof packing and sealed on top with polysulphide sealant. Pipe sleeve size shall be selected so as to give a minimum clearance of 20mm total between pipe OD and sleeve ID.

j. Testing and Commissioning

All piping shall be pressure tested to the Engineer's satisfaction and in accordance with the requirements of the various authorities concerned.

Give the Engineer 48 hours notice of when such testing will take place.

Before pipes are concealed or insulated, hydrostatic pressure of 2 times the working pressure or 1800 kPa whichever is the greater and maintained for 8 hours unless otherwise specified. Pressure should not show a drop of more than 2% over the 8 hour test period.

Record start and finish pressures on the Pipe Test Certificate sheet available from the Engineer, and obtain the required witness signatures.

All piping shall be flushed clean with water or nitrogen as applicable. Strainer baskets shall be removed, cleaned and reinstalled upon completion of the cleaning process.

Also refer to clause .10 above for testing and commissioning of underground pipe.

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2.2. VALVES AND FITTINGS

Minimum working pressure rating 1.5 times the maximum system operating pressure, or 1050 kPa whichever is greater.

Valves 50mm and smaller shall be of screwed connections.

Stop Valves

50mm diameter and smaller

Bronze gate, wedge disc, screwed bonnet, cast iron or cast alloy handwheel, threaded.

Valves used shall be FM, UL or LPC approved.

65mm diameter and larger

Iron gate, bronze trim, rising stem, Outside Stem & Yoke (OS&Y), flanged Table E, or Victaulic couplings. Suitable for and provided with suitably Approved switches for monitoring the valve status (where specified as monitored).

Valves shall be FM, UL or LPC approved and suitable for fire services.

1. Non Return or Check Valves

50mm diameter and smaller

Bronze, swing, renewable composite disc, screwed bonnet, screwed ends.

65mm diameter and larger

Wafer type, iron body, spring loaded swing check, stainless steel or bronze, flanged or Victaulic coupling connection.

2. Pressure Reducing Valves

Diaphragm or piston operated with PTFE ring seals. Body bronze or cast iron, bronze or stainless steel trim in contact with water.

Adjustable pressure reduction. Valves larger than 50mm shall be pilot operated.

Suitable for mounting in vertical or horizontal pipework. Tight shut-off is essential.

3. Tank Make-up Float Valves

Float operated valves shall comply with SS 256 or BS 1212 and be approved by the Water Authority. Wherever possible, one brand of valves shall be used throughout the entire project for all sizes.

Valves shall be of bronze body direct acting float operated type for sizes up to 80mm and of pilot operated type with cast iron body and bronze trim for sizes 100mm and above. The Subcontractor shall be responsible to establish that the pressure at the inlet of the float valve is within the acceptable range.

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4. Automatic Make-up Float Valves

Where there is insufficient free board depth to install the ball float valves, the automatic float valve shall be used. The valve shall be fluid actuated and have a single moving assembly. The valve shall open wide when the float is at a low liquid level and shall close drip-tight when the float is at high liquid level. The float pilot shall have a vertical rod and adjustable high and low float stops for selectable drop in level control.

5. Strainers

50mm diameter and smaller

Bronze, screwed ends, screwed cap, stainless steel screen.

Larger than 50mm diameter

Cast iron, flanged ends or Victaulic coupling connections, bolted cover, stainless steel screen. For 150mm diameter and larger provide permanently installed blowdown connection with stop valve.

6. Flexible Pipeline Connectors

All pipe connections to pumpsets and to any equipment subjected to vibration shall be done by means of flexible pipeline connections.

Connectors shall be proprietary type with bellows of stainless steel mesh reinforced synthetic rubber.

Unless specially remitted by the Engineer, rigid connections between pipelines and equipment will not be accepted.

50mm diameter and smaller

Flanged or union end fittings.

Larger than 50mm diameter

Flanged ends with control bolts to limit elongation.

Neoprene or spring hangers/spring suspension brackets of approved manufacturer shall be used for supporting pump delivery.

7. Pressure Gauges

Pressure gauges shall be of the 100mm diameter brass cased type with flangeless face. These shall be designed for pipe mounting and be calibrated in kPa. All pressure gauges shall be of the Bourdon tube type and selected for normal operating point to be at about mid-point of the scale and with maximum scale value of the order of 200 per cent of the maximum working pressure. All pressure gauges shall be provided with suitable gauge cocks of not less than 6.25mm and snubbers to prevent vibration of the needles. Pressure gauges shall conform to BS 1780.

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Pressure gauges shall have scales with divisions not exceeding 20 kPa for a maximum scale valve of 1000 kPa, not exceeding 50 kPa for maximum scale valves in excess of 1600 kPa.

Compound pressure and vacuum gauge shall be provided for the pump suction line. The face of the dial shall read in mm of mercury and kPa for the suction range. The gauge shall have a pressure range of 200% of the rated maximum suction pressure of the pump.

8. Circulation Relief Valve

Each pump shall be provided with an automatic relief valve listed for the fire pump service and set below the shut off pressure at minimum expected suction pressure. It shall provide flow of sufficient water to prevent overheating when operating at no discharge.

Provisions shall be made for discharge to a drain.

9. Valves Supervision

The suction control valves, discharge control valves and installation control valves shall be supervised open by remote station signaling device that will cause the sounding of an audible signal at the main alarm panel.

The control valves shall be locked open.

10. Vortex Inhibitor

For pumps taking suction from a stored water supply, a vortex inhibitor plate shall be installed at the entrance to the suction pipe. The vortex inhibitor shall be listed for the appropriate usage, ie. flooded suction or suction lift.

2.3 SPRINKLER SYSTEM

a. Requirements

The sprinkler system shall comply with Singapore Standard CP 52 1990 Code of Practice for Automatic Fire Sprinkler System, or NFPA 13 as stated on the Drawings and any other specific requirements of the Fire Authority.

b. Sprinkler Heads

Sprinkler heads shall be of an approved type to the appropriate standard with temperature ratings appropriately selected to suit the environmental conditions; eg cold rooms shall be fitted with dry type pendent heads, while heads in cooker hoods shall be high temperature type.

Exposed heads at false ceiling level shall be of semi-recessed chrome plated pendent type complete with chrome escutcheon plates unless shown otherwise on the drawings. All other areas :(i.e. without false ceiling) shall be provided with conventional heads of bronze finish.

Sprinkler guards shall be provided in low head room areas, ie where installed at a height of less than 2.2m and in lift shafts and pits, to prevent mechanical damage.

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c. Sprinkler Installation Control Valves

Sprinkler installation control valves shall be of FM,UL or LPC approved type.

Each sprinkler installation control valve set shall include a main stop valve, an alarm valve, test and drain valve, hydraulic motor alarm gong and all ancillary fittings and accessories.

The main stop valve shall be of rising stem type fitted with 'shut-open' indicator. All stop valves shall be secured in their normal operating position by means of brass padlocks and stout leather straps.

d. Water Motor Gong

Provide one water motor alarm gong for each installation valve. The gong shall be mounted on the exterior wall adjacent to the installation valve. Where the pressure is likely to exceed the rated pressure of the gong, provide a pressure reducing valve immediately upstream of the gong.

e. Flow Test Line

Provide a correctly sized flow test line, calibrated orifice or venturi, complete with direct reading flow meter and flow regulating valve at each installation valve set, and piped to the adjacent stormwater drain, or back to the tank as shown on the schematic drawing.. Underground pipework shall be denso tape wrapped over its whole length.

f. Flow Switches

Flow switches shall be incorporated in the system pipework at locations indicated on the Drawings. A 12mm diameter test line complete with an isolating test valve drained (to the nearest waste pipe or to the drain line) shall be supplied and installed in the system pipework downstream of the flow switch. The valve shall be padlocked in the close position. Flow switch shall be of an approved type proven in service as appropriate for the duty and shall incorporate a built-in time delay device to prevent false alarm.

g. Fire Service Breaching Inlet

Sprinkler manifold brigade inlet connection shall consist of 4 x 65mm instantaneous male couplings. Provide chained caps, non return valve and identified glass fronted, lockable, weatherproof steel cabinet recessed in wall. Arrange with the Contractor for a wall opening. Allow to provide 2 hour fire rated encasement to the sprinkler incoming main and the breaching main and where it traverse into unprotected area.

h. Sprinkler System Pipework

Refer to clause on PIPEWORK GENERAL of this Specification.

Pipework shall be medium grade black steel to BS 1387:1985 Pipework larger than 150mm dia shall be Schedule 40 mild steel pipe to A.P.I. 5L Std.

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Fittings :

BS 143 Malleable C.I. fittings

BS 1740 Wrought pipe fittings.

All drains and normally dry pipework shall be in medium grade galvanised steel pipe and fittings.

All underground pipework shall be 'Denso' wrapped over its entire length with 50% overlap and to provide a minimum of 2 layers.

2.4 HOSEREEL SYSTEM

a. General

The hosereel system shall comply with the requirements of Singapore Standard CP29:1998 Code of Practice for Fire Hydrant Systems & Hose Reels and as indicated in the drawings.

Hosereels shall be listed under PSB Product Listing Scheme.

b. Performance Requirements

The two topmost hosereels when operating simultaneously shall each be able to deliver at least 0.4 l/s with a jet of 10m length.

The maximum operating pressure of each hosereel shall not exceed 500 kPa. Provide orifice plates to reduce the operating pressure at all stations where the maximum pressure is exceeded.

c. Rubber Hose

The rubber hose shall be of 25mm internal diameter hose suitable for a working pressure up to and including 1050 kPa. The length of the rubber hose shall be 30 metres. The minimum bursting pressure shall be 4200 kPa.

The rubber hose shall be manufactured with an inner rubber tube or lining, a reinforcement of braided textile material and an abrasion resistant rubber cover. The reinforcement shall consist of a single rayon braid or a double braid of cotton.

d. Reel

The reel shall be of adequate dimensions to hold the full length of hose coiled in a fully charged condition within the overall diameter. The dimensions of the reel shall be subject to the Engineer's approval.

The diameter of the inner core on which the hose is wound shall be not less than 80mm. When the full length of the hose is coiled on the hose reel without the use of abnormal tension, the rims of the side plates of the hosereel shall project at least 10mm beyond the external diameter of the coiled hose at any point.

The fitting to which the hose is attached on the hose reel shall be arranged in such a way that the hose is not restricted or flattened by the application of additional layers.

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e. Construction

The hosereel components shall be of adequate strength and rigidity.

The hose reel assembly shall be so constructed that the hose drum rotates round a horizontal spigot or shaft. For hosereels mounted in cabinets or recessed cupboards, the entire assembly shall be free to rotate about a vertical axis so that the hose can be freely withdrawn in any direction.

An approved 25mm inlet valve shall be provided for the connection of the hose reel to the water supply. A notice shall be provided indicating the need to turn on the inlet valve before running out the hose. This notice shall be affixed to the wall in a prominent position adjacent to the reel.

The valve shall be threaded 25mm BSP Parallel. The water connection through the rubber hose shall permit the full flow of water to the hose without external leakage during any rotation of the hose reel.

A shut nozzle assembly shall be provided at the end of the hose in accordance with the following requirement:

1. The assembly shall be constructed of a corrosion resistant material of adequate strength.
2. The assembly shall be capable of easy operation.
3. The assembly shall be permanently marked to indicate the open and shut position of the valve.
4. The internal surface of the nozzle shall be finished to provide a smooth surface.
5. The nozzle shall have an internal diameter of 6mm.

An approved flush-mounted type cabinet shall be provided for each hose reel assembly, unless otherwise specified in the Drawings. The cabinet shall be of galvanized sheet metal construction with a glass fronted door.

f. Identification

The hosereel drum cabinet and piping shall be red in colour.

The cabinet shall bear the words 'FIRE HOSE REEL' in 50mm white lettering.

g. Marking

Every hosereel shall be marked with the following information:

1. The manufacturer's name, trade name or mark of responsible vendor.
2. Instructions for operation and use which shall include the following:
"Turn on inlet valve before running out hose".

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3. The year of manufacture.
4. Test pressure in kPa (or MPa).

h. Hosereel Pipework

Pipework shall be medium grade galvanized steel tube to BS 1387. Any underground piping shall be in accordance with UNDERGROUND PIPEWORK.

Fittings :

B.S. 143 Malleable C.I. fittings, galvanized.

B.S. 1740 Wrought pipe fittings, galvanized.

i. Hosereel Pumps And Controls

Refer to clause on FIRE PUMPS. Provide two electric fire pumps which shall be connected to emergency power supply.

Pumps shall be permanently primed.

Where pumps are exposed to weather, provide weather proof motor.

Controls shall have automatic and manual starting selection.

Pressure switch shall be installed at the discharge piping of the pumps. On sensing pressure drop, the duty pump shall automatically start up to keep the system pressurized. The pump shall stop automatically when the system pressure is more than 20% above the set point.

The standby pump shall start up automatically 10 seconds after sensing that the lead pump has failed to start.

j. Hosereel Tank

Tank shall be constructed and complete with fittings as specified in WATER STORAGE TANK.

k. Electrical Supply

Refer to clause on ELECTRICAL WORK of this Specification.

2.5 FIRE ALARM SYSTEM - OPTION 1 Conventional Hardwired System

This part of the work includes:

1. Main Alarm Panel
2. Sub-Alarm Panel
3. Repeater panel
4. Heat detectors

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5. Smoke detectors
6. Manual call points
7. Alerting devices
8. Alarm transmission to an approved 'DECAM' alarming receiving company
9. Interconnecting circuits

a. General

The fire alarm system and cabling shall comply with Singapore Standard CP10:1993 Code Of Practice for The Installation & Servicing of Electrical Fire Alarm Systems.

The system shall be electrically supervised so that any fault is immediately indicated.

The system shall be complete with 24 volt DC power supply and shall not cause electrical interference in excess of the limits stated in BS 800.

Fire alarm panels shall be listed under PSB Product Listing Scheme.

b. Main Alarm Panel

The main alarm panel shall be of 16 SWG constructions with lockable glass fronted door housing the number of zones and facilities as described. Panel shall also contain a ventilated battery compartment and another separate compartment to house the mimic diagram for all the zones and logbook. All metallic portion of the cabinet shall be rust protected and enamel red painted. Zone cards shall be solid state printed circuit board construction. Provide the following facilities:

1. For each zone
 - Alarm indication. (Red Indicator)
 - Fault indication (Yellow Indicator).
 - Alarm test (short circuit to simulate detection).
 - Fault test (open circuit).
 - Isolation switch and indication (or one common indication)
2. Audible System Fault Indication. (Yellow)
3. Audible System Energization Indication (Green)
4. System Reset Switch
5. Power Supply Monitoring Facility
6. Fault Buzzer & Silencing Switch
7. Fire Alarm Buzzer or Bell & Acknowledge/Silencing Switch
8. Evacuation Switch

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9. Light Indicator Test Facility
10. Transmission of fire alarm and fire alarm fault signals to a 'DECAM' company.
11. Battery test including voltmeter and ammeter.
12. Manual call point mounted adjacent to panel.
13. Fire pumps status indications. (Refer FIRE PUMPS)
14. Fire water tank(s) high/low level alarm.
15. Lift Homing Facility
16. Three (3) sets of voltage free dry contact.
17. Start smoke fire lobby fans, smoke purging fans, staircase pressurization fans, engineering smoke extract system, smoke vents etc.
18. 24 volt DC battery power supply fed by a 230V battery charger which is connected to a non-switched fixed wall outlet. (Not plug and socket). Batteries to maintain in full system operation for at least 24 hours after 230V power failure. The 230 Volts outlet will be provided by the electrical subcontractor.

c. Repeater Panel

Provide a repeater panel of same material of construction as the main fire alarm panel at the location as shown in the Drawings.

The panel shall be complete with the following facilities:

1. Main alarm panel activation for each zone.
2. Main alarm fault/battery low indication.
3. Fire pumps status indications.
4. Fire water storage tank(s) high/low level alarm.

Panel shall include buzzer and alarm silence features. Provide common reset and illumination for each indicator. All wiring shall be supervised with fault indication.

d. Heat Detectors

Detectors shall be 4 terminal type and operate on both temperature and rate of rise. Detectors shall be installed such that they are not in contact with high heat conductivity materials nor can be exposed to direct sunlight. Detectors shall have been approved by the Authority having jurisdiction in their country of origin as well as having received all necessary approvals from the Relevant Authority.

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e. Smoke Detectors

Detectors shall be ionisation 4 terminal type, suitable for 2 wire 24V DC operation and be complete with LED to indicate actuation. Where installed in concealed space, the LED shall be mounted on the ceiling or any other location approved by the Engineer, where it is visible.

Ceiling detectors shall be located out of air stream.

Duct type detectors shall be used in ducts and at duct openings and shall be complete with sampling probe. Detectors shall have been approved by the Authority having jurisdiction in their country of origins as well as having received all necessary approvals from the relevant Authority.

f. Manual Call Points

Manual call points shall be 4 terminal type recess mounting break glass type coloured red. Mounting height shall be 1400mm above floor level. Instructions for raising an alarm shall be attached or embossed on the call points.

g. Alerting Devices

Alerting devices shall be 150mm dia bells with concealed clapper. Either gong or body or both shall be coloured red.

Mounting height shall be 2100mm above floor level.

h. Fire Alarm Cabling

Cabling shall comply with Singapore Standard CP10:1993.

All cabling shall be of sufficient size to prevent any appreciable voltage drop. All cable shall be segregated from all other system. Independent trunking and conduit shall be provided throughout the entire building dedicated to the Fire Alarm System. The minimum conductor size shall be 1.5mm sq.

The galvanised steel conduit shall be earthed and the cable screening shall be connected to the main system earth at one end only.

i. Fire Alarm Transmission

Provide fire alarm transmission facilities to an approved 'DECAM' company and pay all initial charges and fees for the commissioning of the transmission lines (direct and backup) and all subsequent fees until the end of the maintenance period.

j. Fire Alarm Signals

1. Fire alarm signal output cable from main fire alarm panel to lift control panel at lift motor rooms (location as shown on drawings). Cable installed in this Fire Protection subcontract and terminated by lift subcontractor

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2. Fire alarm signal output cable from main fire alarm panel to ventilation (life safety fans) control panel (location as shown on drawings). Cable installed in this Fire Protection subcontract and terminated by ACMV subcontractor.
3. Fire alarm signal output cable from main fire alarm panel to sliding doors (location as shown on drawings). Cable installed in this Fire Protection subcontract and terminated by sliding doors subcontractor.
4. Fire alarm signal output cable from main fire alarm panel to security control panel (location as shown on drawings). Cable installed in this Fire Protection subcontract and terminated by security subcontractor.
5. Fire alarm signals output cables from main fire alarm panel to BMS interface terminal board (location as shown on drawings). Cable installed in this Fire Protection subcontract and terminated by this Fire Protection subcontractor (refer to clause "BUILDING MANAGEMENT SYSTEM INTERFACE" for further detail).

2.6 FIRE ALARM SYSTEM - OPTION 2 Analogue Addressable System

a. General

1. Experience of Subcontractor

This portion of the work shall be carried out by a specialist with at least 10 years experience in design, installation and operation of fire alarm systems and have at least 5 years experience in addressable fire alarm technology. The Subcontractor shall make available sufficient experienced staff for design, engineering, coordinating, installing, commissioning and maintaining the Fire Alarm System.

1. All main equipment, detection equipment, activation interfaces and alerting devices shall be produced by the same manufacturer.
2. Notwithstanding that proprietary systems may be offered for this portion of the Subcontract, it is deemed that the system offered shall fully comply with the specified requirements unless expressly and clearly described as a deviation in Section .3 of the Tender Documents.

Revisions to the Original Tender offer subsequently to bring the system to "fully complying" will not be entertained. All monies for such are deemed to be included in the Original Tender Offer.

3. Scope of Work

This section of the work covers the design, engineering, supply, installation, commissioning and maintenance for one year for the fire alarm system consisting of these major components, plus all other incidental equipment and accessories necessary to achieve the requirements of the Specifications.

Main Alarm Panel

Sub Alarm Panels on indicated on drawings.

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Mimic Panels as indicated on drawings.

Connection from Main Alarm Panel to Decam Station or Singapore Fire Service as required.

All detection alerting and interfacing devices.

Power supply and conditioners

Fire pump (sprinkler, wet riser and fire hose reel system) monitoring and indication of status at the Main Alarm Panel.

Provision and monitoring of all flow switches and outgoing alarm signals.

Provision of preaction control panel and two-circuit combination, ionisation and optical detector detection system.

All other items necessary for the complete and satisfactory operation of the above whether specifically mentioned or otherwise.

b. Relevant Codes

1. The system offered shall be listed with one or more of the following Authorities; LPC, UL, FM, and/or NFPA and shall have been approved by FSB Singapore on at least 60% of the capacity (by addresses) of the proposed system, in the same configuration.
2. Works shall be carried out in accordance with SS CP10: 2005 Code of Practice for the Installations & Servicing of Electrical Fire Alarm Systems CP52:2004, SS638 (formal CP5:1988) and the Singapore Code of Practice for Fire Precautions in Buildings 1991.

c. Basic Performance Requirements and Mode of Operation

1. When fully operational with all zones fully connected, the fire alarm panel shall respond within 2 seconds to a manual call point activation, or within 4 seconds to any other positive activation.
2. Activation of the Main Alarm Panel or Sub Alarm Panels shall sound to all zones in less than 3 seconds. (This is the maximum time delay for any one zone and not the average of response times.)

d. Power Supply

1. The entire fire alarm system including the Main Alarm Panel and the Repeater Panel shall be powered from two control power supply centres.

The power supply shall be approved and Listed by the same Authority as the Main Alarm Panel.

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2. The power supply unit shall contain suitable over voltage protection to prevent any malfunction or damage which might occur from line power surges, (e.g. lightning etc.).

The power supply shall be equipped with approved type batteries capable of maintaining the system at normal working condition for 24 hours, thereafter be able to supply an additional alarm load from 2 separate zones for half an hour, and in addition of supplying the full emergency evacuation alarm load for a period of 30 minutes.

3. After a full discharge, recharging shall be complete in 4 hours.
4. A voltage drop below 22V shall raise a fault alarm.
5. The entire power supply and charger circuits shall be supervised and addressable and any malfunction shall raise a fault alarm.
6. Main supply shall come from an unswitched permanently wired single phase 230V, 50Hz supply as available from in Singapore. Refer to clause ELECTRICAL WORK of this specification.

e. Smoke and Heat Detectors

1. General

In general, all smoke detectors in plantrooms, electrical rooms etc., shall be ionisation type.

All detectors (smoke and heat) shall have a common design of base which will allow interchangeability of smoke with heat without removing the base. Detectors shall be push-in-twist action for each removal and reinstatement. Three extension rods for removing detectors shall be handed over to the Owner at completion.

These rods shall be extendable and capable of reaching up to 7m high, and shall be compatible with both smoke and heat detectors.

All detectors shall be connected to the local panels via four wire circuit. Damage to the circuiting at one point will not preclude the system from identifying which detector/device has been activated.

All detectors shall be suitable for stable and accurate operation in the position and ambient conditions installed, and shall automatically compensate for environmental changes.

Detectors shall have an automatic verification circuitry for confirmation of alarm condition.

Detectors shall register a fault alarm when dust levels exceed the allowable limit.

2. Addressable Smoke Detectors

Ionisation Type

In addition to the above shall be complete with the following features:

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- Shall respond to visible and invisible combustion gases.
- Base mounted LED indicating both alarm and fault (differentiable).
- Where installed in a concealed location, LED shall be mounted on the ceiling clearly visible, and labelled.
- Shall be listed by an accredited laboratory such as LPC, UL, FM.
- Shall have adjustable smoke entry windows for field adjustments.
- Shall have insect screen to prevent entry of insects.
- The radioactive source shall be gold plated.

Photoelectric Smoke Detectors

In addition to (a) above;

- Shall be designed to respond to predominantly light white smoke.
- Shall have the same indication facilities as for (i) above.
- Shall have built in compensation to allow for a brief deceptive phenomena.
- Shall have adjustable smoke entry windows for field adjustment.
- Shall have an integral sounder capable of generating a sound level of 85 dBA (when installed in hotel guestrooms only).
- Shall have insect screens to prevent ingress of insects.
- Shall employ a multiple light pulse coincidence circuit preventing false alarms.

2. Heat Detector

In addition to (a) above;

Shall be combined rate of rise and fixed temperature type consisting two independent thermistors. Bimetal type are not acceptable.

Shall be installed such that they are not in contact with high heat conductivity materials or exposed to direct sunlight.

f. Addressable Manual Call Points

1. Manual call points shall be 4 wire type, fully addressable and compatible with the other devices on the system.
2. The design shall be aesthetically pleasing and suitable models shall be available for flush or surface mounting and shall have the words "In Case of Fire Break Glass" on the front.
3. In general, all call points shall be flush mounted. Only call points in the carpark shall be surface mounted.

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4. The mounting height of all call points shall be 1400mm above finished floor level.
5. Shall be fail safe and activated in the event of any impact which may or may not break the glass.
6. Call points, where installed in kitchens, or exposed to weather shall be IP-66.

g. Addressable Flowswitches

Provide each flowswitch as an addressable element on the Fire Alarm System. Flow switches shall be 4 wire type and listed by the accredited laboratory. Flow switches also shall be UL/FM listed.

Activation of the flow switch will sound the general alarm and activate all alarm bells.

h. Alerting Devices

All alarm bells shall be iron clad, corrosion proof, 24V DC, 150mm round red gong pattern suitable for 20mm conduit entry except otherwise stated. All outdoor alarm bells shall be weatherproof type. Bells should be labelled "FIRE ALARM" in English. Mounting height of bells shall be at 2100mm above finished floor level. The sound level at 3m away shall be minimum 85dBA.

i. Cabling

Cabling shall comply with SS CP10:1993, cabling shall be of sufficient size to prevent any significant voltage drop.

Cable shall be screened and segregated from all other systems. Independent trunking and conduit shall be provided throughout the entire building dedicated to the Fire Alarm System. The minimum conductor size shall be 1.5mm sq. The steel conduit shall be earthed and the cable screening shall be connected to the main system earth at one end only.

Refer to ELECTRICAL WORK clause of this Specification for details.

j. System Expandability

The system shall be modular in design and easily expandable by inserting additional cards. Space should be allowed for an expansion of 30%, however 10% spare capacity shall be provided in terms of each type of device connected.

k. Testing and Commissioning

All elements of system operation shall be verified during the testing and commissioning time. The specialist shall put in place Quality Control procedures to ensure that the system is complete and all software features are proven not later than 6 weeks before Completion of the work. Where a phased Completion is planned, the Main Alarm Panel and the connection to the DECam station shall be completed whether it is in the Phased Completion defined area or otherwise.

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I. Testing Capability

The Main Alarm Panels, Sub Alarm Panels and individual detectors may be switched to test mode for the purpose of carrying out tests on site.

The resulting alarm shall register a visible test confirmation or fault signal at the Main Alarm Panel.

m. Software Storage

All software and system information shall be contained in non-volatile memory (ROM or EPROM). Data entry shall be carried out via the Operator's console only.

n. Fire Alarm Signals

Fire alarm signal output cable from main fire alarm panel to lift control panel at lift motor rooms (location as shown on drawings). Cable installed in this Fire Protection subcontract and terminated by lift subcontractor.

Fire alarm signal output cable from main fire alarm panel to ventilation (life safety fans) control panel (location as shown on drawings). Cable installed in this Fire Protection subcontract and terminated by ACMV subcontractor.

1. The alarm signal output cable from main fire alarm panel to sliding doors (location as shown on drawings). Cable installed in this Fire Protection subcontract and terminated by sliding doors subcontractor.
2. Fire alarm signal output cable from main fire alarm panel to security control panel (location as shown on drawings). Cable installed in this Fire Protection subcontract and terminated by security subcontractor.
3. Fire alarm signals output cables from main fire alarm panel to BMS interface terminal board (location as shown on drawings). Cable installed in this Fire Protection subcontract and terminated by this Fire Protection subcontractor (refer to clause "BUILDING MANAGEMENT SYSTEM INTERFACE" for further detail).

2.7 PORTABLE FIRE EXTINGUISHERS

a. General

Provide fire extinguishers as indicated on the drawings. The extinguishers shall comply fully Singapore Standard CP55:1991 Code of Practice for Use & Maintenance of Portable Fire Extinguishers & SS232:1980 Specification for Portable Fire Extinguishers.

b. Installation

Extinguishers shall be installed at a height 1 metre above floor level. Each extinguisher shall be housed in glass fronted lockable cabinet with a key set in a 50mm by 50mm glass window on the cabinet.

Mounting of extinguisher cabinet shall be done with proper bracket support. Submit sample for approval before installation.

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c. Weight and Pressure Requirements

Ensure that the weight and pressure of all extinguishers are at the correct rating before start and end of Maintenance Period. Refill to required specifications where necessary. Submit copy of checklist witnessed by owner's representative during these periods.

2.8 FIRE COMMAND CENTRE

The fire protection subcontractor shall provide integrated panels/cabinets that can house the following facilities:-

Main Fire Alarm Panel (or mimic panel of the automatic fire alarm, and sprinkler indicator board if main fire alarm panel is located elsewhere.)/console with associated desk and furnishings.

1. The control console of the voice communication system (by Electrical Subcontractor).
2. A fire alarm sounding device.
3. A repeater panel of the lifts position indicator board and lift intercom handset (by Lifts Subcontractor).
4. Status indicator for mechanical ventilation fans (by Air Conditioning Subcontractor). Status indicator for all fire fighting pumps and water tank.
5. Status indicator for emergency generator (by Electrical Subcontractor).
6. A telephone connected directly to the external exchange (by Electrical Subcontractor).
7. A switch to isolate background music where required (by Electrical Subcontractor).
8. A switch for silencing the fire alarm sounders in the building when the voice communication system is in use. (Note : The fire alarm sounders shall operate continuously for one minute after the initiation of an alarm signal before this silencing switch can be effective). This silencing switch shall be separate from the silencing switch at the main fire alarm panel for the purpose of isolating the alarm sounders during routine testing and maintenance.
9. Building Management System (by BMS subcontractor) including PCs, monitors, printers and UPS.
10. Security System (by Electrical subcontractor) including PCs, monitors, VCRs, printers, batteries.
11. Carparking Management System, including PCs, monitoring, printers, card programming device.
12. Provide two swivel type upholstered office chairs (type to the Architect's approval).

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The Fire Protection sub-contractor shall liaise with the respective subcontractors through Main Contractor for the dimensions and interface requirements. All the equipment shall be neatly mounted. Assume full responsibility for the co-ordination and submit complete shop drawing with all the above details. All brackets, openings, fixings, edging and facings are included in this Fire Protection Subcontract. All printers shall be mounted at an easily-accessible location above the desk-top.

All panels/conssoles shall be fabricated of metal with finishes to Architect's approval.

Work bench shall run the full length of the conssoles and shall be at least 450mm wide.

The entire conssoles and work benches shall be designed and constructed to be sturdy and resistant to wear, suitable for its foreseeable use.

2.9 ELECTRICAL WORK

a. Scope

This section of the subcontract includes the supply, installation, painting, wiring, termination, testing and commissioning of all electrical equipment and controls necessary for the proper functioning of the works of this subcontract, and in particular the following:

1. All control panels and all wiring from these control panels to equipment.
2. Wiring from distribution boards or local isolators provided by the electrical services subcontractor to equipment.
3. Earthing

The subcontractor shall supply, install and connect all earth continuity wiring for effective earthings of the whole electrical installation under this scope in accordance with the requirement of the Singapore Standard SS 638 (previous CP 5) and to the Requirements of the Local Authorities.

All points and equipment shall be earthed with the appropriate circuit protective conductor (cpc), the minimum size of which shall be in accordance with the requirements of CP5.

All final circuit protective conductors shall terminate at their respective board's earthing bar.

All electrical controls including sensors, relays, contactors, protection gear and associated control wiring.

Refer to the drawings and the rest of the specifications for interfaces between this subcontract and other subcontracts.

The subcontractor shall allow fully in his Tender Price for attendance during the commissioning of all equipment involved with the electrical and control installation to ensure optimum performance of the overall system, and for attendance on other parties involved in this subcontract control and electrical system or otherwise.

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All electrical work shall comply with the latest SS 838 and all the amendments thereto.

All cables shall be PVC, PVC/PVC or PVC/SWA/PVC cables specified as per tender drawings.

All cables for main power shall be of a size capable of carrying the planned load in accordance with the relevant Code of Practice, using the appropriate derating factors for temperature and site conditions and taking into consideration the permissible voltage drop.

There shall, as far as possible, be no joints in cables between terminations. Where joints are required due to long runs exceeding 100 metres, appropriate jointing boxes specifically designed for this purpose shall be used. No reduction of the strands for this purpose shall be allowed. No reduction of the strands forming the conductors will be allowed at switch or other terminals, but all the strands shall be efficiently secured by screws, nuts and washers or other approved means.

All electrical equipment shall be fully tropicalised.

All control circuits shall be protected by fuses or equivalent means independent of the protection for the main circuits. All control circuit wires shall be terminated by soldering or clamping in such a way that the wires are not damaged. Accessible terminals suitably marked shall be provided for the attachment of incoming and outgoing cables.

All motors and other items of controlled equipment shall be provided with breakers, starters, contactors, isolators, time switches, timers, and with automatic and/or manual controls etc., to form a complete working system.

b. Electrical Power Supply Voltage and Frequency

The electricity supply shall be nominal 400V/230V, 3 phase 4 wires, 50Hz operating with a solidly earthed neutral.

The local power authority refers to the Power Supply Pte Ltd or Power Grid Pte Ltd

c. Control Panels

1. General Requirements

The control panel shall be totally enclosed, wall or floor mounted, extensible, flush fronted and of the heavy duty industrial type.

The control panel shall be constructed without any sag and deformation and shall be capable as a whole of withstanding without damages the electrical, mechanical and thermal stresses likely to be experienced under the short circuit current as indicated on the drawings.

All components shall be suitable for indoor use under tropical conditions. The general equipment arrangement of the control panel shall be as indicated in the drawings. This however shall not restrict the manufacturers from submitting alternative arrangements but will be subjected to the Engineer's approval.

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2. Construction

Each cubicle framework shall be fabricated from rolled steel angle sections and shall be self-supporting when assembled, of standard size, uniform in height and depth. The cubicle panel shall be fabricated from minimum 1.6mm thick sheet steel with turned edges to the front panels and so framed as to provide a clean, flush and rigid construction without welded cross- struts. After fabrication the cabinet shall be thoroughly rubbed down and treated with an approved rust inhibiting primer.

Proper and adequate ventilations shall be provided to each cubicle such that the ambient air temperature within the cubicle, with the breaker/equipment dissipating the heat at rated current, shall not exceed 40°C under all normal operating conditions.

Mechanical forced cooling shall be used where necessary. The cost of such provisions is deemed to be included in the tender price.

Rear and side panels shall be fixed with self-attached screw and of door panel type.

Full access shall be provided to control equipment inside cubicles by means of suitable doors with concealed type hinges. Latching bars shall be of a substantial cross-section and fitted with adequate guides to prevent distortion during operation.

The exterior surface of all cubicles shall be finished semi-gloss grey unless otherwise instructed by the Engineer except those parts normally left bright which shall be cadmium plated and operating parts finished matt black.

The interior of each cubicle shall be finished matt white and shall be dust, insect and vermin proof. The interior of each piece of equipment shall be clearly marked to show the phases. Either coloured plastic discs screwed to fixed components or identification by means of coloured plastic sleeving shall be employed. Plastic tape will not be permitted.

Insulating barriers and shrouds shall be provided around busbars and terminals so that it is possible to work on a dead circuit while the adjacent circuits are still live and to avoid accidental contact.

The control panel shall be factory assembled and tested before delivery to site in sections for installation.

3. Equipment Mounting

All switchgear shall be mounted on angle steel supports and fitted with escutcheon plates. Fuses shall be mounted on insulating panels fixed to the cubicle framing with mild steel brackets.

Instruments, indicating lights, rotary switches, etc., shall be mounted directly on a fixed fascia panel suitably stiffened to hold them firmly under all conditions of operation.

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Relays, contactors, time switches etc. shall be mounted in a separate section or panel away from the power circuits.

4. Busbars and Secondary Wiring

Busbar markings and arrangement, connections and grade of copper shall all comply as appropriate with BS 158, 1433 and 1989.

For breaker rated 300A and above, busbar connecting to main bar shall be provided. The busbars shall be so arranged that they run horizontally through each sectionalised length of the cubicle. Busbars shall be of uniform cross-sectional area, fabricated from Hard Drawn High Conductivity Copper and rigidly mounted on non-hygroscopic insulators. Connections from the busbars to the switches and circuit breakers shall be by means of copper bars securely clamped to the busbars and identified by means of coloured plastic sleeving or painting to indicate the phase colours. All joints in busbars shall be bolted or clamped with contact surfaces suitably prepared to prevent corrosion in service.

Ratings for the main phase and neutral busbars shall be as shown on the drawings provided, but in any case a current density of 1000 Amps per 645mm sq sectional area shall not be exceeded.

All secondary wiring shall be 1000 volt grade multistrand copper PVC insulated cables of minimum 1.5mm square cross-sectional area. Wiring shall be arranged in a neat and systematic manner with cables supported clear of panels and without cross-overs. Bushes shall be provided as necessary to prevent chaffing of cables. Wiring shall be correctly colour coded for ease of identification and shall terminate in an approved type of labelled termination block. No connections or soldered joints shall be permitted.

5. Cable Arrangement

The control panel shall be designed for top or bottom entry for cables as shown on the drawings. Copper bars for breaker rated 300A and above, or cables for breaker rated below 300A, shall be fixed inside cubicles by control panel manufacturer to interconnect all switchgears to suitable terminals mounted immediately adjacent to cable terminations at the base of cubicles.

All wiring in the switchboard shall be of 1000 volt grade copper PVC insulated cables and arranged in a neat systematic manner using proper wiring retaining straps. Cables should be properly colour-coded with numbered PVC sleeves at both ends. Cable supports shall be provided to relieve the terminations of any stresses.

Cable end boxes shall be provided for underground cable with the sheath bonded and earthed through a special earthing system.

Where single core cables are installed, brass plates of sufficient thickness shall be provided to serve as gland plates and these shall be effectively earthed.

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6. Meters and Instruments

Meters, instruments and relays for external panel mounting shall be of flush pattern, with square escutcheon plates finished matt black. Indicating instruments shall comply with BS 89 and/or IEC 51, IEC 414, IEC 529. They shall be of accuracy Class 1. Scale shall be of length 90 degree with external zero adjustment. Integrating meters shall comply with BS 5685. Kwh meter shall be of direct reading type.

Instruments, meters and relays located on the front of the switchboard shall be so positioned that as far as possible, each instrument, meter and relay is adjacent to the unit with which it is associated. Meter panels shall be hinged to provide ready access to connections and small wiring shall be enclosed in flexible plastic conduit. All meters and instruments shall be fully tropicalised. All terminals shall be completely insulated and potential circuits shall be suitably fused.

Removable or hinged covers shall be provided with dust exclusion gaskets. Protective instruments shall be provided with provision for locking to prevent unauthorised adjustments to the settings. Where vibration are present arising from electro-mechanical devices in the vicinity, the meter/instruments shall be mounted on vibration absorbing material to prevent malfunctioning of the devices.

Voltmeters shall be provided with selector switches for phase-to-phase and phase-to-neutral voltage indication

Ammeters shall be provided with selector switches for indication of all phase currents.

7. Current Transformer (CT)

Ring-type current transformers of appropriate ratios and classes shall be provided for the operation of measuring, protection and supervisory equipment.

Unless specified otherwise on drawings, current transformers for meters and instruments shall have accuracy class 1 and burden not less than 15VA.

Protective relays current transformers shall have accuracy class 5P20 and burden not less than 15VA.

Where the limits of the protective relay and/or meter/instrument burdens are exceeded, the CT burden rating shall be upgraded to suit.

The cost of the necessary upgrading is deemed to be included.

All CTs shall be of correct dimensions for fixing in busbars and shall be manufactured to BS 7626 and/or IEC 44, IEC 185.

All CTs shall be capable of withstanding the maximum prospective primary short circuit current for 3 seconds.

The maximum spill current of the protective relay CT group at rated CT current shall not exceed 0.001% of the CT primary current.

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CTs for voltage operated relays shall have knee point voltage of at least twice the required relay voltage setting.

The excitation curve, the magnetising current at relay settings, the secondary winding resistance and other relevant data of the protection CTs shall be selected to ensure that the required relay operating conditions are met.

7. Indicator Lamps

Indicator lamps utilised in switchboards and distribution boards shall be of the transformer type, fitted with coloured lens and flush mounted in door panels. Double filament long life low voltage lamps of suitable voltage rating shall be used.

Indicator lamps used to indicate the 'Phase' of the 3-phase supply shall have coloured lens of red, yellow and blue to indicate 'Red Phase', 'Yellow Phase' and 'Blue Phase' respectively. For indication of motor operating status, coloured lens of indicator lamps shall be green for indicating 'motor running', amber for 'motor tripped' and red for 'motor stopped' conditions. For indicating operation of contactors other than motor starting contactors, indicator lens shall be of green colour to indicate 'contactor closed' condition. Unless otherwise specified, each lamp shall be provided with its own protection cut-out fitted with a 2A HRC fuse link.

The indicator lamps shall be rated for 240 volts (+) or (-) 10%, 50Hz operations.

Unless otherwise stated neon indicator lamps shall not be used.

8. Moulded Case Circuit Breaker (MCCB)

MCCB shall comply with IEC 947 and Local Power Authority requirements. Frame sizes, rated current and rated ultimate breaking capacity (rms) shall be as shown in the drawing.

The rated service breaking capacity of the MCCB shall be equal or greater than 50% of the rated ultimate breaking capacity.

The rated insulation voltage of the MCCB shall be more than 650 volts with a rated impulse withstand voltage of at least 8 KV.

All MCCB shall be of disconnecter type with minimum Class II front face insulation.

A moulded slip-on extension handle shall be provided for MCCBs of current rating 400A and above.

The ON, OFF and TRIP positions of the operating handle shall be clearly defined with the TRIP position approximately halfway between the ON and OFF positions. After a trip operation, it shall be necessary to reset the MCCB by first moving the handle towards the OFF position to engage a latching bar before the breaker can be switched on again. It shall not be possible to prevent the automatic trip action from operating by maintaining the operating handle in the 'ON' position.

The breaker shall be of moulded material with adequate mechanical strength, heat resistant, fire retarding and arc resistant properties to withstand the heat and forces under a fault current appropriate to its interrupting capacity rating.

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Contacts shall be of material with minimum contact resistance, and shall possess maximum freedom from arcing. Arc extinguishing device shall be provided for each phase and shall comprise of magnetic plates mounted on insulating frames. Each pole of the breaker shall be isolated by an integral insulating barrier in the moulded case.

The current rating of the MCCB shall not be affected by the mounting position.

Self locking terminals for connection to external cable shall be provided for efficient and easy application.

The terminals shall apply and maintain a constant and suitable pressure evenly spread over the entire cable ends. Terminals which result in point pressure at the cable ends shall not be used.

The contact resistance of the terminations shall be kept at a minimum at all times.

MCCB's shall have an electrical and mechanical endurance life of not less than 5000 operations with a make and break frequency of not less than 100 operations per hour. Three phase MCCB's shall be rated to operate at voltage and frequency as indicated on the drawings. Tripping devices shall not be affected by a frequency of up to several times the rated frequency.

MCCB's rated for A.C. use shall not be used on D.C. circuits and vice versa. It shall not be allowed to mechanically connect three single phase units by means of an external link bar across the operating handles for use as a three phase unit.

Where specified, MCCB's shall be suitable for mounting of trip coils internally for remote control.

MCCB's shall be mounted in a vertical position with the incoming supply terminals at the top and the load terminals at the bottom.

9. Miniature Circuit Breaker (MCB)

MCB shall comply with IEC 898 and Local Power Authority requirements. The rated current, the rated breaking capacity shall be as indicated in the drawings.

Positive contact indicator shall be provided.

The ON, OFF and TRIP positions of the operating handle shall be clearly defined with the TRIP position approximately halfway between the ON and OFF positions. After a trip operation, it shall be necessary to reset the MCB by first moving the handle towards the OFF position to engage a latching bar before the breaker can be switched on again. It shall not be possible to prevent the automatic trip action from operating by maintaining the operating handle in the "ON" position.

When used as the power supply company's meter cut-off, the MCB shall be provided with an approved means of pad locking the MCB at OFF position.

The MCB shall be of moulded material with adequate mechanical strength, heat resistant, fire retarding and arc resistant properties to withstand the heat and forces under a fault current appropriate to its interrupting capacity rating. The overcurrent

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device shall trip all the phases (through a common trip) to break the phases simultaneously when operating under overcurrent condition.

Contacts shall be of material with minimum contact resistance, and shall possess maximum freedom from arcing. Arc extinguishing device shall be provided for each phase. Each pole of the MCB shall be isolated by an integral insulating barrier in the moulded case.

The current rating of the MCB shall not be affected by the mounting position.

Self locking terminals for connection to external cable shall be provided for efficient and easy application.

The terminals shall apply and maintain a constant and suitable pressure evenly spread over the entire cable ends. Terminals which result in point pressure at the cable ends shall not be used.

The contact resistance of the terminations shall be kept at a minimum at all times.

MCB shall have an electrical and mechanical endurance life of not less than 5000 operations. Three phase MCB shall be rated to operate at voltage and frequency as indicated on the drawings. Tripping devices shall not be affected by a frequency of up to several times the rated frequency.

MCB rated for A.C. use shall not be used on D.C. circuits and vice versa. It shall not be allowed to mechanically connect three single phase units by means of an external link bar across the operating handles for use as a three phase unit.

Where specified, MCB shall be suitable for mounting of trip coils for remote control.

MCB shall be mounted in a vertical position with the incoming supply terminals at the top and the load terminals at the bottom.

10. Isolators

Isolators shall be the on-load type. All boards shall have an isolator on the incoming supply for the equipment. For equipment located remote from the board, additional isolators shall be installed adjacent to or preferably within the equipment housing. Exposed isolators shall be heavy duty weatherproof type.

11. Contactors

Contactors shall comply with BS775 ratings mechanical duty Class II and making and breaking category AC3.

All contactors shall be sized for 3 million operations at rated motor load.

Contacts shall be renewable butt-type solid copper hard silver faced, fully shrouded and the design shall be such as to ensure effective freedom from contact bounce and sticking of the fixed and moving positions of the magnet assembly. Contactor's magnetic coils shall be fully tropicalised and wound for continuous operation at phase voltage $\pm 15\%$ with Class "B" insulation to BS 2613.

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Magnets shall be fabricated from silicon alloy rivetted electrical steel sheet with shaded pole and magnet/armature assemblies shall be fully floating and self-aligning.

No audible humming noise shall be heard from the contactor at all times.

Arc chutes and magnetic blowout coils shall be fitted to the larger sizes as necessary.

12. Terminal Blocks for Control Wiring

Terminal blocks shall be mounted on DIN 35 "OMEGA" rails with partitions, end plates and end brackets provided as necessary. The terminal blocks shall be rated at no less than 500V and 20A and shall be interruptible. The connectors shall be suitable for both flexible and solid wires and designed to ensure good electrical connection.

Markers shall be provided on both sides of the terminal block to uniquely identify each terminal block and wire.

13. Earthing

All trifurcating boxes, auxiliary wiring connector boxes and switches shall be effectively bonded to earth to comply with local power authority and Singapore Standard CP 16:1991.

The subcontractor shall supply and install a main earth bar of Hard Drawn High Conductivity copper with cross sectional area 37mm x 6mm to which all earthing connections shall be made. This earth bar shall run along the full length of all the main switchboard. This earthing bar should be connected to the main earth point of the earthing system in the form of a ring circuit by means of 25mm x 3.0mm copper tape.

Door panels shall be effectively earthed to the fixed metal frame by means of braided copper straps.

14. Drawings

A drawing showing the type, arrangement, actual dimensions and assembly of the control panel shall be submitted to the Engineer for approval prior to fabrication and installation.

A neat "AS BUILT" drawing showing the schematic wiring diagram of the control panel arrangement shall be supplied and displayed in the control panel by the subcontractor. Drawings shall be minimum A3 size.

15. Labels

Labels of approved pattern and design shall be fitted on the front panels to indicate the service of each switchgear and equipment. Labels shall be of white plastic engraved with black figures or letters and fixed to the panel with brass screws. Labels shall also be provided to identify all items of equipment, circuits, cables and where applicable current rating of fuses and setting of relays.

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16. Testing and Commissioning

Testing of the switchboard and certifying that it is safe before supply is energised, and that all the equipment complies with the requirements of this specification shall be done. Generally such tests shall include:

Demonstration that all equipment is installed and all wiring connected so that the board functions as required.

Tests of accuracy of all measuring instruments.

Continuity, phasing out and insulating resistance testing. In general, the insulation resistance of sub-mains feeders and final circuits shall not be less than 50 mega-ohm when tested with a 500V megger.

Protective equipment testing.

Copies of test sheets, showing the results of all tests carried out shall be submitted to the Engineer.

Power Supply Company or local power authority tests on all equipment of the control panel shall be performed prior to the connection of supply. Arrange for early testing of the switchboard immediately after it is completed. All fees in connection with the required tests shall be deemed to be included in the Tender Price.

d. PVC, PVC/SWA/PVC, PVC/PVC Cables

Single core PVC, PVC/PVC cables shall comply with SS358, IEC227, IEC228, IEC228A, IEC811 and IEC885 with voltage grade of 450/750V.

Multi core cables shall comply with BS6346 with voltage grade of 600/1000V.

High conductivity copper conductors shall comply with SS291, IEC228, BS6360 in respect of dimension and resistances. Where shaped conductors are used, they shall be compacted to reduce dimensions and to give a smoother profile. Sizes shall be designated by the nominal cross-sectional area.

Where necessary, PVC fillers shall be used between laid-up wires. In the case of cables with extruded bedding, the cores shall be bound with a non-hygroscopic tape before the bedding is extruded.

For twin and multi-core cables the bedding shall consist of two or more layers of PVC tape. For cables with circular conductors, the bedding shall be an extruded layer of PVC.

For armoured cables, the armour shall consist of a single layer of galvanised steel wire or tape as specified. Armouring for single core cables shall consist of non-magnetic material.

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The cable shall be finished in an extruded black or grey PVC oversheath, the thickness of which shall comply with BS6346, SS358, IEC227 as appropriate. The external surface of the oversheath shall be embossed with the voltage designation and the manufacturer's name.

Corrosion resistant outdoor type cable glands of the appropriate size shall be used where cables enter or exit from a switchboard/DB and/or where required. Glands shall comply with BS 6121 with integral earth facility. The termination of armoured cable shall be in accordance to manufacturer's recommendation and/or to the Engineer's approval.

The sizing of the cable gland shall be based on the nominal dimension of the cable.

Proper compression cable lugs shall be used for terminating the cable cores onto terminals of devices and equipment.

The cores of the cables shall be identified as follows:

Three Core (three phase) - Red, Yellow, Blue

Four Core (three phase) - Red, Yellow, Blue, Black

Auxiliary cable shall be white with black numbers printed on the cores, commencing 1, 2, 3, 4 upwards.

e. Cross-Linked Polyethylene (XLPE) Cables

Cross-linked polyethylene (XLPE) cables shall be of 600/1000V grade and shall be stranded copper conductor, cross-linked polyethylene insulated, PVC inner sheathed with galvanised steel-wire armour (as required) and PVC over sheathed power cables. All cables shall comply with IEC 228, IEC 228A, IEC 811 and IEC 885.

The current carrying capacity and the short circuit final temperature of the cable shall comply with IEC 287 and IEC 724 respectively.

Conductors shall be Class 2 annealed compacted stranded plain copper. Insulation shall be cross-linked polyethylene (XLPE) with a high degree of cross linking, free from contaminants and air voids, good heat resistance and it shall be applied by an extrusion process. The XLPE insulation shall be suitable for use in wet and dry locations at conductor temperatures not exceeding 90 deg. C for normal operation, 130 deg. C for emergency overload condition and 250 deg. C for short circuit conditions (5 seconds max. duration).

The cores shall be identified by using the colours RED, YELLOW, BLUE, BLACK for multi core cables.

Non hygroscopic fillers and bedding may be used as required.

The PVC inner (if required) and outer sheaths shall be by an extrusion process. The outer sheath shall be treated so as to be termite proof. The armour (if required) shall be of galvanised steel round wires of diameter 2.5mm.

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f. Fire Resistant Cable

Fire resistant cable shall comply with SS299, IEC331, BS6387 category C, W, Z and IEC332-3 category A or B and shall be of voltage grade 600/1000 volts.

The fire resistant cable shall be of multi-stranded copper conductor type with glass mica flame barrier and cross linked insulation and sheath.

The insulation and sheath material used shall be halogen free with self extinguishing, flame retardant and low smoke emission properties.

The glass mica flame barrier used shall be able to maintain the circuit integrity at the rated cable voltage up to the melting point of the copper conductor.

The insulation and sheath shall be suitable for continuous operation at a temperature of 90°C.

Fire resistant cable shall be strapped or tied to the cable support system as specified in the drawing using stainless steel cable ties or stainless steel strappings.

The stainless steel material shall be of type 304 or better...

The stainless steel cable ties and strap shall be tested and approved for used in fire resistant wiring systems.

The spacing's of the straps/ties shall conform to the manufacturers recommendation but shall in all cases not exceed 1m interval.

As far as possible, joints in fire resistance cable shall be avoided. Where this is not possible due to extra long run, prior written approval from the Engineer shall be obtained. When permitted by the Engineer, the joint shall be carried out using method and material recommended by the manufacturers.

The joint method and material used shall not undermine the fire, mechanical and electrical integrity of the cable under all circumstances and are subjected to the Engineer's approval.

All relevant test certificates on the fire resistance cables and support system/accessories shall be submitted to the Engineer for approval prior to ordering of the cable.

g. Cable Trunking/Conduits/Trays/Ladders

1. Cable Trunking

Cable trunking shall be factory epoxy powder coated and shall comply with SS249 and/or IEC 1084. Cable trunking may be employed in place of conduit where multiple runs would otherwise occur.

Trunking shall be of the PSB approved type. The trunking shall be manufactured from good quality electro-galvanised mild steel sheet. Thickness of the trunking shall be in accordance to SS249 recommendation.

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The trunking shall be completed as required with factory prefabricated standard bolted flanged outlets, blank ends, reducers, outlet bushes, bends, tees, sleeve couplings, intersection 4-way boxes and fitting adaptors, all of which shall be proprietary-made.

Trunking shall be supported adequately by suitable galvanised steel brackets and hangers spaced not more than 1 metre apart for both vertical and horizontal runs. Vertical trunkings shall be provided with suspension units and thrust blocks. Trunkings shall be supplied in lengths to suit the installation and joints and bends shall be so constructed that cables can be conveniently drawn through without damaging the cable insulation.

Cables for mains voltage and lighting circuits and extra low voltage systems shall not run in the same trunkings unless they are segregated effectively by means of a rigidly fixed metal barrier or screen.

Trunking runs shall be erected completely before any cable is drawn in and the number of cables installed shall be such that a space factor of 45% is not exceeded.

In vertical trunking runs, insulated type cable support pins and retaining clips shall be fitted to support the weights of the cables. Where conduit is tapped-off trunking, suitable brass bushes shall be fitted at all conduit-entry positions.

All cut edges of the cable trunking shall be treated with anti-rust primer and 2 coats of epoxy paints of minimum thickness 45 microns.

Standard factory made fittings shall be used to form all tees, off-sets, joints and terminations.

The cable trunking shall be earthed at the ends of the run using earthing cables or straps of size equal to the largest earth continuity conductor that is being laid in the trunking.

Copper earthing straps shall be installed across all joints.

2. Conduits

Galvanised Conduits

All conduits shall comply with BS 31 and/or IEC 614, IEC 423. All conduit fittings and components shall comply with BS 4568 and/or IEC 1035.

Conduit shall be galvanised, screwed and of welded type class 'B' and fittings shall (be manufactured from steel or malleable cast iron.

Unless otherwise stated, conduit runs shall be concealed in walls, floors and where shown in the drawings. Any request for a waiver must be put in writing to the Engineer for approval.

Concealed conduits shall as far as possible be run in advance, before casting of floor slabs, plastering of walls and casting of columns and beams. The subcontractor shall liaise with the Main Contractor in scheduling this work.

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All conduit and accessories shall be painted with one coat of zinc rich paint whenever the exposed galvanised surface has been cut or otherwise damaged, including all exposed threads and connections after erection.

Conduits shall be properly and tightly screwed into the full depth of box spouts and butted in sockets between lengths to ensure maximum mechanical strength and electrical continuity so that the wiring is continuously protected throughout its whole length, and is not in anyway under mechanical stress.

A separate circuit protective conductor of appropriate size corresponding to the maximum current carrying conductor and in accordance with Singapore Standard CP5 shall be provided in all metal conduits. All conduits shall be effectively earthed at terminations.

Conduit sizes shall be selected for the numbers and sizes of cables they are to contain. Conduit size shall not in any circumstances be smaller than 20mm (3/4 inch) and cables drawn in shall not be greater than the appropriate number permitted in Singapore Standard CP5. Conduit shall be arranged with an adequate number of boxes, accessible for the life of the installation so as to allow easy draw in or draw out of any cables later.

Cables for mains voltage circuits and extra low voltage shall not be drawn into the same conduits. A number of final circuits may be grouped together in larger conduits provided that all final circuits in one conduit are of the same phase. In the case of 3 phase circuits all phase wires and neutral, if any should be drawn into the same conduits.

Where condensation is likely to occur in surface conduits they shall be laid with falls so as to drain off condensed moisture without entry into terminations.

The inside surface of all conduits and fittings used in connections therewith shall be smooth and free from signs of corrossions, burrs or other defects. The ends of conduits shall be cut square, filed and reamed out after die threaded or tapped.

All corners shall be turned by easy bends or sets made cold on bending machines without deformation on the conduits or opening of seams. The inner radius of any bend shall not be less than 2.5 times the outside diameter of the conduit. Where it is impracticable to set the conduits, inspection elbows shall be permitted but in no circumstances shall solid elbows or tees be used.

All switches, socket outlets, accessories and other fittings shall be mounted in conduit boxes of suitable sizes. Every conduit box shall be provided with its individual concealed (vertical) conduit dropper. No looping of boxes shall be allowed. Where conduits terminate at a metal base, distribution board, adaptor box, motor starter terminal box or other fittings not designed to accept screwed conduit entry, a socket shall be screwed to the end of the conduit and a smooth bore brass bush/gromet butted together against the inside of the case. PVC bushes will not be permitted.

Where looping pattern boxes are used for outlets, etc. they shall be of circular pattern with an appropriate number of back outlets. Conduits shall be terminated in these boxes by mans of screwed sockets and male brass bushes. Ceiling boxes shall be of standard circular pattern with long internally tapped spouts.

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All boxes shall be fixed securely to walls, ceilings, etc., by means of at least 2 screws correctly spaced.

Conduit terminations to apparatus including light fittings, detectors, etc. for subject to vibration or movement and installed indoor shall be made in heavy gauge metallic conduit and seated into heavy brass adaptors for connection to the rigid conduit system or apparatus termination boxes.

Conduit termination to apparatus subject to vibration or movement and installed outdoor shall be made in PVC sheathed flexible metallic heavy gauge conduit and seated into PVC sheathed heavy brass adaptors for connection to the rigid conduit system or apparatus termination boxes.

The PVC flexible conduits in its natural form shall be heavy duty type, shall have a minimum of 3 ribs per centimetre (cm). The ribs shall be minimum thickness of 3mm and the ribs shall not be spaced more than 2mm apart. The thickness of the PVC material in-between ribs shall not be less than 1mm. In all cases, the length of the flexible conduit shall be limited to not more than one metre.

All conduit runs shall be straight and run either horizontally or vertically. Diagonal runs will not be permitted. Conduit work and accessories where not concealed shall be fixed effectively by means of heavy pattern spacing full saddles to hold off the conduit from the surface and approved metal plugs and fastenings shall be used. On straight runs the conduit shall be supported by saddles at interval not exceeding 1 metre in addition to supports provided by any structure, box or fittings included in the run. Bends must in all cases be supported on each side by two saddles as near thereto as possible and a draw-in box shall be provided after 2 bends or after not more than each 8 metres of straight run. The subcontractor shall plan the conduit runs such that they are neat and systematic.

On completion of the installation, the subcontractor shall paint all exposed conduit to match the walls, if and where instructed by the Engineer.

3. Cable Trays

Cable trays shall be of the perforated type and constructed of minimum 1.2mm thick galvanised mild steel for width up to and including 75mm and not less than 1.6mm thick for width up to 300mm and not less than 2.0mm thick for larger width. Trays shall be supported at not more than 1 metre intervals by galvanised steel hangers and rods fixed to walls, floors or ceiling in an approved manner. The subcontractor shall ensure that the maximum sag between brackets will not exceed 20mm. Otherwise additional brackets shall be provided. All brackets shall be galvanised. The width of the cable tray shall be such as to allow the cables to be run evenly spaced without overlapping and with spare room to accommodate 30% future increase in number of cables. Shop drawings are to include appropriate sections through each run of tray to show that this is complied with.

All cable trays shall be factory coated with an approved-type epoxy powder of chosen colour and minimum thickness 45 microns prior to installation.

All cut edges of the tray shall be primed with anti-rust primer and finished with 2 coats of an approved-type orange colour epoxy paint of minimum film thickness of 45 microns per coat.

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The tray shall be earthed at the ends of the run using earthing cables or straps of size equal to the largest earth continuity conductor that is being laid on the tray.

Copper earthing straps shall be installed across all joints.

The subcontractor shall plan the cable tray route with a view in affording a neat and systematic array and he shall seek the prior approval of the Engineer before commencing the work.

Cables fixed on to the cable tray shall be clipped on with approved type of saddle with galvanised nuts and bolts and/or approved cable tie fastener. Three phase circuits using single core cables shall be bunched with the neutral and secured as a group. Saddles shall not be spaced at more than 750mm apart.

4. Cable Ladder

Cable ladder shall be manufactured from high quality hot-dipped galvanised mild steel and finished with epoxy powder coating of orange colour. The thickness of mild steel used for both rungs and side rails shall be not less than 1.6mm thick for width up to 450mm and 2.0mm thick for bigger width. The depth of side rail shall be not less than 1.5 times the overall diameter of the biggest cable fixed on to the cable ladder. Generally, the rung spacing shall not be more than 300mm in straight runs.

Cable ladder shall be completed as required with prefabricated reducers, elbows, tees, crosses, splice plates, louvered covers and end closers so as to form a complete installation. Cable ladder installed horizontally shall be adequately supported at not more than 0.75 metre interval by galvanised mild steel C-channel and rods fixed to ceiling in an approved manner. For vertical runs, hold down clamps shall be used to secure cable ladder walls at not more than 0.5 metre interval. The ends of the cable ladder run shall be earthed to the system earth by means of earthing cable of size equal to the largest earth continuity conductor that is being laid on the ladder. Copper grounding straps shall be used to improve earth continuity across splice joints.

Cable fixed on to the cable ladder shall be clipped on with approved type of cable tie or with galvanised bolts and nuts. Three phase circuits using single-core cables shall be bunched in trefoil with the neutral and secured as a group. Saddles shall not be spaced at more than 600mm apart.

2.10 BUILDING MANAGEMENT SYSTEM INTERFACE (FIRE SERVICES)

The Fire Protection Sub-Contractor shall supply, install and wire all the field devices and interface points necessary for the BMS to perform the monitoring and measurement functions listed below.

Wiring from all field devices shall be to an interface terminal board (ITB) supplied and installed in this Sub-Contract. One ITB will be provided at each pump control panel and at the Main Alarm Panel, and shall contain a series of labelled terminal strips to which the field devices are to be wired. All field devices shall be verified with the BAS for final compatibility co-ordination but generally the input/output requirements of all field devices shall be of the 4-20 mA linear type.

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The fire protection tenderer shall advise in the tender submission if any field device requires different from 4-20 mA linear type.

All wiring shall be at least 18 AWG twisted and shielded and shall be run in metal conduit/trunking.

The Building Management System will have the following monitoring functions for the Fire Protection Services installation:-

a. Fire Alarm Zone

- Alarm activation (for each of the zones)

b. Fire Alarm UPS

- ON/OFF status ("ON" means battery discharging)
- Battery charge low alarm

Liaise with the Building Management System Sub-contractor through the Main Contractor to implement all the interface work..