PROPOSED FACTORY COMPLEX FOR SOORTY TEXTILES

BANGLADESH

SPECIFICATIONS

FOR

ELECTRICAL INSTALLATION

CONSULTANT ENGINEER

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GENERAL REQUIREMENT

SECTION A

A1. SCOPE OF WORK

The work embraced by this Specification covers the supply, installation, testing, commissioning and maintenance of the Electrical Installation of the Factory in accordance with this specification and associated Drawings, and without abrogating the more extensive details described elsewhere in the Specification and Drawings, includes (but shall not be limited to) the following:

(a) Installation of Main switchboard and Distribution boards and ancillary equipment and sundry components that are necessary for the complete installation and proper operation of the system as stipulated in this Specification.

(b) Supply and installation of the following mains and sub-mains distribution equipment:

. Power cables, conduits and all other ancillary equipment to complete the installation as shown on the Drawings.

. Distribution boards, including all switch gears, protective devices, ancillary equipment and metal enclosures.

(c) Lamp Fittings & Electrical Switch Boards Supplied by Client.

(d) Provision of small power installation including power sockets, spur units, control Switches contactors and the like for all areas as stipulated in the specification herein and the Drawings.

(e) Supply and installation of earthing system including equipotential/supplementary bonding for exposed and extraneous conductors parts. The system shall be completed with earthing conductors, test links and cross-bonding conductors.

(f) Testing and commissioning of all equipment items installed under this Contract.

(g) Provision of maintenance and emergency call service during the Defects Liability Period.

(h) Provision of as fitted drawings.

A2. SAMPLES

(a) The Consultant shall review samples for colour and texture only. Compliance with other requirements shall be the exclusive responsibility of the Contractor. Colour and texture range of materials eventually produced must conform to the finally approved shall only be granted by the Consultant upon satisfactory inspection of samples.

(b) The Contractor shall submit for approval of samples of the following within one month after award of the Contract:

. Power cables

. Control cables including coaxial cables and twisted pair cables.

. Trunking and conduits/accessories.

. Triaxial cables, earthing tapes and accessories.

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(c) The Consultant reserves the right to review samples which show the quality and workmanship of component parts, and the design of accessories and other auxiliary items, before any installation work proceeds.

(d) The Contractor shall submit to the Consultant for endorsement, manufacturer's specification and installation instructions for trade products.

A3. REGULATIONS AND STANDARDS

(a) Unless otherwise specified, the Electrical Installation shall comply with the latest editions from time to time of the following documents:

. Relevant British Standard and Codes of Practice published by the British Standard Institution.

. The latest edition of the Regulation for Electrical Installation and the subsequent amendments published by the institution of Electrical Engineers, United Kingdom.

. The requirement of Ceylon Electricity Board

(b) Type test or certification of electrical equipment as specified in the Specification herein shall be carried out by the institutions listed here below unless otherwise approved by the Consultant:

. ASTA - The association of short-circuiting Testing Authorities

. BASEC - British Approvals for Electric Cables

. NEMA - National Electrical Manufacturer's Association

. UL - Underwriters' Laboratories, Inc.

A4. SHOP DRAWINGS

Prior to commencement of installation, the Contractor shall submit for the Consultant approval shop drawings (**Three Copies each**) which shall include the following:

. Schematics

. Plans (minimum in 1:100 scale)

. Sections and elevations (minimum in 1:50 scale)

. Schedules and details (minimum in 1:25 scale)

The Shop Drawings shall be generally in accordance with the Drawings supplied with this Specification and updated by the Consultant's Instruction for Variation.

Before proceeding with the manufacture or installation of equipment, the Contractor shall submit for the Consultant's approval shop drawings with full details of the equipment and method of construction and fixing.

Factory or site work shall not proceed until such drawings have been approved. These requirements do not apply to the manufacture or standard machines and controls or similar items for which approval to place orders has been given. Where the Builder's work is directly affected by the requirements of the shop drawings the Contractor shall submit shop drawings to the Main Contractor within 6 weeks of receipt of a letter of intent to order.

In addition to layout drawings detailing equipment, separate drawings dealing Builder's work and confirming structural dimensions shall be provided by the Contractor.

Detailed drawings shall include the following:

(a) Complete switch rooms, equipment layout drawings with full identification of each and every item of equipment.

(b) Complete schematic and control diagrams of all main switchboards and control panels.

(c) Complete cable feeders layout drawings, showing the actual sizes and locations of all cables, fittings and accessories.

(d) Fully dimensioned and detailed drawings for builder's work and work by other Contractors for Electrical Installation to indicate exact locations, quantity and dimensions.

SECTION B LOW VOLTAGE SWITCHBOARD CUBICLE

B1. GENERAL

(a) This section of the Specification covers the general requirements for the supply and installation of all works in association with the switchboard cubicle as detailed in this Specification and on the Drawings.

(b) Notwithstanding anything to the contrary contained herein pertaining to this installation, it shall be the Contractor's responsibility to ensure all works are strictly in accordance with the latest Edition of IEE Wiring Regulations, Supply Rules of the power company and BS 5486 Part 1:1986.

(c) Switchboards which are assembled or manufactured locally under licence from a manufacturer credited with type test certifications from a third reputable independent party (such as ASTA, KEMA and the like) for category of duty specified shall be considered provided that all certification is valid for the locally construction units and the following conditions are observed:

. All drawings covering the design and construction shall be prepared to the satisfaction of the Consultant.

. During the construction of the switchboards, a factory engineer from the licence's works shall be required to visit the local plant on at least two different occasions and to inspect the quality and workmanship of the locally made equipment. Upon completion, a final inspection shall be made by the factory engineer to certify that the completed switchboards is finished in accordance with the approved shop drawings, and that the standard of materials and manufacture fully complies with the type test requirements.

B2. SWITCHBOARD CONSTRUCTION

(a) Each switchboard shall be type-tested assembly (TTA) of switchgear and control gear as defined in BS 5486:Part 1:1986. The switchboards shall be built and assembled to conform with BS 5486:Part 1 Form 3 for general selection and Form 4 for essential selection.

(b) The Switchboards shall be designed and constructed to withstand the thermal and electromechanical stresses set up by short circuit conditions from a source fault level of 50kA at 400V for 1.0 second.

(c) The switchboards shall be designed to offer protection to persons against contact with live or moving parts inside the enclosure, and also protection against the ingress of solid foreign bodies and liquid to an IP standard as defined in BS 5420. In any case, the degree of protection shall not be less than IP 31.

(d) Protection against direct contact shall be by means of insulation of live parts and/or the provision of barriers and enclosures which satisfy the requirements of BS 5486:Part 1.

(e) Protection against indirect contact shall be by means of the use of protective circuits as specified in BS 5486:Part 1.

(f) If the switchboard assembly contains items of equipment which may retain electrical charges after they have been switched off, a warning plate or label shall be provided.

(g) Clearances and creepage distances, and isolating distances shall comply with the minimum recommendations given in BS 5486:Part 1.

(h) Identification of terminals for connecting conductors shall comply with BS 5486:Part 1.

(i) The bottom of the TTA shall be made vermin proof by means of barriers to a minimum standard of IP 31. Also, screened ventilating louvers shall be provided on the sides and rear panels to IP31 of BS 5420 to the approval of the Consultant.

(j) The switchboard shall be suitable for indoor use in the form of free standing, extensible self contained cubicles sectionalised as necessary to facilitate easy transportation and erection. They shall be fixed together to form a flush fronted continuous board of uniform height, depth and width, and be suitable floor mounting. The LV switchboard shall also be provided with an integral channel iron plinth of not less than 100mm height of adequate strength to support and shall be enamel painted in black.

(k) Unless otherwise specified in the Specification or Drawings, the switchboards shall be suitable for rear access with a maximum height of 2.3m.

(l) The cubicle tops, side and back panels, and doors shall be made of sheet steel of minimum thickness 2.0mm. These shall be enamel painted in colour to the manufacturer's standard as approved by the Consultant.

(m) The cubicle sections shall be constructed with rigid sectional frames and folded sheet steel panels. Removable lifting lugs shall be provided with bolts or devices for ensuring they are correctly aligned when being coupled together. Details of construction shall be submitted to the Consultant for approval.

(n) Front access doors shall be provided and the back of panels shall be provided with hinges and lockable handles to facilitate inspection and maintenance. Removable gland plates shall be provided at the top and at the bottom of the switch board with knockouts or blanked off openings for incoming and outgoing circuit cables.

(o) In addition to the item (n) above, maintenance access shall be provided to all equipment within the cubicles, by means of suitable doors fitted with neoprene seals or equivalent as approved by the Consultant.

(p) All doors shall have concealed/exposed hinges and where necessary, shall be interlocked with the switch mechanism. All doors shall be provided with dust excluding gasket of neoprene or other material as provided by the Consultant.

(q) Any exposed hinges to be used shall be made of bright cadmium or plated chromium.

(r) Access to busbars and busbar connections shall be gained only by the removal of covers secured by bolts or studs. these covers shall be indicated by externally mounted mechanically fixed labels with 'BUSBARS' in black lettering (to the approval of the Consultant) not less than 10mm high, on a white background. All removable panels shall have self- retaining fixing screws.

(s) Separate compartments shall be provided for each of the following:

- Incoming circuit breaker.
- Incoming and outgoing conductors and connections of the incoming circuit breaker.
- Each outing functional unit.
- Outgoing conductors and connections.
- Protection relays and terminal blocks.
- Capacitor Bank & Control Relay

(t) On completion of the installation of the switchboard and after connection of incoming and outgoing cables, the Sub-Contractor shall set each protection relay in accordance with the details given on the Drawings.

(u) Voltmeters, ammeters, and the like, together with associated switches and indicating lamps may be mounted on the front cover of the respective functional unit with which they are associated, provided that they do not obstruct the operation of the unit and they are suitably earthed.

B3. BUSBARS

(a) Switchboard busbars shall be four poles, air insulated, with fully rated neutral. Busbars and the connections between busbars and various items of switchgear shall be manufactured from hard drawn high conductivity solid copper bars to BS 1432 and BS 1433 with electro-tinned finish.

(b) The markings, arrangements and connections of the busbars shall be as specified in BS 159.

(c) Busbars shall be of uniform cross sectional area throughout their length. Main busbars shall be arranged horizontally through the switchboard sections, with a continuous rating not less than that indicating on the Drawings.

(d) The methods and materials used in jointing and supporting busbars shall conform to the arrangement detailed in the type test reports for the switchboard assembly.

(e) Busbars shall be mounted on non-hygroscopic, non- tracking insulators of sufficient strength to withstand without damage, forces set up by any thermal expansion within the bars under normal operating conditions and electro-mechanical forces created by prospective fault currents up to 50 kA lasting for one second.

(f) A full complement of busbar links shall be provided for each cubicle section to enable cubicles to be easily coupled. Facilities shall also be provided for extending the busbars for future extension of the switchboard cubicle. These facilities shall be provided at both ends of the switchboards.

(g) In the incoming ACB compartments, the busbars shall be arranged in such a manner as to facilities cables terminations in accordance with the requirements of the power company,

(h) Busbars installed in switchboards shall be so arranged that all conductors can be brought into the without undue bending. Busbars shall be coloured at strategic locations for phase identification to the approval of the Consultant.

(i) For rectangular section busbars, connections shall be made with double split cast brass clamps. On site drilling of the bars are strictly forbidden unless approved in writing by the Consultant.

(j) All conductors between the busbars, circuit breakers shall be high conductivity electro-tinned copper bars, having a current rating of not less than that of the circuit breakers to which they are connected. The conductors shall be coloured to BS colour codes for phase identification.

(k) Removable bolted links shall be provided for the accommodation of current transformers for metering and protection facilities without affecting the mechanical and electrical properties of the busbars as a whole.

B4. PROTECTIVE CONDUCTORS

(a) Sectionalized cubicle switchboards shall have minimum 50x6mm tinned copper bar protective conductors running continuously all along the entire length of the switchboards. This protective conductor shall be securely fixed to withstand the mechanical forces associated with the fault level. The framework of all modular sections of the switchboards, earth terminals of functional units, and earth terminals fitted on the external end surfaces of the switchboard shall be bonded to the protective conductor shall be provided in an accessible position.

(b) An earth bond connection shall be made to each cable gland and/or armour clamp where cables terminate at the switchboards.

B5. MOULDED CASE CIRCUIT BREAKERS

(a) MCCB's to be used in the main switchboards shall be rated for uninterrupted duty, shall comply with BS 4752:Part 1:1977 and with any additional requirements described in this Specification. Short circuit performance category shall be P-2. Current ratings and trip settings shall be clearly displayed on the front of each circuit breaker. The MCCB's shall have a breaking capacity of 30 kA At 415V for a withstanding duration of 1 second minimum.

(b) Switching mechanisms shall be quick-make, quick- break type having independent manual operation.

(c) Handles shall be toggle or rotary action type, mechanically trip free so that contacts cannot be held against overload and short circuit currents.

(d) Clear indication of the 'ON', 'OFF' and 'TRIPPED' conditions shall be provided. It shall not be possible to place the handle in the tripped position manually.

(e) Each pole shall be provided with overload and/or short circuit tripping characteristics appropriate to the application. MCCB overload tripping characteristics shall satisfy the criteria laid down in the IEE Wiring Regulations. MCCBs with adjustable tripping characteristics shall be adjusted to the settings appropriate to the application.

In the event a fault condition is detected on one pole, all poles shall trip simultaneously.

(f) Protection mechanisms shall be thermal magnetic.

(g) MCCBs which are specified for back-up protection to motor starters shall be of motor type capable in handling motor starting current and shall incorporate adjustable magnetic short circuit protection in which the instantaneous tripping point is adjustable as a function of the breaker rated load current.

(e) Shunt trips, and adaptable motor mechanism for remote operation shall be provided as required. These accessories shall all be factory assembled and tested. In each case, a local push-to-test/trip button shall be provided to test the operation and tripping of the breaker. Facilities shall also be provided for the use of a hand held tester for in- service testing of all operational features.

(i) The adaptable motor mechanism shall posses the following minimum features.

. Operating voltage of the mechanism shall be rated at 230V AC +-15%. The maximum operating time for opening the breaker shall not exceed 500 milliseconds whilst that for closing shall not exceed 200 milliseconds.

. Life time of the motor mechanism shall be designed to be not less than 10,000 close and open cycles. It shall be suitable for use as daily closing and opening of the controlled circuits.

. The mechanism shall be equipped with a pad-lockable toggle with indication shoeing the circuit breaker positions and facilities enabling manual reset of the circuit breaker. If the circuit breaker is tripped either by built-in overcurrent device or external shunt trip, the circuit breaker shall not be able to be reclosed unless it is manually reset.

(j) Auxiliary contacts shall be provided for electrical signalling or relaying as required. Auxiliary contacts shall be internally mounted and shall operate simultaneously with the breaker's main contacts. Auxiliary contacts for a trip signal shall operate only when the breaker trips.

(k) Any mechanical interlocks amongst MCCBs shall be of the mechanical shaft linkage type which permits only one breaker to operate at any one time.

(l) Any MCCBs with rating less than 200A shall be provided with current limiting facilities to protect the downstream MCBs which will have a low breaking capacity of 6kA.

B06. DISCRIMINATION

(a) Full discrimination is required between switchboard ACBs and other sub-main switchgears in ensuring that short circuits or overloads on sub-circuits shall not trip the switchboard circuits breakers. The faulty circuit shall be effectively isolated and the healthy circuits shall be unaffected. The Sub-Contractor shall be responsible for ensuring discrimination is maintained at all times.

(b) Where earth fault detection is provided, discrimination shall be ensured as for overloads above. Sufficient adjustment shall be provided ensuring that spurious tripping due to the inherent earth leakage of long cable runs and other equipment, shall not occur, but with discrimination still maintained.

(c) Where circuit protection devices are not provided with earth leakage detection, they shall be arranged to trip on earth leakage by means of the over current protection. A sufficiently low earth fault loop impedance (maximum 0.15 ohms) in accordance with the latest Edition of IEE Wiring Regulations shall be achieved by the Contractor

B07. MICROPROCESSOR BASED MONITORING AND PROTECTIVE DEVICE.

The microprocessor based monitoring and protective device that provides complete electrical metering and system voltage protection as described below shall be provided to all main distribution boards.

Measurement :

Metered values		accuracy
* AC Ampere		± 0.5%
Phase A		
Phase B		
Phase C		
* AC Voltage		± 0.5%
Phase A-B	Phase A	
Phase B-C	Phase B	
Phase C-A	Phase C	
* Watts		± 1.0%
* Vars		± 1.0%
* VA		± 1.0%
* Watt - hours		± 1.0%
* Var-hours		± 1.0%
* VA-hours		± 1.0%
* Power factor		± 2.0%
* Frequency		± 0.1%

* % THD ± 1.0%

Note : All accuracy are of full scale.

Historical values :

* Present demand current (per phase) 5, 10 15, 30 or 60 minute windows.

* Present demand Watts, Vars, and VA 5, 10, 15 30 or to minute windows Sliding or fixed window Sync pulse input IMPACC (Integrated monitoring protection and control communications) broadcast demand sync.

* Minimum and maximum values
  Current (per phase)
  Voltage (per phase, L-L, L-N)
  Watts, Vars and VA
  Power factor (displacement and apparent)
  Frequency

* Maximum values
  % THD parameters
  Demand parameters

Protective functions :

* Protection relaying functions
  Overvoltage
  Under voltage
  Current phase loss
  Voltage phase loss
  Phase unbalance
  Phase reversal

* User programmable trip and reset threshold levels and delay intervals

* Each relay may be programmed to:
  Activate on any one or more of the six relaying figures
  Operate as latched or non latched
  (Self-resetting)
  Operate in mode 1 or mode 2 (energized or de-energized when trigger occurs)

Input/Output Capabilities :

In addition to monitoring three-phase currents and voltages separate inputs shall be provided for both ground and neutral currents. Voltage of neutral-to-ground is also

monitored to indicate the presence of harmonics nd potential downstream grounding problems. Analogue and digital I/O shall provide interfaces for transducers, relays, PLCs and control systems.

Current inputs :

Five ampere secondary ct connections for:

* Phases A,B, C
* Ground
* Neutral
* Separate ground and neutral CT inputs.
* Ct range 5:5 to 1000:5 (any integer)

Voltage Inputs :

* Phases A, B, C (from 120 Vac -500 kVac)
* 120/240 Vac control power input standard-not required with optional line power module
* Separate ground-to-neutral voltage reference.
* Pt range 120:120 to 500,000:120 (any integer)

Features :

* Two-way communication through IMPACC
* Auto-ranging (units, kilo-units, mega units)
* Programmable CT and PT ratios.
* Programming via dip switch
* Direct sensing of voltage up to 600 Vac without external PT
* Powered either by 96 - 264 Vac/100-350 Vdc control power separate source power module or direct from 120 - 160 Vac line (standard three phase power module)
* Non-volatile storage of metered data at time of last trip
* Watt-hour pulse initiator relay user-programmable rate.
* Programmable dry contact input external reset or utility demand window synchronization pulse.
* Protection relays are on optional I/O module, which may be included in the unit at time of purchase or retrofitted by the customer.
* I/O options shall include analogue in-puts, analogue outputs, additional discrete inputs; maximum of four input/output points possible.

The analogue outputs shall be programmed to reflect any of the following.

* Current - Phases A, B, C, Average, N, G
* Voltage - L-L, L-N, N-G
* Power - Real (watts)
  - Apparent (VA)
  - Phases A, B, C, and system 1

* % THD - Current (Phases A, B, C, Average, N)
  - Voltage (l-L, L-N)
* Frequency - System

IMPACC Communications Option

IMPACC-Integrated monitoring protection and control communication shall be provided to enable to easily read, log and trend information's cost effectively from metering, protection and control devices.

SECTION C LOW VOLTAGE ELECTRICAL DISTRIBUTION

C1. GENERAL

(a) This section sets out the requirements, methods, materials and standards of workmanship in connection with the L.V. electrical distribution system of the work defined below and as indicated on the Drawings.

(b) All work shall be in accordance with this Specifications.

(c) All electrical equipment shall be of first grade quality with regard to design, manufacture and installation and shall be completed for satisfactory/safe operation, control, maintenance under all conditions of service.

(d) The L.V. distribution system originates at the main L.V. switchboards as shown on the Drawings.

C2. CABLES INSTALLATION

(a) General Requirement

. Cables being proposed by the Contractor shall either be of BASEC approved types with valid BASEC Certificates or be type tested according to the relevant British Standards with type test certificates issued be recognised authorities. In either cases, the certificates shall be submitted to the Consultant for approval together with specific catalogues (Originals) of the cables.

. All the main power cables to be used in this Contract are shown on the drawings and the Contractor shall provide all the necessary trays, conduits, supports and cable trunking, glands, shrouds, end boxes, clamps, compounds, specialist tools, and the like, necessary to install terminate and connect the cables with good engineering practice and in accordance with the Specification and Drawings.

. All cables shall be provided with identification labels at each end and at all positions where cables change directions. In cases where cables are of multiple runs, labels shall be provided at 10m intervals. Labels shall be copper disc engraved to show the size of the cable and the designated equipment.

. Where multi-core cables are used for indication, protection control applications, each core shall have an identification number and the Contractor shall in addition to the cable identification labels provide engraved ferrules over the cable tails. The ferrules shall be numbered according to wiring diagram approved by the Consultant. All wires shall be terminated with clamp connector to the approval of the Consultant.

- Notwithstanding the above the Sub-Contractor shall install the cables in accordance with the I.E.E. Wiring Regulation.

- Cables running horizontally at high level shall be supported by perforated cable trays or enclosed in trunking as specified on the Drawings.

- Where cables are clipped to wall or ceiling, they shall be secured by means of space saddles at centres as recommended by the I.E.E. Regulations. The space saddles shall be of the hot dip galvanized steel deep spacer type fixed to the surface by means of "Rawlplugs" or other equal method to the approval of the Consultant. Each cable shall be fixed by a saddles fixed to bases by two cadmium plated fixing screws.

- All cables shall be of copper conductor type.

- The voltage drop and current carrying capacity of each circuit shall be in accordance with those indicated in I.E.E. Regulations and its latest amendments and shall be limited to the specified voltage drop (maximum 3% of 400V/230V with respect to the main switchboard).

- When cables pass through walls or floor slabs, pieces of G.I. sleeves of adequate sizes shall be supplied by the Contractor to the Main Contractor for casting-into the walls or floors and the cables shall be drawn therein. The Contractor shall provide fireproof material in accordance with the FSD requirements and to the approval of the Consultant to seal up the gap between the sleeves and the cables.

- The minimum bending radius of all PVC/SWA/PVC, XLPE/SWA/PVC, PVC/PVC shall not be less than eight times the overall diameters of the cable.

(b) PVC/PVC Cables

- PVC insulated PVC sheathed copper cables (PVC\PVC) shall be of single core or multi-core with full neutral and shall be 600V/1000V grade complying to B.S. 6346:1989. The cores of these cables shall be high annealed copper conductors complying with B.S. 6360:1981.

- The PVC/PVC insulated cables shall be colour coded to British Standard for phase identification for both ends.

(c) PVC/SWA/PVC Copper Cables

. PVC insulated, steel wire armoured, PVC sheathed cable (PVC/SWA/PVC) shall be 600V/1000V grade complying to B.S. 6346:1989 multi-core with full neutral. The cores of these cables shall be highly annealed copper conductors complying with B.S.6360:1981.

. The PVC insulated cores shall be colour coded to British Standards and shall be sheathed with PVC which shall serve as a bedding for galvanized single wife armouring. The armouring shall be served with an outer PVC sheath.

. Cables shall be terminated into equipment in cable glands fitted with armour clamps. The gland bodies shall be provided with an internal conical seating to receive the armour clamping cones and clamping nuts which shall secure the armour clamping cones firmly to the armour wires, ensuring that the armour wires shall be tightly clamped between the armour cone and conical armour seating. The spigot on the gland body shall be threaded to suit standard conduit accessories. A PVC shroud shall be fitted to cover the entire gland bodies. The steel wire armour shall be solidly earthed at both ends of the cables.

(d) XLPE/SWA/PVC Copper Cables

. XLPE insulated, steel wire armoured, PVC sheathed cable (XLPE/SWA/PVC) shall be 600V/1000V grade complying to BS 5467:1989 multi-core with full neutral. The cores of these cables shall be highly annealed copper conductors complying with BS 6360:1981.

. Other requirement similar to those for PVC/SWA/PVC cables as specified herein

(e) Flexible Cords

Flexible cords shall be flamed retardant PVC sheathed with copper conductors of 300V/500v grade to B.S. 6500. Minimum size of code shall be 1.5mm2.

C3. CONDUIT SYSTEM

(a) Conduits

. The Contractor shall supply and install all PVC copper wirings and control circuits in PVC conduit and trunking, unless otherwise specified herein or shown on the Drawings.

. All conduit shall be concealed type.

. Before any work on the installation is commenced the Contractor shall prepare drawings of proposed conduit runs showing the number, size and circuit reference for all conductors for the approval of the Consultant prior to the commencement of works. The Consultant's endorsement shall not relieve the Contractor from liability in respect of the provision of adequate numbers and/or sizes of conduits for the installation.

. The minimum size of conduit used in the installation shall be 20mm diameter.

. Separate conduits shall be provided for circuits at an extra low voltage.

. Conduits shall be installed to enable "loop-in" wiring to be carried out.

. Inspection-type and non-inspection type conduit bends, elbow and tees shall not be permitted.

. Conduit systems shall be arranged, wherever possible, to be self-draining to conduit outlet points for equipment. The system when installed, and before wiring, shall be kept plugged with wooden plugs.

. All surface conduits shall be run in a vertical or horizontal direction. Diagonal runs shall not be permitted. The conduits shall be secured to the surface by means of heavy spacing saddles fixed with brass or rust screws.

. On straight runs, 20mm and 25mm dia. conduits shall be supported by not less than one saddle every 600mm and conduit above 25mm dia. shall be supported by not less than one saddle every 1000mm in addition to any support provided by structures, boxes, or fittings and the like. In all cases bends shall be supported by two saddles fitted as near to either side of the bend as practicable.

. Runs between draw-in boxes shall not have more than right angle bends or their equivalent and the length of such shall be limited to 10m to permit easy draw-in of cables.

. In concealed conduit systems all adaptable boxes for accessories and draw-in boxes shall be installed such that the outer rim of the box is flush with the finished surface of the wall.

. In concealed conduit systems where flush type distribution boards are installed, a separate 20mm conduit for each spare way, shall be installed from the distribution board to a convenient point in the wall near the ceiling and shall be terminated in a common B.S. adaptable flush type box.

. All conduit shall be entirely separated from other piping services and no circuit connections shall be permitted between the conduits and such pipes.

. Conduits and outlets fixed in areas where there is waterproofing to the building shall be installed with no damage to the waterproofing.

- All conduit systems shall be efficiently earthed.
  Before any cable is drawn into the conduit, a test for continuity of the system shall be carried out and result of the test shall be notified by the Contractor to the Consultant for approval.

- Where a conduit crosses an expansion joint, special arrangements shall be made to allow relative movement to occur on either of the expansion joint.
  A separate circuit protective conductor shall be installed to maintain an effective electrical continuity across the expansion joint. The circuit protective conductor shall have a cross sectional area rated to suit the largest live conductors drawn into the conduits in accordance with the IEE Wiring Regulation.

- The maximum number of cables permitted in one conduit shall be in accordance with the IEE Regulations.

- All cables used in conduit installations shall have copper conductors and shall be PVC-insulated.

- Each conductor inside the conduit run shall be of one continuous length. Joints in a conductor in any part of a run shall not be permitted unless approved in writing by the Consultant.

- Where flexible metallic conduits are fixed to the rigid conduit this shall be achieved by means of either male or female adapters terminating at a B.S. or adapter box. The adapters shall be of brass, sweated or screwed onto the flexible conduit.

- Where conduit systems are installed exposed in weather, all fittings used shall be installed in such manner that each is watertight.

C4. MCB AND MCCB DISTRIBUTION BOARDS

(a) MCB Distribution Boards

- MCB distribution boards shall comply with and be type tested to SB 5486:Part 12. Consumer units shall comply with and be type tested to BS 5486:Part 13. Rated voltage shall be 230V, single phase or 400V three phase. Rated frequency shall be 50Hz.

- Enclosures and doors for the MCB distribution board shall be constructed from sheet steel having a thickness of not less than 1.0mm and stove enamelled to a light grey finish or to the nearest manufacturer's standard colour as approved by the Consultant. The MCB distribution board shall be of robust construction and suitable for indoor application in commercial and light industrial situation with a degree of protection not less than IP 30. Conduit knock-outs shall be provided in top, bottom and both sides. Hinged enclosure doors are to be fitted with ball catch locks or similar as approved by the Consultant.

. The back plate assembly shall be off sheet steel of minimum 1.2mm thickness and attached to the back of the distribution board enclosure for mounting of MCBs and switches.

. The metal front plate assembly shall be of minimum 1.2mm thick sheet steel and shall be finished to the same colour as the distribution board enclosure. The front plate shall be screwed on the enclosure, making the assembly suitable for both surface and flush mounting. The front plate shall have labels affixed for circuit identification.

. All current carrying parts of the distribution board such as busbars, neutral and earthing terminals, incoming cable terminals and the like shall be of copper and shall be Electro-tinned.

. Blanking-off plates shall be supplied for space circuits for all distribution boards.

. All distribution boards shall be provided with line, neutral and earthing terminals for the incoming cables. There shall be one neutral and one earthing terminal for each outgoing MCB way.

. Outgoing MCBs shall be connected to busbars by means of bolted joints. Plug-in type of current carrying contacts shall not be accepted.

. Space shall be provided for the future accommodation of 10% additional circuit breakers in all distribution boards. All necessary busbars, studs and neutral bar ways shall be allowed.

. Circuit schedules shall be provided and installed behind a Perspex sheet on the inside of distribution board door, giving in English for the following information:

- Distribution board designation
- Rating of all circuit breakers
- Size of all cables
- Type and locating of circuit load

(b) MCCB Distribution Boards

. The design, construction and testing specification of the distribution boards shall comply with BS 5486:Part 1 and shall be suitable for use on 400V (3 phase) 50 Hz supply.

. The enclosure and door of MCCB distribution boards shall be constructed from sheet steel having a thickness of not less than 1.5mm, rust proof and baked enamelled to a light grey finish or to the manufacturer's nearest standard colour as approved by the Consultant. Removable gland plate shall be provided on the top and bottom. The construction shall be of robust design, capable of withstanding the mechanical, electrical and thermal stresses under all working conditions including fault conditions. The

enclosure shall have an index of protection not less than IP30. The hinged doors are to be fitted with locks or similar as approved by the Consultant.

. MCCB distribution boards shall be provided with triple-pole and neutral copper busbars of rating not less than that of the supply side protective device subject to a minimum of 250A. All busbars shall be of hard drawn copper shall be eletro- tinned. Neutral busbars shall be of the same cross section area as the phase busbars, and shall have adequate number of terminals for outgoing circuits including spare ways.

. The configuration of the busbars, busbar supports and the busbar mounting arrangement shall be type tested and certified to a short-time withstanding current of not less than 14KA in the case of boards with busbars rating 225A or 22KA in the case of boards with busbar rating 225A or above, or the prospective short circuit current which can occur at the point of installation whichever is the largest for 0.2 second at a voltage of not less than 400 volts. Test reports shall be submitted to the Consultant for approval.

. Outgoing MCCBs shall be mounted on both sides of the busbars. The connection between the MCCBs and the phase busbars shall be by means of copper tapes and bolted joints. Plug-in type of current carrying contacts shall not be accepted.

. Every distribution boards shall be provided with an external earthing terminal for connection to the main earthing terminal. In addition, a multi- terminal connector shall be provided within the distribution board for connection of protective conductors of all outgoing circuits including spare ways.

. Each distribution board shall be provided with spare ways for future expansion. Each spare way shall be blanked off with a suitable blanking plate having a finish comparable to that of the distribution board.

C5. MINIATURE CIRCUIT BREAKERS (MCB)

(a) All miniature circuit breaker (MCB) shall be of triple-pole or single-pole and shall conform to BS 3871:Part 1. The MCB shall have the tripping classification of type 2 for general lighting/power circuit and type 3 for motor loads in accordance with 15th Edition of IEE Regulation.

(b) The body and base of the units are to be moulded bakelite, or similar material as approved the Consultant and the units are to be sealed after assembly.

(c) The load handling contacts shall be silver/tungsten and the contacts and operating mechanism so designed as to give a wiping action both at make and break.

(d) The breaker operating mechanism shall be of the trip-free type and shall be designed to prevent the load handling contacts from closing on a fault.

(e) Circuit protection against overload and fault conditions shall be provided by means of a thermal- magnetic or thermal-hydraulic device designed to give thermal operation on overload and magnetic/hydraulic operation under fault conditions.

The tripping mechanism shall be designed to give stable time/current characteristics in accordance with Table 5 of B.S. 3871:Part 1.

(f) Miniature circuit breakers shall comply and be type tested to B.S. 3871. The minimum requirements for circuit duties are as follows:

- Single pole breaker 5KA
- Triple pole breaker 6KA

(g) MCBs with current carrying contacts of plug-in type shall not be acceptable.

(h) Cable terminals of the MCBs shall be at top and bottom of the unit with access from the front, and suitable for terminating the size of solid or strand conductor in accordance with Table 6 of BS 3871:PART 1.

(a) Positions of the breaker operating dolly are to be clearly indicated for 'ON and 'OFF'.

(b) All cable and busbar terminations shall be sweated and tinned prior to connection to M.C.B. terminals.

C6. MOULDED CASE CIRCUIRT BREAKERS (MCCBs)

(a) General

- MCCBs shall be four-poles, triple poles or double poles, independent manual closing air break type.
  They shall be totally enclosed in a moulded casing formed from an insulating meterial. The construction of the casing shall be capable of withstanding the appropriate rated short circuit current and reasonably rough use without fracture or distortion. The moulded casing shall have protection not less than IP30.

- MCCBs shall comply with and be type tested to BS 4752:Part 1.

- MCCBs to be use for Control Panels shall be of motor type and shall be capable of handling the starting currents.

- All MCCBs shall be complete with current limiting devices for protection of downstream MCBs.

- All MCCBs shall be completed with dust-proof metal enclosures with all the live terminals totally enclosed.

(b) Operation Characteristic

MCCBs shall have a thermal-magnetic tripping mechanism giving and adjustable, stable, inverse time-current characteristic. The operating characteristic shall be such that:

. The time delay on overload tripping shall be inversely proportional to the overcurrents up to a threshold value of approximately 7 times the rated current.

. There shall be no intentional time-delay on overcurrent tripping due to short-circuit or heavy overcurrents exceeding the threshold value.

. The overload trip setting can be adjusted on site from 60% to 100% of breaker rated current in 10% steps.

(c) Performance Characteristic

MCCBs shall be certified, in accordance with BS 4752:Part 1and shall have the following performance characteristics:

. Rated short circuit breaking capacity - not less than 22 kA for lateral submain installation or the prospective fault current at the point of installation whichever is greater. Short circuit current withstanding duration shall not be less than 1 second.

. MCCBs short circuit performance shall be cat. P-2 as defined in BS4752 Part 1.

(d) Shunt Trip Release

This shall operate correctly at all values of supply voltage between 70% and 120% of the nominal supply voltage under all operating conditions of the MCCB.
MCCBs incorporating shunt release shall be provided with block terminals and shunt release lead cables.

C8. EARTH LEAKAGE CIRCUIT BREAKERS (ELCBs)

(a) Earth Leakage Circuit Breaker (ELCBs) shall comply with BS 4293:1983.

(b) ELCBs shall be of double-pole or 4-pole as required with an operating residual current of 30mA (otherwise specified) and a short circuit current capacity of not less than 6KA.

(c) The casing of the ELCB shall be formed from insulating material designed to withstand reasonably rough usage.

(d) A quick make and quick break switching mechanism irrespective of toggle switching speed with trip free mechanism shall be provided and the switching mechanism shall be totally enclosed with moulded bakelite.

(e) 4-pole ELCB shall be interlocked internally so that earth leakage on any one phase shall trip all three phase of the device simultaneously.

(f) ELCBs shall be suitable for independent toggle operation. The automatic toggle operation shall be of the passive type, i.e. it shall not involve the amplification of the operating residual current and shall not rely on the supply voltage.

(g) An integral test device shall be provided on the front of the ELCB to enable the operation of the ELCB to be tested. Operation of this test device shall create an out-of-balance condition simulating an earth fault.

C10. CONTACTORS

(a) Contactors shall be electromagnetically controlled, double air-break, four-pole, triple-pole, double pole or single pole as required. They shall comply with and shall be tested to BS 5424:part 1.

(b) Contactors shall be of utilization categories AC-1 for general application and AC-3 for motor circuits.

(c) Both the main and auxiliary contacts shall be rated for uninterrupted and intermittent duty. The main contacts of the contractors shall be silver or silver-faced.

(d) Two spare sets of N/C and N/O dry contacts shall be provided in addition to the contacts being used.

(e) Control circuits of the contactors shall operate at 400V Three phase supply.