SECTION 262300

LOW VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 SUMMARY

A. General: Read this section with General Requirement Division 1, Design Drawings, Document II Conditions of Contract, and other Sections of Document III-2 Particular Specifications.

B. Section Includes: Procurement, installation, testing and commissioning of the electrical distribution equipment complete with switches, circuit breakers/fuses, relays, meters, and other accessories and component equipment, all as indicated on the drawings and/or as specified herein and in accordance with the requirements of the Contract Documents for safe operation. Work includes but is not limited to the following:
1. Main Low Tension Panel.
2. Main and Sub-main Switchboards.
3. Distribution Boards.

C. Related Sections:
1. Section 230995 - Building Automation System
2. Section 260500 - Common Work Results for Electrical
3. Section 260519 - Low Voltage Electrical Power Conductors and Cables
4. Section 260533 - Raceway and Boxes for Electrical Systems
5. Section 260536 - Cable Trays for Electrical Systems
6. Section 260553 - Identification of Electrical Systems
7. Section 262500 - Enclosed Bus Duct Assemblies
8. Section 262726 - Wiring Devices
8. Section 263213 - Engine Generators
10. Section 263533 - Power Factor Correction Equipment
11. Section 265100 - Lighting

D. The nominal voltage value shall be as specified in Section 260510. All Equipment shall therefore be rated for operation on this electrical supply.

E. The contractor scope includes the supply, install, testing and commissioning main low tension switch boards, main and sub-main switch boards, distribution boards, isolators, switch fuses, etc., and all panels and Equipment as shown in the drawings.

1.2 SUBMITTALS

A. Refer to Section 260510 - "aBasic Electrical Requirements".

B. Product data shall have the following information:
1. Forms of Separation, Enclosure types, and details
2. Service voltage, number of phases, and frequency.
3. Main bus-bars capacity (Ampere Rating) and short circuit rating.
4. Overcurrent protective device types with short circuit, frame, trip ratings, features, and characteristics.
5. Metering equipment types and functions.
6. Time-current coordination curves for each circuit breaker.
7. Feeder incomer and outgoing details and termination.
8. Metering provisions with an indication of approval by statutory authority.
9. Surge protection arrangements, dehumidifiers, ventilating fans
10. Bus configuration, current, and voltage ratings.
11. C.E. listing for a series rating of installed devices.

12. Short-circuit current rating of distribution panels and boards and overcurrent protective devices.
13. Features, characteristics, ratings, and factory settings of individual auxiliary components.
14. Project Reference List.
15. Approval from statutory authority.
16. Qualification data for field-testing organization certificates, signed by The Contractor.
17. Sample Test Formats.
18. Compliance Statement.
19. Factory Type Test certificates.
20. Manufacturer Seismic Qualification Certification: Submit certification that all panel boards and distribution boards including the busbars and busducts shall withstand seismic forces.
    Basis of Certification: Indicate whether withstand certification is based on an actual test of assembled components or calculation. The term "withstand" means "the unit will remain in place without separating parts from the device when subjected to the specified seismic forces, and the unit will be fully operational after the seismic event."

C. Calculations
1. Short circuit calculations.
2. Bus bar sizing calculations
3. Calculations for breaker discrimination
4. Calculation for Temperature rise within the Panel assembly and ventilation.
5. Software simulations/Calculations that limit Total Demand Distortion (TDD)/Total Harmonic Distortion(T.H.D.) within the specified as per IEEE Std 519-1992.
6. Power factor calculation and sizing of capacitor banks.

1.3 SHOP DRAWINGS: FOR EACH SWITCHBOARD AND RELATED EQUIPMENT

A. Refer to Section 260510 - "Basic Electrical Requirements".

B. Include dimensioned general arrangement (G.A.) plans, elevations, sections, and details, including required clearances and service space around Equipment. Show tabulations of installed devices, equipment features, ratings, and openings.

C. Detail enclosure types.

D. Detail bus configuration, current, and voltage ratings.

E. Detail short-circuit current rating of switchboards and overcurrent protective devices.

F. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.

G. Details of metering provisions as per the local regulations.

H. Include evidence of Approval listing for a series rating of installed devices.

I. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components and recommended safety settings.

J. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards.

K. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

L. Include schematic and Point-to-point control wiring diagrams for power, signal, and control wiring.

M. Load Summary.

N. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around Switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

O. Typical installation instructions.

P. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

Q. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 CLOSE OUT SUBMITTALS

A. OPERATION AND MAINTENANCE MANUAL
The operation and Maintenance manual comprises the following duly approved and stamped by the engineer and approval authority as required:

1. Set of A0 As-built drawings duly approved and stamped by the Engineer and one set of A3 size prints from the "As built" record drawings.
2. General description of the systems, Equipment used, and method of control systems.
3. Schematic diagrams and control diagrams.
4. Approved Manufacturers/Distributors Contact list.
5. Manufacturer Approved catalogue
6. Schedule of routine maintenance (for each system)
7. Schedule of periodic maintenance for specialized Equipment (for each system)
8. Schedule the method of adjustments and typical sequential fault-finding routines.
9. Wiring diagrams of Equipment etc.
10. Separate from the service manual shall be duplicate sets of Manufacturer's catalogues relating to specialized plants.
11. Schedule of Equipment giving name, address, and telephone number of the Manufacturer, plant serial number, horsepower, and electrical supply.
12. Description of emergency action, which should be undertaken in the event of breakdown of Equipment. Telephone number of essential contacts to be included.
13. Test and Performance Data (Approved and witnessed by the Engineer)
14. Signed and Witnessed Test Certificates.
15. Equipment and component characteristics such as C. T. curves, etc.
16. Recommended spare part list, item description, part number, and replacement time scale.
17. Health and safety notes, advice, and declaration.

B. QUALITY ASSURANCE

Testing Agency Qualifications:

1. Testing Agency:
   a. Testing of Equipment shall be performed by an independent third party to ensure accuracy and impartiality.
   b. Testing agency must have the experience and capability to conduct the

testing indicated. It must be a member of ASTA/ NEMA/ KEMA or be an internationally recognized testing laboratory. Agency must be acceptable to local authorities having jurisdiction.

c. Testing a g e nc y' s field supervisor must be a person currently certified by NETA to supervise on-site testing specified in Part 3.

2. Source Limitations: Obtain switchboard and distribution boards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.
3. Product Options: Drawings indicate distribution board size, profiles, and dimensional requirements based on the specific system.
4. Applicable local laws and regulations
   a. All panel boards shall be manufactured only by Manufacturer having BSEN ISO 9001 Certificates. The Contractor shall also submit test certificates such as ASTA or KEMA as issued by any other independent testing authority confirming the declared short circuit ratings of Switch Boards and circuit breakers.
   b. The approved local assembler (channel partner) shall deliver fully type tested assembly as per IEC 61439-1.
   c. Design, manufacture, testing, and method of installation of all apparatus and materials furnished under t h e requirement of this specification shall conform to the latest publications or standard rules of the following:
      I. Kuwait MEW regulations for electrical installation works
      II. Kuwait Fire Directorate requirements
      III. Kuwait Ministry of communications standards and requirements
      IV. British Standards, particularly BS 7671 (I.E.E. Wiring Regulations).

C. REFERENCES

Electrical Components, Devices, and Accessories: Comply with the following standards, including all amendments.

IEC	60529	Degree of protection provided by enclosures (I.P. code)
IEC	61000	Electromagnetic Compatibility (E.M.C.)
IEC	60269	LV HRC fuses
IEC	61439-1	LV switchgear and control gear assemblies- Part1:Type tested and partially type-tested assemblies.
I.E.C.	60947-1,4:2007	Low Voltage Switchgear – Contactors, Overload relays,
IEC	60831-1,2	Capacitors
BSEN	61439-1-5	LV switchgear and control gear assemblies- Part1:Type tested and partially type-tested assemblies.
BS EN	60947-1:2006	LV Switchgear and control gear – Part-1: General rules
BS EN	60947-2:2007	LV Switchgear and control gear – Part-1: Circuit breakers
I.E.C.	61439-1&2	Switchgear Assemblies
IEC	60185	Current Transformers
IEC	60186	Voltage Transformers
IEC	51,414	Measuring Instruments
IEC	600144	Diesel Generators
IEC	61921	Low voltage power factor correction banks

IEEE	519	Recommended practices and requirements for harmonic control in electric power systems
I.E.C.	337-1,60947-5	Industrial Control Relays
BSEN	60085-1	Electrical Insulation- Thermal evaluation and designation.
I.E.C.	60947-5-1, 337-1, 60536	Indication lamps, Push buttons, Switches Protection Against Electrical shocks.
I.E.C.	68-2-30,2,11	Environmental Testing
I.E.C.	947-6-1	Auto Transfer Switching equipment.
BS IE	5685 521	Electricity meters Electricity meters
BS	6231	PVC Insulated cables for Switchgear and control gear wiring
BS EN	62208:2011	Empty Enclosures for low voltage switchgear and control gear assemblies.
BS EN	60898-2:2006	Electrical accessories. Circuit breakers (over current protection) & (ac&dc operation)
BS EN	61008:2004	Residual current Circuit breakers without integral overcurrent protection (RCCBs)
BS EN	61009:2004	Residual current Circuit breakers with integral overcurrent protection (RCBOs)
BS EN	60044-1:1999	Instrument Transformers. Current Transformers
BS	159:1992	Specification for high voltage bus bars and bus bar connections
BS EN	60664-1:2007	Insulation coordination for Equipment within low-voltage systems
BS EN	61557-6:2007	Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. Equipment for testing, measuring or monitoring of protective measures. Effectiveness of residual current devices (R.C.D.) in T.T., TN, and I.T. systems
BS EN	62053-11:2003	Electricity metering equipment (a.c.). Particular requirements
BS EN	60051-1:1999	Direct acting indicating analogue electrical measuring instruments and their accessories. Definitions and general requirements common to all parts
BSEN	60801:1993	Electromagnetic compatibility for industrial-process measurement and control equipment
BS EN	60255-22:2008	Measuring relays and protection equipment. Electrical disturbance tests.
B.S.	7671:2008	Requirements for Electrical installations. I.E.E. Wiring Regulations, 18th edition.
IEC	60050	International Electrotechnical Vocabulary

IEC	60060	High-voltage Test Techniques
IEC	60068	Environmental Testing
IEC	60071	Insulation Coordination
IEC	60127	Miniature Fuses
IEC	60137	Bushings for Alternating Voltages above 1000 V
IEC	60255	Electrical Relays
IEC	60352	Solderless connections
IEC	60480	Guide for checking of Sulphur Hexaflouride taken from electrical Equipment
IEC	60512-6	Climatic and soldering tests
IEC	60629	Standard Sheets for a modular system
IEC	60695	Fire Hazard Testing
IEC	60750	Designation of equipment and control cubicles
IEC	60983	Miniature lamps
IEC	61058	Switches for Appliances
IEC	61554	Panel mounted Equipment
IEC	61969	Mechanical structures of electronic equipment-outdoor enclosures
IEC	62051	Electricity Metering - Glossary of terms

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prior to delivery, the panel shall be fabricated, tested and certified by the third party consultant with the engineer witness and approval. No Alterations on the panel at the site will be allowed unless with the consent of the Engineer.

B. The Equipment shall be properly packed and delivered at site with prior notice to the Engineer. The Equipment shall bear all accessories, test certificates and the G.A. drawing copy. The Equipment shall be stored at the site at a high level with proper supports at the bottom and covered with a Polythene sheet of 2micron thick to protect from ingress.

C. The Panel shall bear the lifting eyebolts at the top to ease the equipment handling. All fixings will be carried out at the site with help of rust proof accessories.

D. Delivery: Handle Equipment carefully to prevent damage. Deliver Switchgear in sections of lengths that can be moved past obstructions in delivery path after completion of the successful factory inspection.

E. Handle and prepare switchboards for installation according to MEW/BS/IEC Standards.

F. Storage: Store equipment in a clean, dry place. Protect from weather, dirt, construction debris, and physical damage—store switchgear indoors in a clean, dry space with a uniform temperature to prevent condensation.

G. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage. Cover switchgear to protect from weather, dirt, dust, corrosive substances, and physical damage if stored in areas subjected to the weather.

H. Contractor to use plywood for sliding/moving the panels horizontally to the required positions with extra safety into consideration. Any bolts/nuts and screws/washers used for the installation shall be Stainless steel.

I. Remove loose packing and flammable materials from inside switchboards and open the panel for engineers' inspection before site installation.

J. Do not deliver or install switchboards until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and work above switchboards is complete. The temporary HVAC system operates and maintains ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.6 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace building components and structures to provide a pathway for moving Switchgear into place.

B. Product Selection for Restricted Space: Drawings indicate approximate dimensions for Switchgear, including clearances between Switchgear and adjacent surfaces and other items. Indicated actual dimensions and provided adequate spaces.

C. Environmental Limitations: Rate Equipment for continuous operation under the following conditions, unless otherwise indicated:
Ambient Temperature: As per MEW requirements
Altitude: Not exceeding (500 m). All materials shall be suitably selected and installed for use in I.B.C. Seismic Design Category C.

D. Coordination: Coordinate layout and installation of switchgear distribution boards and components with other construction that penetrates walls or is supported by them, including electrical and other types of Equipment, raceways, piping, and encumbrances to workspace clearance requirements. The coordinate size and location of concrete bases .Cast anchor-bolt inserts.

PART 2- PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements and specification, provide products by the following:
1. ABB Power Distribution - Italy/Europe
2. Eaton - U.S.A./Europe
3. Schneider Electric - France / Europe
4. Siemens - Germany
5. Or approved equal

B. Approved Switchboard/Panel Manufacturers:
1. SAHARA
2. Salem Al Nisf
3. Kuwait Switchgear Controls Co.

2.2 MAIN LOW TENSION PANEL

(MLTP) A. General

1. Refer to the Approved Manufacturers list section for the product selection. Any deviation from the product and origin shall be included in the Contractor's bid. The Engineer reserves the right to recommend the product under the list with the client's approval.
2. Provide close-coupled, coordinated integral low-voltage Switchgear with l ow- voltage distribution sections as specified herewith and as shown on the drawings. The unit shall be designed, manufactured, and tested per the latest standards of BS EN 61439-1, BS EN 60947, and BS EN 60664-1, and must use all products of the same Manufacturer.
3. The supply and distribution arrangement shall be as indicated in the drawings' schematic diagrams. All panels shall have 20% spare capacity.
4. The panel boards shall be provided with surge protective devices wherever required. Detail to be submitted for Engineer's approval
5. The switchboards shall be of I.P. 52 construction, and in pump, rooms shall be I.P. 54 construction following IEC 60529.
6. The main switchboards shall be of 600V/1000V insulation grade and shall be designed and constructed to comply with the requirements of BSEN 61439. The switchboard shall be Form 4, Type 2 and to be coordinated with the room dimension. The switchboards shall be modular cubicle pattern; a floor mounted, rear access, air-insulated, totally enclosed, and fully interlocked
7. Provide all requirements for Capacitor Banks listed in Section 263533.
8. All main low- tension panels shall be rated for a short circuit current rating as per the drawings.
9. Provision shall be made for top or bottom entry for cables or busduts, as appropriate. All necessary cable boxes, glands and clamps appropriate to the cable sizes shall be provided.
10. The switchboard shall be of suitable design to facilitate ease of cabling, maintenance, inspection, and testing.
11. The general arrangement of the switchboards is detailed in the appropriate drawings. However, it shall be the responsibility of the Electrical Contractor to submit with his working drawings, for the Engineers approval, the proposed arrangement and physical layout of the switchboards together with the manufacturers specification and full technical details of the Switchgear and all proposed ancillary Equipment.
12. The Electrical Contractor shall ensure that his offer includes all items, whether or not explicitly specified, but which are considered necessary for a complete, safe and satisfactory installation. The Electrical Contractor shall also ensure that the switchboards offered shall be of suitable layout and dimensions for the locations specified. A complete set of plans indicating details and fixing dimensions together with the necessary number of foundation bolts for each switchboard shall b e provided.
13. If necessary the switchboards shall be arranged for delivery to t he site in sections which can be easily placed in position and then bolted together. Lifting lugs shall be provided for each section. However the switchboards is to be shipped from the factory with assembled busbar system, apparatus group, and metering system.
14. The switchboards shall be assembled and coordinated by one Manufacturer and shall be constructed per BS EN 61439-1.
15. Combination of different makes will not be permitted for the site installation.
16. The switchboards shall be made of folded steel construction; minimum 2 mm thickness, fully rust proofed and stove enameled.
17. All exposed bolts or screw heads shall be chrome or cadmium plated.
18. All doors and removable covers or plates shall be provided with suitable P .V . C . or neoprene gaskets to prevent ingress dust, vermin and insects.
19. Each switchboard unit shall be housed in its own cell fitted with a hinged door mechanically I n t er l o c k ed so that the cell door can only be opened when the switch is in the "OFF" position.

20. Switching units shall be arranged in separate compartments or sections to protect against accidental contact with adjacent Equipment when handling the elements in the section and to prevent the spreading of faults from one section to the other.
21. Adequate cableways shall be provided in the switchboard accessible by hinged lids or removable covers.
22. The Equipment in the switchboards shall be accessible with indicating instruments mounted not higher than 2m and the center lines of operating devices not higher than 1.8m above switch boards base. The switchboard shall be adequately fixed to the floor with foundation bolts grouted in the floor or bolted to channels laid across the cable trench.
23. The switchboards shall contain the air circuits breakers, busbars, bus couplers, MCCBs, instruments, protection relays, etc., as specified hereunder with ratings and arrangement as shown on the Drawings and shall be complete with all internal wiring and connections.\
24. The switchboards shall be tested at the manufacturers premises as well as after installation in accordance with tests stipulated in BS E N 61439-1 and witnessed by the Engineer. Test certificates shall be submitted to the Engineer.
25. The panels shall be type tested as per BS EN 61439 part 1.
26. The breakers and meters shall be connected to the B.M.S. system for monitoring and control for load sharing when required. All components shall be suitable for B.M.S. interfacing. Provide all necessary panel and field wiring.
27. The panel shall be provided with surge protective device(s). The Electrical Contractor shall provide details for Engineer's approval.
28. Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument compartments, a centralized bus compartment and a rear cabling compartment. Each individual circuit breaker compartment, or cell, shall be completely segregated from adjacent compartments or sections using steel barriers at the rear, top, bottom, and sides.
29. Small wiring, necessary fuse blocks, and terminal blocks within the switchboards shall be furnished as required, including all groups of control wires.
30. Engraved nameplates shall be furnished for all main and feeder circuits including control fuses and all indicating lights and instruments.
31. Nameplates shall give item designation, c i r c ui t nu mb e r , frame ampere size, and appropriate trip rating. Furnish Master Nameplate giving switchgear designation, voltage ampere rating, short circuit rating, Manufacturer's name, general order number and item number.

B. BUSBARS

1. The A.C. switchboards shall be provided with 3- phase and neutral busbars.
2. All busbars and jumper connections shall have high conductivity high purity(99.9%) tinned copper. The busbars are to be sized to carry the rated current of the Switchgear without exceeding the temperature limit stipulated in IEC 439-2 and as specified in technical data sheets. They shall be air insulated.
3. Contractor to submit the certification of busbar purity from an independent testing laboratory.
4. The busbar system comprises horizontal and vertical busbars and earth bar.
5. The busbars to be located and sealed in separate compartments. The busbar system is to be arranged in the most favorable form considering the dynamic forces due to short circuits and ventilation requirements.
6. The earth bar shall be provided running the whole board length, and it should be electrically and mechanically connected to the frame by clamps.
7. The cross section of the busbars shall be according to the latest IEC 60865-1 recommendation, uniform throughout the length of Switchgear and shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents.
8. The neutral busbar shall be the same size as the phase busbar.

9. All busbars shall be adequately supported by non-combustible, track-resistant & high-strength polyester fibre glass moulded insulators. Separate supports shall be provided for each phase and neutral busbar.
10. All joints of busbars shall be provided with high tensile steel bolts, spring washers and nuts, to ensure good contacts at the joints. Non-silver plated busbars joints shall be thoroughly cleaned at the joint locations, and suitable contact grease shall be applied just before making a joint.
11. The Electrical Contractor shall furnish calculations establishing the adequacy of busbar sizes for the specified current ratings.
12. Auxiliary buses shall be provided for control. The material for all auxiliary buses for control power supplies shall be of high conductivity high purity tinned copper.
13. The supply for A.C. auxiliary buses shall be tapped from the main power buses before the incomer for each switchboard.
14. Connections from the main busbars to MCCB's controlling outgoing distribution shall be via solid copper busbars and NOT cables.
15. Bus bars shall be tinned copper with a P.V. C. sleeving or enclosure fully insulated.
16. Moulded P.V.C. shrouds shall be provided over joints.
17. Bolted copper busbar links shall be provided where specified and shall be used for maintenance purposes only. The link section shall be easily accessible from the front or top of the board and shall have a lockable cover. Provision for storing the links, nuts, and bolts shall be made in the switchboard.

C. EARTH BAR

1. The earth bars shall be provided at the bottom of each panel and extend throughout each panel's length. It shall be welded/bolted to the frame work of each panel and breaker earthing contact point, vertical earth bus shall be provided in each vertical section, which shall in turn be bolted/welded to main horizontal ground bus.
2. The cross-section of the earth bar shall be according to latest IEC 60865-1 recommendation. It shall have sufficient cross-section to carry the momentary short circuit and short time fault currents to earth without exceeding the allowable temperature rise.
3. Suitable arrangements shall be provided at each end of the horizontal earth bus for bolting to Substation earthing conductors. The horizontal earth bus shall project outside the panel ends and shall have predrilled holes for this connection. All joints to earth bus shall be made through at least two bolts.
4. All non-current carrying metal work of the switchboards shall be effectively bonded to the earth bar. Electrical conductivity of the entire enclosure framework and the truck shall be maintained even after painting.
5. The truck and air circuit breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions i.e., 'SERVICE' & 'ISOLATED', as well as through out the intermediate travel.
6. Each module frame shall get engaged to the vertical earth bus. Before the disconnecting contacts on the module are engaged to the vertical busbar.
7. All metallic cases of relays, instruments, and other panel mounted board shall be connected to earth bus by independent standard copper wires of size, not less than $2.5mm^2$. The insulation color code of earth wires shall be green/yellow. Earth wires shall be connected to terminals with suitable clamp connectors; soldering is not acceptable. Looping of earth connection, which would results in loss of earth connection to other devices when a device is removed, is not acceptable. However, looping of earth connections between boards to provide alternative paths or earth bus is acceptable.
8. V.T. and C. T. secondary neutral point earthing shall be at one place only, on the terminal block. Such earthing shall be made through links so that earthing

of one secondary circuit shall be removed without disturbing the earthing of other circuits.

9. All hinged doors shall be earthed through a flexible earthing braid.
10. Caution nameplate' caution-live Terminals' shall be provided at all points where the terminals are likely to remain live, and isolation is possible only at the remote end.
11. All earth bars and jumper connections shall be of high conductivity, high purity(99.9%), tinned copper

D. AIR CIRCUIT BREAKERS (A.C.B.)

1. Design:
   a. The air circuit breakers shall be of the air break, trip free, fully withdrawable, draw out type with the main contacts encased in a reinforced polyester casing and offer double insulation from the operators on the breaker front face.
   b. The air circuit breaker shall be fully tropicalized (T2) and have salt spray resistance as per BS EN 60068-2.
   c. The A. C.B. shall comply with BS EN 60947-2 utilization category B with Ics=Icu=Icw and shall accept reverse feeding without performance reduction.
   d. The A.C.B. shall comply with the isolating function requirements of BS EN 60947-2, and shall have a minimum 500V 50 Hz operational voltage,1000 V 50 Hz rated insulation voltage, and 8kV withstand surge voltage (Vimp).
   e. The breaking capacities shall not be less than 65 kA symmetrical for 3 sec. At 415 volts. Test certificates shall produce evidence of the service breaking capacity (Ics) from one of the internationally recognized High Voltage Laboratories (ASTA, CESI, ESEF/ASEFA, KEMA,).
   f. It shall be possible to change the position of the rear connection such as horizontal or vertical.

2. Operating mechanism:
   a. The operating mechanism shall be of the O-C-O stored energy spring type with a closing time less than or equal to 80 millisecond.
   b. Electrically operated circuit breakers shall have the spring charging motor connected so that the springs remain charged always with the motor disconnected after charging.
   c. A standby manual operating handle for spring charging shall be provided for operating the circuit breaker in case of power or motor failure.
   d. Anti-pumping function shall be provided by integral devices to prevent reclosing after a close-open operation if the closing impulse is maintained after the breaker has opened.
   e. Racking and draw-out:
      i. The circuit breaker shall have three positions of the draw-out mechanism:
         1. Service position, where all main and auxiliary contacts are made.
         2. Test position where main contacts are open but auxiliary contacts are closed.
         3. Isolated position where all contacts are open.
      ii. Mechanical indication on the front of the A.C.B. shall be provided to indicate

         a) main contacts closed 'ON'

         b) main contacts open 'OFF'

         c) springs charged

d) springs discharged

e) service position

f) test position

g) isolated position for draw-out mechanism.

iii. Any attempt to withdraw or insert the breaker when it is 'ON' shall trip the breaker automatically. An interlocking shall be provided to prevent insertion of a circuit breaker having a rating higher than the current rating of the A.C.B. cradle.

iv. Insulated safety shutters shall screen all live parts in the A.C.B. cradle when the breaker is isolated or racked out.

v. The racking handle shall be stowed on the A.C.B. in such a manner as to be accessible without defeating the door interlocking.

3. Contacts:
   a. The moving contacts comprising the main and arcing contacts shall have visual wear indicator and be of the spring-loaded type. The main contacts and clusters shall be site replaceable.
   b. The circuit breakers shall have sufficient number of auxiliary contacts for interlocking system as indicated and described on the drawings and shall be suitable for interfacing / communication with the B.M.S. via a bus under Modbus or any other open protocol.
   c. It shall be possible to connect all auxiliary wirings from the front face of the air circuit breakers. These wirings shall be taken through a set of disconnecting contacts, so that all auxiliary wirings are automatically disconnected in the isolated and drawout positions.
4. Overcurrent & earth leakage protection:
   a. The circuit breakers shall be equipped with Making Current Release (M.C.R.) overcurrent and earth leakage protection by means of integral self- powered microprocessor based on solid state R.M.S. sensing current relays.
   b. The long time overcurrent protection shall have a setting range between 40 and 100 per cent of sensor rating. The corresponding time delay shall be adjustable from 15 to 480 seconds.
   c. The short time overcurrent protection shall have a setting range from 40 per cent to 15 times the sensor rating. The corresponding time delay shall be adjustable from instantaneous to 400 milliseconds.
   d. The instantaneous overcurrent protection shall be adjustable from 2 times the rated current up to the circuit breaker electrodynamical withstand.
   e. The earth leakage protection shall have current settings from 10 per cent of the rated current to 1200A in steps of 10 per cent. The time delay setting shall be variable from 100 millisec. to 400 millisec. in steps of 100 millisec.
   f. Measurement chain shall be independent of the protection chain.

5. Display & history:
   a. The interrupted current, phase currents and type of fault currents shall be displayable as digital display on the breakers.
   b. A maintenance indicator shall give an indication of the main contact wear according to the number of operations.
   c. The trip unit shall have thermal memory, which should in the event of repeated overloads of faults memorise temperature rise by using thermal integration. Internal overheating of the control unit shall be indicated by a self-monitoring alarm.

E. Current Transformers

a. Current transformer shall be of the bar primary type, air cooled and suitably insulated.
b. They shall be of Class 1 accuracy for measurements and of Class 10P10 accuracy for protection in accordance with BS EN 60044-1.
c. The secondary windings shall be rated at 5A and the rated output shall be suitable for the burden

F. Instruments

a. The measuring ins t r u me nts shall include ammeters, voltmeters, power factor meter, maximum demand indicators, and selector switches as indicated on the Drawings.
b. The instruments shall have anti-glare glass fronts, anti-parallax scales and white faces with black numerals and markings. The length of scales shall not be less than 250 degrees and uniformly divided. The instrument cases shall be semi-flush mounted and shall be approximately 100 x 100mm square. Accuracy shall be one per cent of full-scale values. Moving elements shall be provided with zero adjustments external to the cases.
c. Ammeters shall be moving iron type, to BS 89-2 and BS EN 60051-1, scaled for 0-1600A (1000 KVA), 0-2000A (1250 KVA), or 0-2500A (1600 KVA) for main incoming supply.
d. Voltmeters shall be moving iron type to BS 89-2 and BS EN 60051-1, scaled 0-500V and provided with 6-position selector switches allowing reading of line to line and line to neutral voltages.
e. Digital indicators for above mentioned measuring instruments may be provided subject to the Engineer's approval.
f. Maximum demand indicators shall be of the thermal type with a 20-minute time delay.

G. Meters

a. Kilowatt hour meters shall conform to BS 37 Parts 1 & 4. They shall be dust and vermin proof and shall be of robust construction so that they will keep their accuracy over many years of service under the rigorous climatic conditions of Kuwait. The counters shall be of the cyclometer type with six digits to give direct reading of power consumption, the lowest figure being units and not tenths of units. Pointer type counters are not acceptable. The calibrating adjustment should be operated by screwdriver only. Meters should have not less than 5mm diameter terminal holes. They shall be operated through three current transformers of primary rating as A.C.B. frame and secondary of 5 Amps, and the meter counter should be calibrated to read the primary kwh.
b. All meters shall be handed over to the Ministry of Energy (Electricity and Water Department) for calibration before final installation and connection.

H. Moulded case circuit breakers (MCCB)

The moulded case circuit breakers shall comply with BS EN 60947-2 standards.

1. Design:
   a. They shall be of utilization category 'A' for breaker rating less than 630 Amps and category 'B' for a rating greater than 630 Amps.
   b. Rated service breaking capacity (Ics) sha ll be as indicated in the drawings.
   c. The circuit breakers shall be suitable for isolation as per BS EN 60947-2 and shall have rated operation voltage Ue of 690V 50 Hz and the insulation voltage U i of 800 V, 50 Hz.

d. The breaker shall be available in a 3 or 4 pole version as per the drawing. All poles shall operate simultaneously for circuit breaker opening, closing, and tripping.
e. The mechanism shall be completely enclosed in the compact moulded bakelite case. The moulded case circuit breaker shall provide class II insulation (according to BS EN 60664-1) between the front and internal power circuits.
f. The breaker shall be designed for both vertical and horizontal mounting, and it shall be possible to supply power either from the upstream or downstream side without any adverse effects on the electrical performance.
g. Breakers contacts shall be made of non-welding and non-corrodible composition.
h. Test certificates shall produce evidence of the service breaking capacity (Ics) from one of the internationally recognised High Voltage Laboratories (ASTA, CESI, ESEF/ASEFA, KEMA, or SATS).
i. The MCCB's shall communicate with the Building Management System (B.M.S.).

2. Operation:
   a. MCCBs shall be of the quick make and quick break type, having an accessible toggle mechanism ensuring full contact pressure until time of opening, whether actuated automatically or manually.

   b. Circuit breakers shall be actuated by a toggle or handle that clearly indicates the three positions 'ON', 'OFF' and 'TRIP' thus indicating clearly abnormal conditions of the circuit.

   c. In order to ensure suitability for isolation complying with BS EN 60947-2, the operating mechanism shall be designed such that the toggle or handle can only be in OFF position if the power is all actually separated.

   d. The moulded case circuit breakers shall be able to receive a locking device in the "isolated" position and there shall be a "push to trip" button in front to test the operation and the opening of the poles.

   e. The circuit breaker rating, the push to trip button, outgoing circuit identification and the contact position indication must be visible and accessible from the front, through the front panel or the switchboard door.
   f. Single pole breakers with a handle tie or a bar equivalent construction are not acceptable for a multi pole breaker.
   g. Moulded case circuit breakers shall be fixed type. Plug in type breaker connection are not acceptable.

3. Tripping:

   a. Breakers shall have the ratings and rated service breaking capacities (Ics) as per BS EN 60947-2 as indicated in the drawings. The breakers shall be of current limiting type. For short circuits, the maximum thermal stress I^2t shall be limited to 10^6 A^2S for highest ratings up to 250A and 5 x 10^6 A^2S for higher ratings.

   b. Circuit breakers shall have inverse time tripping characteristic with automatic release secured through action of a combination of thermal-magnetic or electronic trip units which shall trip free of the handle and operate in response to an overload or a short circuit.

c. It shall be possible to equip the moulded case circuit breaker with a motor mechanism if needed and closing of mechanism shall take place in less than 80 ms. The operating mechanism shall be of the stored energy type only. Adding a motor mechanism or a rotary handle shall not affect circuit breaker characteristics and shall not block the device settings.

d. MCCB with ratings up to 250A shall be equipped with thermal magnetic or electronic trip units, which are fully interchangeable. The breakers with ratings over 250A shall be equipped with electronic trip units, which shall remain operational for ambient temperatures up to 60°C.

e. Electronic trip unit shall comply with Appendix F of BS EN 60947-2 standard. It shall be possible to fit lead seals to prevent unauthorised access to the settings of the electronic and thermal magnetic trip units and shall be communication capable via Modbus or other open protocol.

f. MCCB's up to 250A frame size equipped with electronic trip units shall sense the actual R.M.S. values for:

i. Long time protection from 40% to 100% of the trip unit rating.

The short time protection shall be adjustable from 2 to 10 times the thermal setting.

ii. The instantaneous protection shall have the threshold fixed between 12 and 19 times nominal current, depending on the rating.

iii. MCCB's over 250A frame size shall be equipped with electronic trip units and shall sense the actual R.M.S. values for:

- Long time protection from 40% to 100% of the trip unit rating.
- The short time protection shall be adjustable from 2 to 10 times the thermal setting.
- The instantaneous protection threshold shall be adjustable from 1.5 to 11 times nominal current.
- Thermal memory (in the event of repeated overloads, the electronic trip units shall optimize protection of cables and downstream devices by memorising temperature variations).
- When using an electronic trip unit it shall be possible to differentiate remotely the type of fault (overload, short circuit, etc.)
- Measurement of electrical parameters (current, voltage, power factor, etc.) shall be possible and should display these parameters and fault status on the display screen of the breaker and shall be communication capable via Modbus or other open protocol.

- MCCB's equipped with thermal magnetic trip units shall have adjustable thermal protection and fixed magnetic protection for current ratings up to 160A. For current ratings greater than 160A the thermal magnetic trip unit shall be adjustable from 5 to 10 times the current rating. In four- pole breakers, the neutral pole shall have the tripping threshold equal to that of the phases unless otherwise stated in the drawing.

4. Extension:

   a. The MCCB's shall be designed for adding auxiliary contacts such as shunt or undervoltage releases after installation at site.
   b. The auxiliaries shall be separated from power circuits.
   c. It shall be possible to install auxiliary switches for fault/status indication in already energised MCCB without the need to trip the MCCB.
   d. It shall be possible to assemble earth fault protection of MCCBs by adding a residual current device directly to the circuit breaker case.
   e. R.C.D.s shall operate without an auxiliary power supply.
   f. The add-on R. C. D. s shall comply with Appendix B of BS EN 60947-2 standard.
   g. They shall be immunized against nuisance tripping as per BS EN 60255 and IEC 60801 standards.

5. Circuit breakers of synchronizing panels
   a. All circuit breakers shall be 3 pole, draw out type, provided with self-aligning, line-side and load-side disconnecting devices. Breakers shall be electrically operated. Breakers which have the same ratings shall be interchangeable with each other. Breakers shall be equipped with the "stored energy operation"
   b. The circuit breakers shall be rated as follows:
      i. Nominal voltage, 415V.
      ii. Rated continuous current, as indicated.
      iii. Rated frequency: 50 Hz.
   c. Rated dielectric strength: In accordance with ANSI standards C37.04 and C37.06 for above listed nominal voltage class.
   d. Other voltage, current, interrupting ratings, operating times, duty cycle, etc., are in accordance with ANSI C37.04 and C37.06.
   e. Operating mechanism: Stored energy, maximum closing time 5 cycles.
   f. Control voltage: 24 VDC. Trip: 240 VAC close and charge.
   g. Provide auxiliary contacts, interlocks, and relays as required. Provide four (4) spare auxiliary contacts in addition to those required for control, alarm, and interlocking functions.
   h. Interchangeability: In accordance with ANSI C37.20.
   i. Operation: Controls shall function in both OPERATE and TEST breaker positions.
   j. Breaker control wiring: In accordance with ANSI C37.11 with separate fusing of close trip circuits.
   k. Provide means for manual tripping and closing of a breaker.
   l. Interlocks:
      Provide mechanical interlock to prevent removal or insertion of breaker while in a CLOSED position.
      Provide interlock on the breaker, which automatically discharges closing spring upon removal from or insertion into the compartment. Accessories:
      Manual positioning device.
      Testing and routine maintenance
      Tools:
      Set of tools for manually charging breaker stored energy device

I. EARTH LEAKAGE RELAYS

1. The relay shall comply with BS EN 61557-6.

2. The relays shall be protected against nuisance tripping caused by switching surges or by lightning surges.

3. The relays shall be of solid state type (mechanical type shall not be accepted).
4. Self-protected from high magnitude earth faults and protected against dirt, vibration and moisture.
5. The relays shall be able to operate in the presence of fault currents with D.C. components.
6. Each relay shall accept a wide range of auxiliary supply voltages from 48V to 240V A.C. and 48V to 300 V DC as per the requirement in the drawings.
7. The relays' sensitivity shall be adjustable per the requirement in the drawings from 0.03A to 25A. The relays shall have time delay option if required selectable in eight steps from instantaneous to 1 sec.
8. The size of the relays shall be compact. They shall be suitable for mounting on a symmetrical rail horizontally or vertically.
9. The relays shall be equipped with one changeover output contact. The continuity of the measurement circuit shall be monitored to ensure that the toroid circuit is not open.

J. Current Sensors (Torroids)

1. Shall be a rectangular type for bus duct feeders
2. Shall be circular/ring type for cable feeders
3. The toroid shall be of the closed type with an inside diameter ranging from 30 to 200mm.
4. The toroid shall have cable guides to ensure that feeder cable is centered within the toroid. The maximum link resistance from the toroid to the relay must not exceed 3 ohms.

K. BUS SECTION COUPLERS

Bus section couplers shall be air circuit breakers as specified in the design documents but without protection.

L. CIRCUITS AND CONNECTIONS

1. All outgoing circuits shall have separate compartment and/or be screened so that Equipment for any one circuit can be maintained without risk of contact with live connections on any other circuit.

2. Feeders for circuits rated up to 32A shall be connected to terminal blocks located in separate compartments at top or bottom, conveniently arranged to facilitate termination of cables and suitably identified.
3. For feeders rated more than 32A copper links shall be suitably extended, Rigidly supported and covered with coloured P.V.C. sleeves or painting for phase identification.
4. All feeders shall be provided with cable lugs and brass cable glands.
5. Removable gland plates suitable for the glands required for the specified cables shall be provide. The gland plates shall be of a non-ferrous metal.
6. Wiring:
    a. All small wiring shall be of stranded copper, not less than 2.5 mm^2 with P.V.C. insulation to BS EN 6231.
    b. Small wiring shall be neatly bunched and cleated in harness form or enclosed in plastic trunking or troughing.
    c. Wiring cleated to metal surfaces shall be insulated from the metal. Where wiring runs through sheet steel panels, holes shall be grommets with suitable grommets.
    d. Small wiring associated with external circuits shall be connected to terminal strips conveniently arranged.

e. Each connection shall have separate incoming and outgoing terminals and no more than two wires shall be connected to any terminal.
f. All spare contacts shall be wired to terminal strips suitable positioned.
g. All wiring shall be identified using plastic ferrules at both ends.

2.3 MAIN AND SUB-MAIN SWITCHBOARDS

1. Refer to the Approved Manufacturers list section for the product selection. Any deviation from the product and origin shall be included in the Contractor's bid. The Engineer reserves the right to recommend the product under the list with the client's approval.
2. The normal and emergency main and sub-main switchboards shall be of 600V/1000V insulation grade shall be designed and constructed to comply with BSEN 61439. The switchboard shall be Form 3, Type 2. The switchboards shall be modular cubicle pattern, floor mounted, front access, air insulated, totally enclosed and fully interlocked. All sub- main distribution boards shall have 20% Spare capacity. Finished color: light grey
3. The main and sub-main switchboards in mechanical rooms shall be of I.P. 54 protection degree; in the electrical room and closets, they shall be constructed for I.P. 52 as per IEC 60529 and shall be of Form 3 construction
4. Panels shall be rated to withstand thermal and mechanical stresses set up by short circuit conditions from a source fault level as indicated on the drawing.
5. The panel boards shall be provided with surge protective devices wherever required. Detail to be submitted for Engineer's approval.
6. To be constructed from sheet metal panels built on a substantial rolled or folded sheet steel sections framework.
7. Cabinet shall have stiffeners to ensure a rigid structure.
8. Sheet metal for the buildup of the panels shall be not less than 16 SWG (1.6 mm).
9. Switchboard shall be divided integrally with sheet metal webs to separate low voltage equipment from instruments and control equipment and to ensure overheating does not occur.
10. Access doors shall have concealed hinges, stops and interlocks where required, and a dust excluding gasket contained in a rebate.
11. Door handles shall be the rotating type closing onto ramps, of approved pattern, finished in a black, hard wearing nonconductive material.
12. Cabinet shall have adequate means for lifting and shall be capable of being rolled or moved into the installation position and bolted directly to the floor.
13. Switchboards shall have necessary cut-outs, drillings and the point of entry of bus duct feeders and cables.
14. After fabrication, steelwork shall be cleaned; zinc sprayed and stove enameled with one primer coat, two undercoats and one finishing coat, and the surface rubbed down after each coat.
15. The breakers shall be connected to the B.M.S. system for monitoring and control for load sharing when required. All components shall be suitable for B.M.S. interfacing.
16. Components shall be the product of one Manufacturer. Switching and protective devices shall have clear on/off identification. Circuit devices shall be individually mounted in a cubicle form, front accessible for installation, adjustment, and inspection and rear accessible for connection with line and load connection terminals. The operating handles of each protective device shall project from cut- outs in the front door.

    Components shall be labeled for easy identification.

    a. P.V.C. insulated color-coded cables.
    b. Factory installed, neatly bunched and supported, and extended onto labelled terminal boards for the connection of external services.

c. Terminals: anti-turn solderless type suitable for cable sizes shown on the Drawings.
d. Small wiring, necessary fuse blocks, and terminal blocks within the switchboards shall be furnished as required. All groups of control wires leaving the Switchgear shall be provided with terminal blocks with suitable numbering strips

17. All main and sub-main switchboards shall have C.T. provisions for energy monitoring.
18. The moulded case circuit breakers, earth leakage relays, C.T., toroids, instruments, contactors, etc. shall be as specified elsewhere.
19. Current limiting circuit breakers
    a. To be similar to moulded case circuit breakers, but shall be capable of interrupting heavy short circuits current similar to the cut off characteristic of high rupturing capacity fuses.
    b. To incorporate electromagnetic repulsing mechanism, shall have a breaking capacity as specified in the schematic diagram.
20. Non-automatic circuit breaker shall be similar to the moulded case circuit breaker in every respect but without overcurrent protection.
21. Bus bars
    a. Electro-tinned, hard drawn, high conductivity copper(99.9% purity), suitably sleeved for phase identification.
    b. Rating: as indicated on the Drawings.
    c. To be adequately supported by porcelain or moulded insulators spaced at suitable centres so that the complete assembly can withstand the maximum mechanical stresses to which it may be subjected under fault conditions.
    d. To be enclosed in separate compartments and arranged so that all conductors can be brought onto the bars without undue bending.
    e. Bus bar compartments shall not be used as switchboard wiring ways.
    f. An earth bus bar, minimum size 25 x 3 mm, shall be provided for the full length of each switchboard with each separate section of the board bonded to it.

2.4 DISTRIBUTION BOARDS

1. Refer to the Approved Manufacturers list section for the product selection. Any deviation from the product and origin shall be included in the contractors bid. The Engineer reserves the right to recommend the product under the list with the client's approval.
2. To be totally enclosed, dust protected, vermin proof, recess mounting type except in electrical rooms and closets where surface type boards shall be provided, containing all the necessary switching and protective devices, busbars and moulded circuit neutral connector block.
3. D.B.s shall be interfaced with B.M.S. for status indication as well as lighting control.Contractor shall provide all contactors and relays in the D.B. for the B.M.S. control and monitoring as shown in the drawings and schedule of points.
4. Cabinet shall be made from robust sheet steel, fully rust proofed and stove enameled, and shall not be less than 2mm thick.
5. Cabinet shall have a hinged door fitted with a lock and key.
6. It shall be necessary to open the door to operate miniature circuit breakers. Access to interior components and internal wiring shall be gained by dismantling and removing a separate barrier within the enclosure.
7. Cabinet shall bear environment resiliency ratings appropriate to its installation location.
8. Cabinet shall be designed to BS EN 61439 and BS EN 62208
9. All distribution boards shall be rated for a short circuit current rating as per drawing
10. Bus bars shall be of appropriate current carrying capacity at least equal to the rating of the main incoming MCCB isolator and shall be constructed conforming to BS EN 61439-2.
11. Moulded circuit neutral connector block shall be of ample size to ensure a separate way is available on the connector block for the neutral conductor of each circuit.
12. Miniature circuit breakers

a. M.C.B.'s shall comply with BS EN 60898 and BS EN 60947-2 and shall be symmetrical rail mounted type available in one, two, three, or four poles version.
b. They shall be trip-free with a quick make, quick break mechanism.
c. The rated ultimate breaking capacity (Icu) of the M.C.B.'s shall be at least equal to the prospective fault level at the point of the distribution system where they are installed.
d. The minimum rated ultimate breaking capacity (Icu) of the M.C.B. shall be 6kA for0.25 seconds.
e. It shall be possible to reverse the M.C.B. without a reduction in performance.
f. Trip ratings as indicated on the schedules of points.
g. The M.C.B. shall have a thermal overload trip to accept 5% overload and to trip at 30% of rated current as per BS EN 60947-2.
h. The instantaneous magnetic trip shall operate at 5 to 10 times the rated current for 1P, 2P, 3P, or 4P breakers, unless otherwise indicated on the drawings.
i. It shall be possible to replace 3 single-phase units with one 3-phase unit.
j. The breakers shall be of DIN type.
k. Test certificates shall produce evidence of the ultimate breaking capacity (Icu) from one of the internationally recognized High Voltage Laboratories (ASTA, CESI, ESEF/ASEFA, KEMA, or S.A.T.s).
l. The operating mechanism shall be mechanically trip free from the operating handle so as to prevent the contacts from being held closed against short circuit and overload conditions. It shall be "automatic resetting type."
m. The operating handle shall be of the toggle type with t he possibility of padlocking
facility and rotary handle.
n. Each pole shall be provided with bi-metallic thermal element for overload protection and magnetic element for short circuit protection.
o. Current discriminations tables shall be provided for each rating of the breaker.
p. The terminals shall be of the tunnel type (IP20) in order to minimize the risk of direct contact.
q. It shall be possible to fit at the site auxiliaries like shunt trip coil, under voltage release, ON-OFF switch, alarm switch, or residual current device 30 or 300 mA with remote tripping possibility.

13. Contactors

a. Shall conform to BS EN 60947-1-4.2007 and shall have minimum making and breaking capacity in accordance with utilization category AC3 and be suitable for minimum Class II intermittent duty with minimum rated insulation voltage (Ui) 690V and rated impulse withstand voltage (Uimp) of 6 K.V. operational up to 60° C without derating.
b. Single coil, electrically operated, mechanically held type.
c. Positive locking shall be obtained without the use of hooks, latches or semi- permanent magnets.
d. Contactor rating and number of poles: as shown on the drawings.
e. Operating coil; suitable for 240V, 50Hz supply.
f. Main contacts: double break silver to silver type protected by arcing contacts.
g. Contacts: self-aligning, renewable from the front panel.
h. Solenoids: The shaded pole pattern of such construction eliminates lamination noise.
i. Control of contactor: by local or remote switches as indicated. A manual operating lever shall also be included.
j. Separate bus bar shall be provided in the distribution boards for the contactors controlling part of the lighting circuits.
k. Lighting contactors controlling all or part of the lighting circuits of distribution boards shall be mounted in the board enclosures.

14. Over Current Protective Device

a. Residual current circuit breaker with overload (RCBO)

i. RCBO's shall comply with BS EN 61009-1.

ii. RCBO's shall have a minimum of 17kA for 0.25 sec breaking capacity.

iii. RCBO's shall have 30mA sensitivity with type B curve tripping characteristics for power and Shall have 100mA sensitivity type "C" curve for lighting and inductive loads circuits.

iv. Test push button shall be incorporated to verify breaker operation.

v. RCBO's shall be capable of carrying pulsating or D.C. currents and shall therefore be Type A (pulsating dc sensitivity).

b. Residual current circuit breaker

Construction: RCCB shall consist of the following parts mounted in a robust body of all insulated material:

i. Current transformer

ii. Tripping coil with contact assembly

iii. Main supply contact

iv. On/off switch

v. A test button

vi. A trip free mechanism

Design: RCCB's shall comply with BS EN 61008-1.

i. The RCCB's shall provide the functions of isolation, switching and earth leakage protection of electrical circuits.

ii. They shall have a residual current operated electromechanical release, which operates, without auxiliary supply source, to an earth leakage fault between active conductor and earth.

iii. RCCB's shall incorporate a filtering device preventing the risk of unwanted tripping due to transient voltage.

iv. They shall provide a high degree of protection against earth faults, fire hazards and electric shock.

v. They shall have an operating temperature from -5 to +45^{O}C.

vi. RCCB's shall have a trip indication on the front face by a red mark.

vii. It shall be possible to achieve vertical discrimination with RCCB's.

Electrical characteristics:

i. They shall be suitable for operation on 415 V, 3 phase, 4 wire, 50 Hz supply.

ii. RCCB's alone shall have a short circuit withstand capacity of 17 k A For 0.25 sec.

iii. RCCB's shall be available in 2 and 4 pole versions with current ratings from 16A to 100A and an earth leakage trip rating as specified in the schedule of points.

iv. RCCB's shall be capable of carrying pulsating or D.C. currents and shall therefore be Type A(pulsating dc sensitivity).

Configuration:

i. RCCB must be protected with short circuit protective devices installed upstream.

Where a RCCB is used as a separate item and not housed within a distribution or switchboard, it shall be housed in a dust protected enclosure to prevent accidental contact with live terminals

2.5 ISOLATORS AND SWITCH FUSES

1. Isolators and switch fuses, where mounted individually shall be of sheet steel construction with doors and front operated handles. They shall be of the quick make, quick break type with removable shields over the fixed contacts, door

interlocks and 'ON/OFF' indicators. Alternatively switch disconnects for motor switching can be of high impact polycarbonate housing.

2. Isolators and switch fuses shall be single or triple poles with neutral ratings as indicated on the Drawings and provided with earth terminals. They shall be in accordance with IEC 408 "On Load Break" AC23 continuous duty. The switch fuses shall be suitable for H.R.C. type fuses of Class Q1 to B.S. 88 / IEC 60127.
3. All isolators shall be of I.P. 54 construction. Watertight cabinets shall be provided in plant rooms, mechanical rooms, car park and outdoor areas. In kitchen the watertight cabinet construction.

2.6 FEEDER PILLAR - EXTERNAL LIGHTING AND POWER DISTRIBUTION

1. The feeder pillar for external lighting and power distribution shall be of robust construction fully suitable for outdoor installation.
2. Number of ways and arrangements for MCCB sections and M.C.B. sections shall be as in schematic / schedule of points, and panel dimensioned accordingly.
3. Feeder pillar shall be fabricated from galvanized sheet steel or electroplated sheet steel of minimum thickness 3 mm.
4. Feeder pillar shall consist of one compartment of galvanized sheet steel housing except for the one housing M.C.B. distribution board as an integral part in a second mechanically segregated compartment. They shall be with equipment mounting panel, control devices, bus bars, all wired and ready for use and shall be complete with M16 size, 300 mm long anchoring bolts, two nuts and two washers all galvanized for installation purposes. Substantial stool hook shall be welded at the top two sides of the feeder pillar for transportation and carrying facilities.
5. The compartment doors shall have minimum 4 nos. of 80mm long stainless steel hinges and a suitable and substantial latching device with handles only to keep the doors properly in place when closed. This should not be lockable and suitable pad locking arrangement shall be provided. The doors shall be gasketted to provide protection against the ingress of moisture and dust to comply with a degree of protection IP54 in accordance with IEC-60529. On the inside of the left door, a pocket shall be provided for keeping the drawings etc.
6. A ventilating system shall be provided incorporating suitable louvers and dust filters to maintain the degree of protection of the two sides of the housing. Periodical cleaning of the filters shall be possible.
7. The roof shall be sloped and extended up to 50 mm on all four sides to shed rain water. The equipment mounting panel shall be from galvanized sheet steel of adequate thickness. It shall be possible to install and remove the panel from the front of the feeder piller. Suitable handles shall be fitted at the sides for this. All cable connections shall be in the front of the panel and a cover of insulating material or sheet steel (with Engineer's Representative's approval) at the front shall be provided to prevent any accidental contact with Bus-bars or other live materials during maintenance.
8. The Switchgear and other components inside the feeder pillar shall be as shown in schematic and the schedule of points, and as specified hereinbefore.
9. The incoming terminals shall be suitable for connecting 4-core cable of sizes as in drawings and be provided with suitable bimetallic arrangement. Loose washers for this will not be accepted. The outgoing terminals shall be suitable for connecting copper strips or bare copper conductors. All connections shall be at the front side and it shall be possible to connect the bare conductors directly onto the terminals without the use of any lugs. All power terminals shall be protected against direct finger contact by shrouding.
10. The moulded case circuit breaker unit shall be connected to four numbers busbars of amperage rating as shown in drawings. The contactor shall be as specified hereinbefore.
11. The Contactor shall have all contact assembly dust protected. Also the construction of the contactor shall be such that all current carrying and live parts shall be properly shielded and it should not be possible to come into accidental contact with them. All

terminals shall be suitable for connecting copper strips or bare copper conductors of substantial size and shall be front connected.

12. The operating coil shall be of 240 volts rating and generously sized and it should be possible to replace the coil from the front side without dismounting the contactor. The contactor shall be equipped with at least 2 nos. of normally open (No) and 2 Nos. of normally closed (N.C.) spare auxiliary contacts in addition to the main contacts and auxiliary contacts for manual-off-auto operation.
13. All the circuit wires from the moulded case circuit breakers, neutral busbar and earth bar shall be brought to a suitably located shrouded terminal strip.
14. Terminal rows and compression type cable gland shall be mounted inside feeder pillar suitable for XLPE/SWA/PVC cables for all circuit feeders and main feeders of size as shown in drawing and schedule.
15. Terminal blocks including those for earth conductors of outgoing circuits shall be from poly-carbonate, polyamide or better insulating material that cannot be easily damaged and are suitable for operation at the severe climatic conditions specified. They shall also be free from deformation and cracking. Terminal blocks of porcelain or similar material shall not be accepted.
16. All wiring within the feeder pillar shall be with PVC/PVC copper cables, colour coded for identification. Insulation to be Type-5 and sheath Type-9 to B.S.S.: 6746. All the wiring leads shall be so arranged as to permit reading current with the help of clip- on ammeter in each phase of main incoming and all outgoing circuits.
    The wires shall be coloured as follows:
    3-core - Red (Phase); Black (Neutral); Green, Green - Yellow (Earth). Or 5 - Core - Red; Yellow & Blue (Phases); Black (Neutral); Green or Green-Yellow (Earth). A window fitted with a transparent clear polycarbonate plate shall be provided on one side of the feeder pillar for permitting the operation of the photoelectric cell. The window shall be of 15cms length and 10cms width.
    The feeder pillar shall be insulated on the inside of the sides, back, top and inside of the doors with 25mm thick fiberglass insulation and the insulation shall be faced on the inside with 1.5mm thick fiberglass reinforced plastic protective mat. Alternatively, an integral backing or stove enameled sheet steel backing of minimum 1mm thickness can be provided.
17. Feeder pillars housing MCBS, contactors and busbars shall be the same as in for MCCB boards.
18. The feeder pillar housing shall be provided with a protective coat of approved paint and finished with application in an approved colour. All welded joints shall be cleaned and treated against corrosion by an approved means.
19. A sample feeder pillar shall also be submitted for the Engineer's approval before production of ordered quantity.
    The Contractor shall submit the detailed drawing illustrating the type and size of housing, the details of the various components alongwith the Manufacturer's catalogues etc.

2.7 SOURCE QUALITY CONTROL

A. GENERAL CALCULATIONS: Temperature rise calculations shall be submitted to prove that the temperature rise is within the temperature tolerance levels of the switchboard components. Type test report performed in an independent laboratory to be provided.

B. TESTING AND INSPECTION

1. Type Tests

Following type tests to conducted on each type of switchboards as per BS EN 61439 (part1-5), and a complete original type test certificate including drawings shall be submitted.

a. Temperature rise limits
b. Dielectric properties
c. Short circuit withstand strength
d. Effectiveness of the protective circuit
e. Effective connection between the exposed conductive parts of the assembly and the protective circuit. Short circuit withstand strength of the protective circuit
f. Clearances and creepage distance
g. Mechanical operation
h. Degree of protection
i. Wiring, electrical operation
j. Insulation
k. Protective measures
l. Insulation resistance

2. Routine tests: All mains and sub main panel boards shall undergo the following routine factory tests before dispatching and a test certificate shall be forwarded for the same. a. Primary injection test for all circuit breakers and meters
b. Secondary test for all protective relays
c. Millivolt drop test
d. Insulation test

3. If original type test certificate is not submitted, all such tests shall be witnessed by Engineer. The Contractor is responsible for complying with all codes, which apply to the Equipment. Any special certification requirements or inspection by other authorities arising from the above shall be arranged by the Contractor and the costs for the same included in this quotation. Switchgear and Panel boards should be Total Type Tested by ASTA or KEMA

4. The Contractor is responsible for the cost of the ticket, lodging, boarding, visa,and transport facility etc. for minimum of five persons from the client to witness the factory testing of the Equipment.

PART 3 – EXECUTION

3.1 EXAMINATION

General Checks

A general check of all the man switchgear, labelling and ancillary Equipment shall be made and shall include a check of the completeness, correctness and condition of earth connections, painted surfaces, cables, wiring, plates and all other auxiliary and ancillary items.

Checks shall be made for any leaks, and that insulators are clean and free from external damage.

Shutters, interlocking, earthing procedures and the interchangeability of components shall be checked. Installation, testing and commissioning shall be strictly in accordance with Manufacturer's recommendations, MEW requirements and shall be as per the relevant item of specification.

3.2 PREPARATIONS

A. Install switch boards and distribution boards as indicated on the drawings. Verify site conditions and access available for switch board to the switch room and ensure that switch boards are brought in suitable sizes

B. Switch boards shall be levelled properly and supported uniformly. Any site modification, assembly of components etc., shall be done by qualified personnel from the switch board manufacturer only.

C. All instruments, relays and meters shall be checked and, if necessary adjusted and calibrated for satisfactory operation after installation.

D. No switch or protective device shall be positioned with operating handle higher than 1.8m above floor level.

E. Identify all outgoing circuits including neutrals and earth with approved labels/ferrules. Properly segregate, support and identify all cabling within the panels. Do not use terminal connections as supports.

F. All cables shall be identified by suitable cable marker and labelled permanently on both sides.

G. Approved as-built drawings shall be kept inside each MLTP's, A.T.S., M.S.B.'s,

SMSB's,
Distribution Boards,etc.

H. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

I. Create a directory to indicate installed circuit loads after balancing switch board loads.

J. Obtain approval before installing. Use a computer to create directory.

K. Switch Board Nameplates: Label each board with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

L. Continuity of cable connections and phasing sequence to be checked.

M. Check Insulation between Phases, Insulation to Earth.

N. Mechanical Inspection:

All relays are to be examined to ensure that they are in proper working condition and correctly adjusted, correctly labeled and that the relay case, cover, glass and gaskets are in good order and properly fitted.

O. Wiring:
Inter-relay, inter-unit and cubicle wiring, if carried out at site is to be checked to the appropriate circuit wiring diagram. Where it is found necessary during pre-commissioning work, to effect site modifications to the secondary wiring, site copies of the appropriate schematic and wiring diagrams shall be suitably marked as agreed with the Engineer before the circuit is commissioned.

P. Secondary Injection:
Secondary injection shall be carried out on all A.C. relays, using voltage and current sinusoidal wave form and rated power frequency.

Q. Interlocking and Trip Tests:
All interlocking arrangements both electrical and mechanical shall be fully checked and tested.

R. On Load Tests:

In view of the hazards inherent in these tests, they shall be carried out under the direct supervision of Engineer at site.
An operation and stability test shall be carried out for on load commissioning of unit type protection.
On-load checks shall be made after the protection gear has been placed in service to ensure that all connections and test links have been replaced and test leads removed as well as to confirm the integrity of the current transformer circuits.
Where necessary, voltage readings shall be taken at the terminals on each relay to ensure that loop connections between the relays are complete.

S. Tests on Completion:
The Contractor will be responsible to perform functional cheeks/tests, with actual system conditions, of the discharge devices under Manufacturer's supervision.
The exact nature of the tests and presentation of the results shall be to the approval of Engineer at site.

3.3 INSTALLATION

A. Install freestanding Equipment on concrete bases. Cast-in-place concrete is minimum of 110mm height with inclusion of 250mm clearance on all sides of the panel subject to the Engineer's approval.

B. Maintain minimum workspace according to MEW requirements. Connect remote monitoring communication module to electrical power monitoring and control data network through appropriate network interface unit.

C. After installation and leveling, render the entire switchboard rodent proof by means of steel plates.

D. Provide full length rubber mat in front of switchboard. Installation of switchboard shall be fully in accordance with the Engineer's requirements.

E. Switchgear and distribution boards and panels shall be surface mounted/free standing type and shall be mounted on the building structure by means of suitable mild steel straps or angle iron frames.

F. Where distribution boards or Switchgear are required to be directly attached to brickwork etc., the fixing shall be by means of grouted in bolts, or bolts of the expansion type.

G. Any live metal in the switch board shall be screened with insulation material, so that circuit breakers can be replaced without any danger to the operator.

H. The circuit breakers shall be situated to allow wiring to be carried out with sufficient slack to enable them to be removed for inspection without disconnecting any circuit wiring.

I. All Main, Submain and final Distribution boards shall have a spare capacity and shall also be provided with enough spare breakers as shown on the drawings.

J. All panel board and distribution boards shall consist of adequately rated circuit breakers. Circuit breakers shall be temperature compensated at the Manufacturer's works to give the design current ratings as follows: Indoor air conditioned areas at $40^{O}C$, ventilated or air conditioned areas at $40^{O}C$, indoor car park at $45^{O}C$, roof at $60^{O}C$.

K. Non-compensated breakers will not be approved and a formal certificate shall be required from the Manufacturer confirming that the breakers have been suitably temperature compensated.

L. Install main low-tension board as indicated in accordance with equipment manufacturer's written instructions and with recognised industry practices to ensure that the Equipment fulfils requirements. Comply with the applicable installation requirements of I.E.E. Wiring Regulations and local authorities.

M. Provide earthing connections for the main switchboard as indicated on the drawings.

N. Tighten connections to assure permanent and effective grounding.

O. Prior to energization of the switchboards, check with megger tester to ensure requirements of all applicable wiring regulations, including BS 7671 and any local electrical codes, are fulfilled.

P. Frame and mount printed basic operating instructions for switch boards, including control and key interlocking sequences, and emergency procedures, fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on the front of the switchboards.

Q. Distribution boards shall be surface or flush mounted to suit the situation and as directed by the Engineer at site. Covers for D.B.'s in public areas shall be with counter sunk recessed covers to accept the same finish as the walls. They shall be installed with the vertical sides plumb and the top of D.B. at 1.8 m above finished floor level or as directed by the Engineer.

R. The boards shall be properly earthed by connecting an earthing conductor from the main distribution earth bus bar to an earth connector welded to the cabinet and earthing bushings on the incoming and outgoing feeder circuits.

S. Install filler plates in unused spaces. When warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

3.4 SITE QUALITY CONTROL

A. The Contractor is responsible for submitting all contract works to site inspection by the Engineer, before site tests are commenced. Before commissioning, the Contractor shall depute an experienced and qualified testing Engineer from the Manufacturer's works to

carry out the tests on the Equipment and such other tests that may be considered necessary by the Engineer.

B. The Site Acceptance Test (S.A.T.) format for the switchboards shall be forwarded to the Engineer prior to the S.A.T.

C. The Contractor's test engineer shall complete all pre-commissioning tests, commission all plant and Equipment supplied by him and hand over the entire contract works to the Engineer. All the charges connected with the pre-commissioning tests of the Equipment shall be included in the tender price.

D. The Contractor's testing engineer shall carry out all commissioning tests in cooperation with and to the satisfaction of the Engineer who will take part in all these tests.

E. The Contractor shall provide all test equipment required for different test purposes at site.

F. The following test / inspections at site shall be carried out:

1. Mechanical Tests:

a. Visual inspection to verify degree of protection, creepage and clearance distances.
b. All conductors and cables are checked for proper routing and all devices for proper mounting.
c. Check effectiveness of all mechanical devices, e.g. handles, locks, interlocks, operating devices, etc.
d. Check panel conformity to drawing and Engineer's requirements. Checking of all mounting plates/fasteners.
e. Checking of dimensions and components as per drawings.
f. Electrical circuits fasteners tightness/ surface area contacts.
g. Crimping and ferrules as per drawing.
h. Labels / Identification/ Nameplate.
i. All doors checking, safety and accessibility.
j. Switchboard cabinet surface finish / smoothness
k. Inspect for defects and physical damage, testing laboratory, labels, and nameplate compliance with up-to-date circuit connections.
l. Verify that potential transformers and current transformers shall meet specified requirements.
m. Perform operational test and exercise of mechanical components and other operable devices in accordance with Manufacturer's instruction manual.
n. Check switchboard anchorage, area clearances, and alignment and fit of components.
o. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to Manufacturer's instructions for proper torque values.
p. Clean switchboard interior and exterior-using manufacturer's approved methods and materials.
q. Perform visual and mechanical inspection and related work for Overcurrent Protective Devices.

2. Electrical Tests:
   a. Insulation resistance test shall be carried out at all main circuits through to final terminals. Insulation resistance shall exceed 10 mega ohms. Record all measurements.
   b. Repeat Insulation resistance test to verify insulation resistance has not been affected by the dielectric test.
   c. Function test of all circuit breakers switches, contacts, etc. and every circuit to verify correct operation.
   d. Primary and secondary injection tests of all relays, C.T.'s and indicating and metering instruments.
   e. Insulation resistance tests between phases and earth and between neutral and earth.
   g. Operational test on components.
   h. Switching ON / Off of capacitor bank on various KVAR requirements. i. Checking of Display parameters.
   j. Switching On / off logic verification.

G. Prior to energizing, the following checks shall be carried out at site:
1. Operate the Equipment through all design functions, including remote operation, actuation of alarm and indicating devices, mechanical and electrical tripping and closing and operation of the protective devices.
2. Insulation resistance measurements on the buses, phase to phase and phase to ground, with all breakers in the fully connected position and contacts open.
3. Control circuit insulation resistance to ground.
4. Inspect all relays and protective devices, and verify settings in accordance with the Manufacturer's instructions.
5. Inspect current transformers and relays for correct polarity of connections and the installation of jumpers on unused current transformer circuits.
6. Simulate the operations and check the logic of interlocks.

7. Manually close and trip each breaker checking and adjusting the main contact alignment and wiring action in accordance with the Manufacturer's instructions.
8. Check the phasing on each side tie breaker, before closing.
9. Test protective relay operation for incomer air circuit breakers.
10. Insulation resistance test of buses and portions of control wiring that disconnect from solid state devices through normal disconnecting features.
11. Ratio and polarity tests on current and voltage transformers. Ground resistance test on system and equipment ground connections.
12. Verify appropriate capacity, overcurrent protection, and operating voltage of control power elements including control power transformer and control power wiring.
13. Check phasing of alternate supply sources to the same bus. Test overcurrent protective devices as specified for compliance.

H. Field quality-control test reports including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
   4. Qualification data for testing agency.
   5. Distribution Board Schedules:
      a. Detail all circuits, loads, and diversity factors.
      b. Clearly indicate room/area names and functions. Note ring circuits.
      c. State M.C.B. and cable sizes used for each circuit.
      d. Submit final versions after load balancing.
      e. Contractor to provide final load schedule as per the Equipment shown in M.E.P. / Landscape / Infrastructure drawing to the approval of authority.

I. Pre-testing: Upon completing installation of the system, perform the following preparations for tests:
   1. Make insulation resistance tests of switchboard buses, components, and connecting supply, feeder, and control circuits.
   2. Make continuity tests of circuits.
   3. Provide set of Contract Documents to test organisation. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in original Contract Documents.
   4. Provide Manufacturer' s instructions for installation and testing of switchboard to test organization.

J. Quality Control Testing Program: Conform to the following:
   1. Program Objectives: To assure switchboard installation meets specified requirements, is operational within specified tolerances, provides appropriate protection for systems and Equipment, and is suitable for energising.
   2. Procedures: Make field tests and inspections and prepare switchboard for satisfactory operation in accordance with Manufacturer's recommendations and these specifications.
   3. Schedule tests and notify Engineer at least one week in advance of test commencement.
   4. Reports: Prepare written reports of test results and observations. Report defective materials and workmanship; include complete records of adjustments and remedial efforts.
   5. Labelling: Upon satisfactory completion of tests and related effort. Apply a label to tested components indicating test results, person responsible, and date.
   6. Protective Device Ratings and Settings: Verify indicated ratings and settings and make the final system adjustments of Overcurrent Protection Devices.

K. Retesting after fault correction: Correct deficiencies identified by tests and observations and retest switchboards.
Verify by the retests that switchboards meet specified requirements.
1. Infrared Scanning: perform an infrared scan of switchboard bus joints and connections. Open or remove metal doors, covers, inspection plates, and barriers to make joints and connections accessible to a portable scanner.
2. Instrument: Use an infrared scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
3. Record of Infrared Scanning: Prepare a certified report identifying all connections checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

L. Prepare for acceptance tests as follows:
1. Test insulation resistance for each distribution board bus, component, connecting supply, feeder, and control circuit. Test continuity of each circuit.
2. Engage a qualified testing and inspecting agency to perform the field tests and inspections and prepare test reports.
3. Perform field tests and inspections as per MEW, BS and I.E.C. requirements and prepare test reports. Perform each electrical test and visual and mechanical inspection.
4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
Measure as directed during period of normal system loading.
Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving Equipment.
After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
Difference exceeding 20 percent between phase loads, within a distribution board, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

M. The Contractor will be responsible for carrying out required tests to prove the correct operation of the following Equipment under the Manufacturer's supervision
1. A.C.B.s, MCCBS, Breakers pre-settings
2. Overvoltage Protection
3. Under voltage Protection
4. Bus coupler Interlock (both Electrical & Mechanical)
5. B.M.S. Interface(All incoming and outgoing Breakers of Electrical Panels & MCC, meters, A.T.S., Power factor correction panel, Bus Couplers , V.F.D.s etc. shall be interfaced with B.M.S.)
6. Power factor control relay service settings will be provided by the Manufacturer of the capacitor bank.

N. WARNING NOTICES :
GENERAL
1. All items of Equipment or enclosure within which voltages exceeds 250 volts or separate enclosures or items of Equipment that allow simultaneous contact with live parts exceeding 250 volts shall be so arranged that before access may be gained a warning of the maximum voltage present shall be clearly visible i.e. 'DANGER 500 VOLTS'.
2. On unit construction switchgear the label shall be centrally placed and preferably on the bus bar section.

3. The number of labels shall be determined by the size of the switchboard but at least one label every two meters length of switchboard shall be provided.
4. Each switchboard shall have the primary warning triangle sign denoting "Caution, Risk of Electric Shock".
5. Where a dis-connector leaves any part of Equipment or enclosure "live" when in the OFF position a warning notice shall be used indicating that the Equipment is not totally isolated and giving instructions for achieving further isolation.
6. Warning labels shall be fixed to high-voltage cables or their protective covering at 1.5 meters (max) intervals with lettering 10mm high in red on a white background.
7. A safety sign shall be fixed to every enclosure associated with a high-voltage discharge lamp installation e.g. inductors, resistors, capacitors and transformers. In addition, a supplementary sign shall be located below the warning sign. This shall be 10mm x 50mm yellow background with 5mm black lettering stating DANGER, plus the highest open-circuit voltage to earth (e.g. 500 volts A.C.).
8. All H.V. and L.V. switch rooms and Electrical Rooms shall have a warning sign and a notice on all doorways or access panels as follows:
   a. The warning sign shall be the yellow triangle with black edging and the electrical symbol within the triangle.

   b. The warning notices shall be a yellow background with black lettering stating "NOTICE AUTHORISED PERSONS ONLY" with " KEEP LOCKED AT ALL TIMES" with a minimum letter size of 25mm high.
9. If a switch room has automatic gas suppression protection, a mandatory notice informing the possible discharge of gas shall be displayed on or adjacent all entrances.
10. All the warning signage shall comply with the local regulations and shall be typed in English and Arabic.

3.5 ADJUSTING & CLEANING

After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
Clean components internally, on completion of installation, according to M anufacturer's written instructions. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards and panel boards. Demonstrate method of determining optimum settings for system controls.

END OF