

<b>2</b>	<b>LOW VOLTAGE (LV&lt;1000V AC) FACTORY BUILT ASSEMBLIES (FBA'S).....</b>	<b>2</b>
<b>2.1</b>	<b>GENERAL.....</b>	<b>2</b>
2.1.1	Scope .....	2
2.1.2	General Reference .....	2
2.1.3	References .....	2
2.1.4	Submissions .....	3
2.1.5	Quality Assurance.....	4
<b>2.2</b>	<b>PRODUCTS.....</b>	<b>6</b>
2.2.1	Cubicle Switchboards .....	6
2.2.2	Motor Control Centres .....	23
2.2.3	MCCB Panel Boards.....	27
2.2.4	Distribution Boards .....	28
<b>2.3</b>	<b>INSTALLATION.....</b>	<b>30</b>
2.3.1	General.....	30
2.3.2	Earth Bonding.....	30

## **2 LOW VOLTAGE (LV<1000V AC) FACTORY BUILT ASSEMBLIES (FBA'S)**

### **2.1 GENERAL**

#### **2.1.1 Scope**

- 1 This Part shall include all labour, materials and accessories for the complete performance of all LV Cubicle Switchboards, Main Switchboards, Submain Switchboards, Motor Control Centres, MCCB panel boards, distribution boards in accordance with the Specifications and Drawings.
- 2 Related Parts and Sections are as follows:  
  
This Section  
Part 1..... General Provisions for Electrical Installation  
Part 3..... Protective Devices  
Part 4..... Motor Starters  
Part 5..... VFD  
Part 6 ..... Cables and Small Wiring  
Part 7 ..... Conduits  
Part 8 ..... Trunking  
Part 9 ..... Cable Trays  
Part 16..... Power factor correction capacitors
- 3 Factory built assemblies of switchgear and control gear (MCCs) shall be suitable for operation under the ambient and service conditions specified. They shall comply with all local regulations and requirements. The Contractor shall be responsible for making himself aware of any special conditions which apply to the installation.
- 4 The Contractor shall be responsible for ensuring that all details relating to the construction and protection systems are fully compliant with the latest requirements of QGEWC (KAHRAMAA) and construction shall not commence until QGEWC approval has been obtained. The Contractor shall provided all protection relays, interlocks and devices deemed necessary by QGEWC.
- 5 For voltages and frequencies, regulations and requirements of Kahramaa and relevant authorities should be taken into account.

#### **2.1.2 General Reference**

- 1 The work of this Part is integral with the whole of the Project Documentation and is not intended to be interpreted outside that context.
- 2 Co-ordinate the work with all other services affecting the work of this Part.

#### **2.1.3 References**

- 1 The following standards or updated/amended/revised versions are referred to in this Section:  
BS 159, IEC 61439 ....Busbar and connection (Low-voltage switchgear and controlgear assemblies)  
BS 37 Pt. 1 .....Electricity meters general

BS 142	.....	Electrical protective relays
BS 4752, IEC 157-1, IEC 61439		Switchgear and control-gear
BS 4794, Pt. 2 IEC 337-2		Control devices
BS 5472, IEC 61439		Specification for low voltage switchgear and controlgear for industrial use. Terminal marking and distinctive number. General rules
BS 5685, IEC 521	.....	Electric meters( IEC-62052-11, IEC-62053-11, BS-EN-60521)
BS 6231	.....	Electric cables. Single core PVC insulated flexible cables of rated voltage 600/1000 V for switchgear and controlgear wiring
BS 7354, IEC 61439, EN 6094		Electrical power switchgear (EN 50522, EN 61936-1)
BS 7626, IEC 185	.....	Current transformers (EN 61869-2)
BS 88, EN 60127	.....	Cartridge fuses
BS 89, IEC 51	.....	Direct acting indicating electrical measuring instruments (EN 60051)
EN 60073	.....	Basic and safety principles for man-machine interface, marking and identification coding principles for indicators and actuators
EN 60529, IEC 529	...	Degree of protection of enclosures
EN 60947-3, IEC 408		Air break switches
EN 60947-4 IEC-1 & 1A		Contactors
EN 61010-1	.....	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements
IEC 61439, IEC 439	..	Factory built assemblies LV

## 2.1.4 Submissions

- 1 Shop Drawings: All submittals in accordance with Part 1:
  - (a) submit dimensional drawings of all the switchgears, switchboards and motor control centres, including sections and elevations, showing the following:
    - (i) Arrangement of all components, instruments, indication and dimensions of all busbars
    - (ii) Positions and method of fixing cables and boxes
    - (iii) Location of terminal blocks
    - (iv) Single line diagram of the circuits showing the rating of all components, the type and size of the incoming and outgoing feeders
    - (v) Schematic and elementary wiring diagrams, for each control unit, showing numbered terminal points, numbered wires and numbered interconnections to other equipment and remote devices
    - (vi) Connection wiring diagrams, for each control unit, showing numbered terminal points, numbered wires and numbered interconnections to other equipment and remote devices
    - (vii) Complete catalogue information for all components
    - (viii) A complete list of parts, with prices, that would be necessary to maintain and/or modify the equipment
    - (ix) Protection coordination studies for all types of MCC/LV panel breakers.
    - (x) other relevant data.

2 Product Data:

- (a) Full specifications of the enclosures and the components of the FBA, switchgear, switchboards and motor control centres, with relevant sheets of manufacturer's catalogues
- (b) Type test certificates of all components fully type tested and whole assembled FBA/MCCs from an internationally recognised testing authority ~~or from internationally independent testing lab~~ in accordance with IEC 61439 or updated/revised/amended version.
- (c) Confirmation that the switchgears, switchboards and motor control centres comply with the relevant specification as mentioned in this Section.

**2.1.5 Quality Assurance**

- 1 The switchgear manufacturer must have a previous record of satisfactory service in Qatar for at least 3 5 years in similar applications.
- 2 All new and refurbished FBA/Motor Control Centres shall be subject to routine tests to detect faults and workmanship in accordance with IEC 61439 or revised/updated version. Standard assemblies and/or products used within the assembly shall also be subject to tests at the manufacture's works who supplied the products. Routine tests shall include:
  - (a) the effectiveness of mechanical actuating elements, interlock, locks etc. shall be checked. The conductors and cables shall be checked for proper laying and the devices for proper mounting. A visual inspection is also necessary to ensure that the prescribed degree of protection, creepage and clearances are maintained.
  - (b) all termination types and connections especially screwed connections shall be checked for adequate contact and torques.
  - (c) factory built assemblies such as motor control centres for pumping stations and treatment plants, unit mounted stand alone control panels etc. shall be inspected thoroughly and tested at the manufacturer's works to verify the electrical operation in accordance with the control philosophy by simulating the site conditions.
  - (d) the manufacturer shall submit the process flow diagram together with cause and effects for the assemblies involving complex control schemes and complicated interlock, sequence controls, etc.
  - (e) the tests so conducted on the assembly at manufacturer's works shall be repeated as integrated tests on site with all field devices and interfaces present.
  - (f) the manufacturer shall submit in advance, the testing procedure to the Engineer for approval prior to conducting the tests.
  - (g) Motor Control Centres shall be subjected to dielectric tests as described in IEC 614391 and 2 or latest /updated version of the standard.. All electrical components of the assembly shall be connected for the test, excluding those designed for lower test voltage and currents e.g. measuring instruments.
  - (h) anti-interference capacitors installed between the live and exposed conductive parts shall be capable of withstanding the test voltage without being disconnected from the circuit.
  - (i) the protective measures with regard to protection against direct and indirect contact shall be checked as per IEC 61439 or latest /updated version of the standard.

- (j) Motor Control Centres shall be Totally Type Tested to IEC 61439-1 and 2 ASTA/KEMA type test certificate together with test report including reports/terms under (k) shall be submitted to the Engineer for approval.
- (k) following is a list of verifications and tests to be performed on a Totally Type Tested Assembly according to IEC 61439-1 A type test report shall be submitted to the Engineer.
- (i) Strength of material and parts 10.2 Not required as "Type test" but as "Design and construction" rules on paragraph 7 or on subsidiary standard
- Resistance to corrosion 10.2.2
  - Properties of insulating materials 10.2.3
  - Thermal stability 10.2.3.1
  - Resistance of insulating materials to normal heat 10.2.3.2
  - Resistance to abnormal heat and fire due to internal electric effects 10.2.3.3
  - Resistance to ultra-violet (UV) radiation 10.2.4
  - Lifting 10.2.5
  - Mechanical impact 10.2.6
  - Marking 10.2.7
- (ii) Degree of protection of enclosures 10.3 8.2.7
- (iii) Clearances and creepage distances 10.4 8.2.5
- (iv) Protection against electric shock and integrity of protective circuits 10.5-8.2.4
- Effective continuity between the exposed conductive parts of the Assembly and the protective circuit 10.5.2
  - Effectiveness of the Assembly for external faults 10.5.3
- (v) Incorporation of switching devices and components 10.6 Not required as "Type test" but as "Design and construction" rules on paragraph 7 or on subsidiary standard
- (vi) Internal electrical circuits and connections 10.7
- (vii) Terminals for external conductors 10.8
- (viii) Dielectric properties 10.9
- Power -frequency withstand voltage 10.9.2 8.2.2
  - Impulse withstand voltage 10.9.3
- (ix) Temperature rise limits 10.10 8.2.1
- (x) Short-circuit withstand strength 10.11 8.2.3
- (xi) Electromagnetic compatibility (EMC) 10.12 + Annex J 8.2.8 + Annex H
- (xii) Mechanical operation 10.13 8.2.6

## 2.2 PRODUCTS

### 2.2.1 Cubicle Switchboards

#### 1 General:

- (a) L.V. cubicle switchboards shall be of indoor construction, purpose made, floor standing, totally enclosed, cellular cubicle type, dust protected, vermin proof and of clean and modern appearance containing the main components shown on the Drawings and/or specified
- (b) The switchboards shall be fabricated, assembled, wired, checked, tested and co-ordinated at the factory by one manufacturer using the same make for all internal switchgear components and shall be constructed in accordance with IEC 61439 or latest /updated version of the standard..
- (c) The switchboard shall be equipped with Air Circuit Breakers, moulded case circuit breakers, relays, instruments, transformers, ancillary devices necessary for operation protection or measurement purposes and Automatic Transfer control with Manual operation bypass arrangement as indicated on the Drawings
- (d) The normal components, fittings and accessories required for safe and proper operation of switchgear shall be provided, whether specifically mentioned herein or not
- (e) To withstand thermal and mechanical stresses set up by short circuit conditions in accordance with the fault through current of the feeding transformer. In general fault breaking capacities for main switchboards shall be as stipulated in QGEWC regulations minimum 44KA for 3 Seconds.
- (f) Spare ways indicated on the Single Line Diagram shall be fully equipped
- (g) All FBA's should have a manufacturers name plate indicating minimum; Manufacturer name, address, project No. busbar rating, fault current, year of manufacture, serial no. IP, etc.as per Engineer approval.
- (h) the MCCs shall be designed, manufactured and tested to IP54 in compliance with the requirements of IEC 60529.
- (i) equipment such as Variable Frequency Drives (VFD), UPS and others with large watt loss, if specifically mentioned in the particular requirements to be included in the MCC, that require forced ventilation by employing external fan and louvers as recommended by the manufacturer, the degree of protection (IP rating) shall be reduced to IP 43 from IP54.
- (j) The LV/MCCs panels shall be designed and type tested to withstand a fault current of 44 kA for 3 seconds symmetrical. Additionally the MCCs shall be type tested for safe containment of an internal arcing fault, which will check the capability of the steel structure to withstand the forces associated with the arc, and ensure safety and integrity of the assembly for continuous use. This is to establish that the enclosure of LV/MCCs together with internal partitions and/or barriers withstands the pressure and temperature arising from internal arcing with short circuit current and thus provides protection for persons in front of or within the close proximity of the MCCs in the event of internal arcing.
- (k) The test certificate must show that the neutral bar has been tested with the full fault current and for the full time specified.

- (l) The MCCs shall be designed and equipped with properly sized circuit breakers and/or fused disconnect switches, having a minimum factor of safety of capacity 1.5 taking into account the connected load and its diversity, with provision for selective short-circuit co-ordination so that faults are cleared without disturbing other circuits.
- (m) The MCCs shall be designed for indoor installation except where specified for outdoor installation.
- (n) The MCCs shall be designed to operate satisfactorily in an ambient air temperature of +50° C and RH exceeding 90%.
- (o) Unless otherwise specified temperature up to +70° C and RH up to 100% shall apply during transport, storage and installation. Equipment subjected to these extreme service conditions without being operated shall not suffer irreversible damage when operated under normal specified conditions.
- (p) The altitude of the site installation shall not exceed 100 meters.
- (q) The MCCs shall normally be located indoors in service conditions as specified above. However some parts of the MCCs such as sensors, field instruments and pilot devices may require installation in highly corrosive gaseous environments. Gases such as hydrogen sulfide and methane may adversely affect the functions of the components and devices. In such application environments, special measure shall be adopted to prevent corrosion and the subsequent rise in resistance leading to temporary or permanent interruption in control or power circuits.
- (r) The temperature rise in MCCs shall not be allowed to damage the components, connectors, wires, terminals etc. With the equipment in normal service condition, no live part shall become subjected to high temperature causing overheating that increases the risk of internal arcing accidents.
- (s) Extreme care shall be taken while designing the MCCs to ensure external surface temperature is maintained within the specified limits.
- (t) the clearances and creep age distances in the MCCs shall be based on rated impulse withstand voltage in accordance with IEC 61439 to ensure that the equipment designed is capable of withstanding the specified voltage without failure under specified test conditions.
- (u) The equipped MCC must confirm to the clearance and creepage distances and withstand voltages explicitly by taking into account the specified service conditions.
- (v) The maximum height of assemblies shall be 2200 mm above the finished floor level.
- (w) Site consideration including safety and maintenance shall be taken into account in the design of assemblies. These considerations shall include:
  - (i) Clear floor space of at least 2000 mm shall be provided in front of the LV/MCC panel from the free edge of the doors in the open position. Clear floor space of 900mm shall be provided behind the MCC when the doors are in the open position if the MCC is less than 4000mm long. If the MCC is 4000mm or longer the space provided shall be 1200mm. The clear floor space behind the MCC is not required when a true front access assembly is provided.
  - (ii) In order to provide an unobstructed exit route a clear path of not less than 1000mm shall be provided at each end of the MCC.
  - (iii) Provision of sufficient space to allow for doors to open fully without fouling other items of equipment or other open doors.



- (iv) Limiting the size and weight of assembly sections to those imposed by transportation, site access and permitted levels of site floor loading.
- (v) Clear floor space of at least 1000 mm shall be provided from the sides of all MCCs in order to allow possible future extension.
- (vi) Provide a 2 m clear opening, cable basement access room below the LV/MCC rooms for cable access including the required fire alarm, ventilation, earthing and lighting requirements as listed elsewhere and as per Qatar UPDA Municipality requirements.
- (vii) All cable penetrations from MCC basement to MCC through the MCC floor shall be sealed with 2 hours fire rated spray compound, subject of Engineer's approval.
- (viii) 50% standby capacity Air Conditioning (minimum one unit) shall be provided for the MCC/LV room.

2 Construction:

- (a) unless specified otherwise in the Project Documentation, main FBA switchboards and MCC for general purpose indoor uses shall be constructed to comply with the requirements of IEC 61439 –Form 4b Type 7, or Form 4 Type 7 conform with GAMBICA
- (b) Switchboard shall be factory built, totally enclosed, and have provision for rear access. Size, rating arrangements shall be as indicated on the Drawings
- (c) The switchboard shall consist of standard cubicles assembled together on continuous base channels to form a rigid in line flush fronted free standing continuous switchboard assembly. For small installations where particularly specified, true front access MCCs must be provided. For all other cases front and rear access MCCs must be provided. MCCs shall be constructed such that doors and covers are flush with one another and aligned to a common vertical plane; manufactured out of mild steel coated with Alu Zinc having the following thickness:
  - (i) Plinth/bed frame - 3.00 mm
  - (ii) Frames - 2.00 mm
  - (iii) Covers and Doors - 2.00 mm
  - (iv) Mounting plate - 3.00 mm
  - (v) Gland Plate - 3.00 mm
- (d) A separate cubicle section shall be provided for the main incoming circuit breaker and cable glands shall be provided for the incoming cables in accordance with the QGEWC regulations.
- (e) Each cubicle shall be divided into segregated busbar section and circuit section. The circuit section shall be further divided into segregated compartments for housing main and emergency circuit breakers and other devices. Access to internal components of any compartment must be feasible by isolating its particular switch. The hinged door shall be mechanically interlocked with the switch in such a manner that the door can be opened only in the 'OFF' position
- (f) The switchboards shall be totally enclosed, all hinged doors, covers shall be gasketed to provide protection against dust
- (g) Cabinet shall have adequate means of lifting and shall be capable of being rolled or moved into the installation position and bolted directly to the floor



- (h) The switchboards shall be provided with suitable cable glands to suit the type, size and number of cables as indicated on the Drawings. The cable glands or bracket where required shall be adequately mounted inside the switchboard. The switchboards shall be provided with the proper cable fixing clamps and terminal lugs for incoming and outgoing cables as well as earth bonding connections
- (i) After fabrication, steel work shall be cleaned, zinc sprayed and stove enamelled with one prime coat, two under-coats and one finishing coat, the surface being rubbed down after each coat or epoxy coated subject of Engineer's approval.
- (j)
- (k) The finish of all parts shall be entirely suitable for the climatic conditions on site.
- (l) The equipment shall be finished with at least two coats of undercoat and two coats of high grade acrylic stove enamel or epoxy coated subject of Engineer's approval. Cubicle interiors shall be completely painted white, however this is not essential for the rear of the door. The height of the switch board shall be limited to 2200mm unless specifically required to meet the site constraints and approved in writing by the Engineer.
- (m) any damage caused to the finish during transportation and erection shall be returned to the manufacturer for repair if it cannot be perfectly repaired on site. The structure shall be protected from rust and oxidization. The paint shall be applied to rust and grease free surface of metal. The steel shall be electro – zinc plated (ZINTEC) and must have a minimum of priming coat, undercoat and finishing coat or epoxy coated subject of Engineer's approval. The undercoat and finishing coat shall be stove enamelled.
- (n) The exterior shall be green to BS 4800, shade 14E53. The switchboard degree of protection shall be IP 54 to EN 60529.
- (o) all plastic parts used within the assembly shall be of flame-retardant, self extinguishing type and halogen free.
- (p) MCCs shall have internal separation by means of metallic or non-metallic partitions or barriers.
- (q) all internal components within the compartment /cubicle shall be provided with the degree of protections to IP 2X as minimum whereas the degree of Protection to IP4X shall be provided to adjacent functional units preventing contact with live parts.
- (r) electrical continuity between the exposed conductive parts of MCCs and protective circuits of the installation shall be ensured to provide protection against indirect contact by using protective circuits.
- (s) the protective circuits throughout the installation shall be so designed that it is impossible to break the protective path with the removal of any component from the MCC.
- (t) all outgoing circuit's protective conductors shall have a separate terminal of adequate size duly identified in accordance with the Identification Section explained elsewhere in QCS.
- (u) MCCs must be designed by giving highest importance to accessibility especially when in service/fully powered, allowing easy viewing for inspection and operation, replacement of fuses and extension of additional functional units etc.

- (v) floor mounted assemblies shall either be provided with an integral plinth or a separate rolled mild steel channel bed frame, at least 50 mm high. Fixing shall be by not less than four holding down bolts per assembly/column section, located around the periphery of the section. The fixing shall not be visible from outside the section, but shall be readily accessible from within.
- (w) fixings for wall and pole mounted enclosures shall be provided outside the enclosure. The back of the enclosure shall not be drilled to accept fixings.
- (x) the type of cubicle construction shall be multi-compartment type unless specified otherwise.
- (y) Compartments containing switchfuses, starters, control sections, distribution boards, busbars, drowndroppers and similar equipment shall be fully segregated. There shall be no aperture large enough to admit a 5mm diameter wire between any two adjacent compartments. Each cubicle/compartment shall have its own door.
- (z) Interconnecting cables between adjacent compartments shall not proceed directly from one to the other but shall pass through a vertical wall into a cabling compartment before re-entering. Holes for interconnecting cables shall be of the minimum size necessary. All such holes shall be filled with insulating grommets.
- (aa) All cubicles shall be provided with a means of ensuring that equipment can be adequately isolated for maintenance purposes without interrupting essential loads which may continue to operate whilst maintenance is being undertaken.
- (bb) Distribution sections shall be fully insulated to allow safe operation by non-engineering personnel.
- (cc) doors shall be adequately sized to accommodate readily and neatly all mounted equipment, open at least 120 degrees, be rigidly constructed, suitably braced and provided with at least two substantial hinges which shall be captive when the door is closed. Doors shall be provided with stays to prevent over opening.
- (dd) each door shall be provided with non-rusting metallic 'T' type handles at least one of, which shall be lockable.
- (ee) the doors shall be fixed to the frame by substantial single knuckle non-rusting type, or internal concealed type hinges. Hinges shall be on the left hand side of the door. Hinges shall not be welded to either the door or frame. Substantial continuous stainless steel type hinges over the whole height of the door may be considered if the manufacturer can provide evidence of long continuous service of this type of hinge on his product.
- (ff) locking combinations shall be provided as specified. Three keys for each key type shall be provided on individual key rings having a nametag showing identify details.
- (gg) where the need of padlocking facilities is identified by the engineer/employer, the padlocks shall be supplied and fitted.
- (hh) equipment shall not be mounted on covers. Covers shall not weigh more than 30 kg, and any cover over 7.5 kg shall be provided with a means of supporting the lower edge when its securing bolts are being inserted or removed.
- (ii) removable back covers shall be provided.
- (jj) each door shall be provided with an internal welded earthing stud, and shall be bonded to the assembly main earth bar.

- (kk) every incomer, starter, feeder, etc. shall have an individual terminal/gland box. Control compartments and small power and lighting distribution boards must also have independent gland boxes but these may be common to more than one circuit.
- (ll) terminal/gland boxes may be externally mounted on the rear of the MCC or internal. Terminal/gland boxes shall not inhibit access to or maintenance of any part of the MCC.
- (mm) outgoing main and control cables shall be glanded at the compartment so as to ensure a full earth screen to each compartment and shall also be glanded at plinth level to make the complete MCC vermin-proof. Compartment gland plates shall be a minimum of 300mm above the plinth level gland plate.
- (nn) gasket material used for sealing panel doors and covers and for door mounted instruments shall be of highest quality and should not be subject to deterioration by temperature, UV, hydrogen sulphide and methane.
- (oo) doors and covers giving access to potentially live conductors shall be provided with prominent warning labels, in English and Arabic.
- (pp) doors on outdoor assemblies shall be retained in the open position by the provision of adequately fixed stays.
- (qq) each cubicle/compartment shall be provided with a removable steel components mounting plate located clear of the cubicle rear panel.
- (rr) all components, other than door mounted, shall be located on the component mounting plate by bolting into tapped holes or by using self-tapping screws. Nuts used for securing components shall be captive.
- (ss) rail type fixings may be used where appropriate. Components shall not be mounted on any other surface.
- (tt) no components shall be located within the assembly at a height greater than 2000 mm or less than 500 mm above finished floor level.
- (uu) it shall be possible to replace and maintain any component without first removing other components.
- (vv) bolts and nuts for cover fixing shall be captive and provided with protective washers to prevent damage to paintwork.
- (ww) unless specified otherwise control supplies shall be 110V a.c. derived from a transformer within the control compartment or in a separate compartment, fused on its primary circuit. Neutral shall be earthed with a removable link. Individual compartments shall be fed through a fused tapping next to the main 110v bus adjacent to the transformer. Proper fuse coordination to be achieved to avoid one section fault from affecting the other section. Transformer shall be rated for at least 150% of the maximum loading for long service life.
- (xx) auxiliary supplies such as 24 V AC/DC, 240 V AC etc. are specified in the relevant individual component's specifications.
- (yy) each compartment shall be provided with a separately fixed compartment heater rated 110 Volts AC. Apart from those in motor starter compartments the heaters shall be controlled by means of individual "OFF/AUTO" switches. Auto operation shall be by means of adjustable panel mounted humidistat covering the range of humidity envisaged.
- (zz) MCCs shall be designed for ready extension at each end.

- (aaa) all terminals for outgoing connections shall be located at a low level in the compartment adjacent to the cable gland trays. Adequate space shall be provided the installation and dressing of site cables. It should be noted that site cables are frequently oversized to allow for high ambient temperatures and long cable routes. Direct termination on equipment such as Distribution Board Fuses or Miniature Circuit Breakers (MCB's) shall not be permitted.
- (bbb) all main switches shall be arranged such that a minimum distance of 700mm exists between the glandplate and the bottom of the circuit breaker or terminals, whichever is the less.
- (ccc) all live terminals, bus bar joints, main incoming and DG cables lugs/joints with the Busbar ACB terminals (or similar cases) shall be fully shrouded by using removable jointing caps high-grade high temperature material subject of Engineer's/client approval.
- (ddd) all cable entries shall be affected using brass cable glands to IP rating as specified.
- (eee) all cable glands shall be provided with earth tags.
- (fff) cables shall enter assemblies through detachable steel or aluminum/brass (for single core cables); gland plates fitted at least 200 mm above finished floor level.
- (ggg) gland plates shall be rust proofed and provided with a welded and bonded earthing stud, and adequately sized to accommodate present and known future cabling requirements. Access to both sides of each gland plate when it is in position shall be possible from within the assembly. Cables shall enter at the top or bottom of assemblies as specified and/or as shown on the relevant drawings where applicable.
- (hhh) cableways shall be provided to ensure that apart from inter-connections no cable routed to one cubicle shall pass through any other cubicle.
- (iii) for cable sizes 300mm<sup>2</sup> and above insulated glands shall be fitted.
- (jjj) provision for accommodation of rising armored cables shall be provided with adequate cable supports and a form of cable entry via approved cable glands secured to a steel glanding plate.
- (kkk) space shall be provided to accommodate cable glands of appropriate size for incoming and outgoing circuits. All gland plates and trays shall be adequately earthed.
- (III) cable disconnecting links shall be provided where specified and shall be used for maintenance purposes only. The links shall be fitted to the bus bar risers immediately before the cable terminations and shall be easily accessible. The links shall be labeled 'ISOLATING LINK' and the circuit or cable reference shall be quoted.
- (mmm) within each assembly, all metal parts of equipment supplied, other than those forming part of an electric circuit, shall be bonded to the earth bar. Metalwork may be used for this purpose provided that earth continuity conductors are fitted at all joints and other discontinuities and those connections to metal work are made using a welded or bolted stud.
- (nnn) the following metal parts must be provided with equipotential bonding connected to an earth busbar system by using yellow/green earth cable of at least 6.0 mm square.
  - (i) gland plates
  - (ii) gland covers
  - (iii) side sheets

- (iv) top barriers
  - (v) intermediate barriers
  - (vi) top covers
  - (vii) end covers
  - (viii) rear Covers
  - (ix) front covers
  - (x) cable Boxes
  - (xi) doors and bolted front covers
  - (xii) horizontal busbar barriers.
- (ooo) Where specified in contract document, each compartment shall be provided with a smoke detector. In addition to this, where specified in contract document, a heat sensitive cable shall be run throughout the MCC passing through each compartment. Both shall be connected to the fire alarm panel and shall additionally be arranged to open the main supply circuit breaker and inhibit the start up of the standby generator.
- (ppp) Where specified in contract document, FBA/MCC panel shall be provided with capsular type fire extinguishing system using FM 200 clean agent as described in section 23. One cylinder for maximum 2 columns shall be provided. The system shall be connected to the fire alarm panel and shall be arranged to open the main supply circuit breaker and inhibit the start up of the standby generator. No objection letter shall be provided by the FBA manufacturer for installation of Capsular Fire Extinguishing system in the FBA panel.
- (qqq) The height of the switch board shall be limited to 2200mm unless specifically required to meet the site constraints. Proposal shall be approved in writing by the Engineer.
- (rrr) Provide carriage/Lifting Truck if an ACB exceeded 25kg in weight (One carriage only for each site/project regardless of number of breakers provided).
- (sss) The different panel compartments shall be arranged in the following order when facing the front of the MCC and reading from left to right:
- (i) Supply incoming ACB/MCCB including Electricity Supply Authority metering.
  - (ii) Diesel generator ACB/MCCB incoming.
  - (iii) Pump starters (current pump installation-if existing)
  - (iv) Pump starters (future pumps) –
  - (v) Miscellaneous feeders / valve actuators, etc.
  - (vi) PLC

### 3 Instrumentation Labels:

- (a) Provide identification on all equipment e.g. control panels, MCC, controllers, raceways, boxes and conductors, devices etc in accordance with BS 61346, BS 61666, BS 61175 and BS 60445 standards or latest edition of other applicable standards to the approval of the Engineer.
- (b) All labels shall be permanent, and be machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS SHALL BE ALLOWED.

- (c) Prior to making any label or nameplate for the purpose of identification, submit a detailed schedule indicating nameplate size, lettering size, color, material and actual nameplate information for the Engineer's review and approval.
- (d) All external labels, nameplates, operational and warning signs shall be provided in English.
- (e) Material used in making the engraved labels shall be of highest quality suitable for the environmental and climatic conditions as specified in the relevant section.
- (f) Critical devices such as disconnect switches; service feeders and branch circuit protective feeders shall be legibly labeled to indicate its purpose and point of origin. The legibility distance shall not be less than 2.0 meters.
- (g) Identification nameplates shall be provided in addition to the manufacturer's equipment nameplates as required by NEMA, BS, IEC or UL.
- (h) Warning signs and instruction labels wherever needed shall be provided in accordance with all applicable local regulations.
- (i) The Contractor shall clearly show locations and fixing arrangements of nameplates and labels on layout drawings.
- (j) The Contractor shall comply with the following requirements for labels:
  - (i) Provide equipment identification labels for all electrical equipment including, but not limited to switchgear, control panels, switchboards, transfer switches, disconnect switches, transformers, generators, power factor capacitors, fixed equipment, motor starters, MCCs etc.
  - (ii) Provided sub-classification label for all emergency power system, junction boxes and pull boxes.
  - (iii) External labels: 3 mm thickness minimum, Clear Perspex ~~back~~ rear white engraved, in white letters on black background in English with chamfered edges fixed with stainless steel screws with nuts and flat & lock washers. The letters should be filled in white and the rear surface painted black.
  - (iv) Internal labels: Multi-layered plastic to an approved design engraved in English, and fixed with stainless steel screws. Alternatively special purpose made DIN rail may be used for fixing labels as approved by the engineer.
  - (v) All labels shall be screw or rivet fixed and adhesive labels shall not be permitted under any circumstances.
  - (vi) Internal components labels shall have circuit designations correlated with the drawings.
  - (vii) Labels shall not be attached to trunking covers or other readily removable items.
  - (viii) electrical equipment enclosures, vaults, doors and fences shall be provided with "DANGER KEEP OUT" warning sign, showing proper voltage.
  - (ix) disconnect switches and emergency devices shall have "CAUTION" warning signs as directed by the Engineer.
  - (x) fuse and MCB distribution boards shall be provided with internal, screw fixed, engraved circuit labels. Ink on paper, ink on plastic, printed paper, printed plastic, plastic film or any kind of adhesive labels shall not be permitted.



- (xi) Provide a main Title Label all for electrical distribution and all other control equipment, panels etc.
- (xii) Provide a Function Label for door mounted components.
- (xiii) Every internal component - Identification Label.
- (xiv) Provide a Identification Label for Protective devices - ( e.g. fuse/mcb type, rating).
- (xv) Provide a Title Label for Communication equipment.
- (xvi) Compartments with doors and covers not electrically interlocked to an isolator, external label - " DANGER, LIVE TERMINALS " with flash and voltage in red letters on white background in Arabic and English.
- (xvii) Provide a function description Label for group of terminal blocks.
- (xviii) Letter size shall be to the approval of the Engineer
- (xix) Removable rear cover shall be provided with identification and the location on the Switchgear panel shall be provided with identification label.

#### 4 Switchboard Wiring:

- (a) Wiring shall generally be of the multi-stranded high temperature to minimum 105° C flexible PVC insulated, 600/1000V single core stranded copper type cable to EN 6231. Where it is proposed to use alternative high temperature, double insulated or other special cable or insulated flexible laminated bus bar this should be brought to the attention of the Engineer for his approval.
- (b) Wiring shall be supported in insulated cleats or cable trunking. Adhesive type cleats or mounts shall not be used unless augmented by screw fixings.
- (c) Busbar chambers shall not be used as trunking for small wiring.
- (d) Wiring shall be neatly laid and run in limited compression insulated cleats, insulated straps or, where more than ten wires follow the same route, in plastic slotted-sided trunking with clip-on covers. Where trunking is used, the effective overall cross-sectional area of cables shall not be greater than 70% of the trunking cross sectional area.
- (e) Wiring to items of equipment mounted on hinged doors or subject to movement shall run in plastic sleeving or flexible conduit, being securely anchored at both ends; leaving ample slack to prevent wiring strain, arranged so that they are subject to torsion rather than bending.
- (f) Holes in steelwork through which cables pass shall be protected using grommets or bushes, suitable for the size of hole.
- (g) Cables used for control, extra low voltage and instrument signal transmission, likely to be affected by interference, shall be screened and/or spaced from each other and from heavy current power cables. The separation distance shall ensure that the resultant electrical noise is insufficient to cause any form of malfunction of associated equipment or give false readings.
- (h) A sufficient number of terminal connections including 15 % spare terminals shall be provided for all control and instrument wiring.
- (i) All wiring shall be identified at each end by means of glossy plastic ferrules showing the wire number as on the schematic diagrams. Ferrules shall be color coded, 'Z' type and indelibly marked.



- (j) Where single core cable is to be accommodated, a non-magnetic gland plate shall be provided. For cable size 300 mm Sq. and above insulated glands shall be fitted.
- (k) Undrilled gland plates shall be provided for the reception of conduits and threaded glands. Boxes and glands shall be within the cubicles except where otherwise approved.
- (l) Single strand wire shall not be used. The minimum cross sectional area of the wire used shall be 1.0 mm<sup>2</sup> (multi strand flexible) for control circuit and 2.5 mm<sup>2</sup> for power circuit. Both ends of every wire shall be fitted with a white cable marker as described above. Clip on type cable markers shall not be used.

Color-coding shall be:

- |                    |                               |
|--------------------|-------------------------------|
| • Red              | - Red phase                   |
| • Yellow           | - Yellow phase                |
| • Blue             | - Blue phase                  |
| • Black            | - Neutral                     |
| • Green and Yellow | - Earth/Protective conductors |
| • Grey             | - 110V a.c                    |
| • White            | - 60 D.C                      |
| • Purple           | - <50V a.c                    |
| • Brown            | - Current Transformers        |

Identification of conductors and auxiliary circuit shall be in accordance with EN 60445 and EN 60446

- (m) Terminations shall be as follows:-
  - (i) All wiring shall have crimped terminations, only one wire being held by any one crimp. Crimped lugs shall be of the insulated type without conductor exposure between the crimp and wire insulation.
  - (ii) The type of crimp used shall be appropriate for the type of terminal to which it connects. The crimping shall be tubular when the tightening screw sits directly above it, or fork type if the tightening screw passes through the lug.
  - (iii) Terminations shall be neatly arranged leaving adequate length for one termination.
  - (iv) All terminal blocks for the connection of small wiring shall comprise shrouded anti-tracking molding of melamine phenolic or comparable material with provision for securing conductors either by high tensile screws and clamps or alternatively in the case of small telephone type conductors by solder tag connection.
  - (v) Terminal blocks shall be arranged to facilitate easy access to both terminals and wiring ends. Connections for outgoing circuits to auxiliary pilot cables shall be provided with test links.
  - (vi) Removable rail terminals shall be provided for all wiring, mounted at an angle to provide ease of access. Centre-disconnecting link type terminals shall be provided for analogue signal circuits, external control devices and all alarm/telemetry signals. Sufficient, suitably sized earth terminals and end stops shall also be provided.
  - (vii) The gap between gland plates and associated terminals shall be such that conductors can be safely manipulated and connected without damage. Terminals shall face the door of a cubicle for ease of connection.

- (viii) Barriers shall be provided on all terminal banks, to group terminals into logical divisions. Power terminals of different phases shall be barriered from each other and separated from control terminals.
- (ix) In all cases care shall be taken to ensure that terminals are easily accessible after all wiring and plant cabling has been installed and terminated. All connections shall be made on the front of terminal blocks.
- (x) No more than one conductor shall be connected to one side of a terminal. Where several conductors are to be connected, shorting bars shall be provided across multiple terminals. Outgoing cables shall be wired so that all assembly wiring is connected to one side only.
- (xi) The terminal numbers, voltage grouping and terminal block layout shall correspond precisely with wiring diagrams so that quick and accurate identification of wiring can be made.
- (xii) All terminals shall show the circuit wire number reference.
- (xiii) A separate dedicated telemetry/RTU section shall be provided in the MCC cubicle equipped with all terminals duly wired and located in the side or on the top of the compartment interior leaving maximum room for free issued fully wired and tagged RTU complete with all associated hardware's on a mounting plate. When a PLC control system is provided the PLC should be suitable for telemetry communication and shall be configured to communicate with the SCADA master station.
- (xiv) The MCC vendor shall co-ordinate with the RTU vendor through the Contractor to confirm the size of free issued duly wired RTU on a backplate. The MCC vendor shall install and complete interconnection wiring between the RTU and the MCC accordingly.
- (n) The Contractor shall submit for the Engineer's approval, samples of wires, numbered ferules, and terminal pins or lugs which he proposes to use.

## 5 Safety Measures.

- (a) circuit breakers shall be provided with suitable means to prevent unauthorised and accidental operations. Interlocks to prevent dangerous operations shall be provided wherever necessary. High voltage parts shall be protected to prevent accidental human contact. Warning signs of durable type fixed on visible place shall be provided on high voltage parts. Earthing of metal parts shall be provided.
- (b) mechanical interlocking shall be provided where required. All electrical interlocking shall be of the double interlocked type having separate permissive and prohibitive interlocks. Thus to allow a device to operate there must be an absence of prohibitive signals and a presence of permissive signals from the remaining devices in the interlocked system i.e. fail safe.
- (c) suitable equipment shall be provided mechanically to prevent a device being manually operated when a prohibitive signal from another part of the interlocked system is present.
- (d) when the MCC includes a standby generator incomer in addition to the QGEWC incomer, mechanical and electrical interlocks shall be provided in accordance with QGEWC regulations.

6 Pilot Devices:

- (a) pilot devices shall conform to EN 60947-5.1. These shall be circular, 22 mm dia suitable for mounting on the cubicle door. The pilot devices shall have two main parts the operator and the Snap-On contact block. The mounting between the cubicle door and the operator shall be done through Snap-On flange. Pilot devices shall be designed to provide IP65 as a minimum protection when installed in the enclosures. Terminals shall be protected to IP2X.
- (b) push buttons shall comply with the following specifications unless specified otherwise in particular requirements: -
  - (i) standard design
  - (ii) mushroom/stayput/lockable type where specified
  - (iii) non illuminated
  - (iv) anodized Aluminum Bezel
  - (v) 1NO+1NC configuration minimum
  - (vi) RED button for STOP function
  - (vii) GREEN button for START function [Recessed type]
  - (viii) mushroom RED for Emergency STOP function
  - (ix) BLACK button for manual RESET
  - (x) WHITE button for lamp test
  - (xi) push buttons for other functions where applicable shall be subjected to the approval of engineer.
- (c) selector switches shall comply with the following specifications unless specified otherwise in particular requirements: -
  - (i) standard design
  - (ii) lever type cam operated
  - (iii) Twist Release/Push-Pull/KEY type where specified and/or approved by engineer.
  - (iv) non illuminated
  - (v) anodized aluminum bezel
  - (vi) No. of positions as per logic diagram
  - (vii) BLACK color
  - (viii) 1NO+1NC configuration minimum
- (d) indicators shall comply with the following specifications unless specified otherwise in particular requirements: -
  - (i) low voltage transformer latch type 110V/50Hz primary
  - (ii) bulbs shall be long life neon types rated at least 10% higher than the operating voltage.
  - (iii) GREEN colour for RUN/ON indication
  - (iv) WHITE/Grey colour for STOP/OFF indication
  - (v) AMBER colour for TRIP/FAULT indications

- (vi) BLUE colour for equipment selected 'On-Auto' indication
- (vii) WHITE color for SUPPLY AVAILABLE / ENERGISED
- (viii) RED colour for DANGER (in operation) indication
- (ix) indicators for other conditions where applicable shall be subjected to the approval of the Engineer.
- (x) the pilot light operator shall be designed to facilitate removal of bulb from the front of the unit without requiring any tool.
- (e) LEDs shall be allowed.
- (f) emergency and safety switches where specified shall confirm to EN 60947-3, Utilization Category AC23 and comply with the following specifications: -
  - (i) IP65 metal/thermoplastic enclosure suitable for installation in non-safe areas involving Methane and H2S gases.
  - (ii) visible operating handle with marking OFF/ON position
  - (iii) lockable in Off position by using padlocks
  - (iv) suitable for base/wall mounting
  - (v) the breaking capacity shall be more than the largest circuit it breaks
  - (vi) the emergency switch shall have red handle on a yellow background

7 Busbars:

- (a) the busbars shall be electro-tinned hard drawn, high conductivity 99.9 % purity, suitably sleeved for phase identification to BS 158
- (b) all busbars shall extend through the length of the board with same cross section throughout unless indicated otherwise
- (c) a copper Earth Busbar sized at least 50 % of the phase busbars or 300 mm<sup>2</sup>, whichever is greater, shall be provided along the full length of the board
- (d) busbars shall be adequately supported by porcelain or moulded insulators spaced on suitable centres so that the complete assembly can withstand the maximum mechanical stresses to which it may be subjected to under fault conditions
- (e) unless otherwise stipulated in the particular specification or drawings busbars shall be housed in separate adequately ventilated compartment which shall not contain any wiring or apparatus other than that required for connections for busbars
- (f) rating : As indicated on the drawings.
- (g) the mechanical and dielectric strength of bus bars and supports shall be capable of withstanding the worst conditions of electrical surge, which can occur in the installation
- (h) bus bars shall be sleeved for phase identification by using high temperature grade heat shrinkable colored PVC sleeving throughout its length. In no circumstances will any kind of wrapping tape be accepted on busbars.
- (i) all three phases and the neutral busbar shall be of same size enclosed in a common separate chamber.

- (j) the mains horizontal busbars shall be housed in a separate chamber located on the top of the assembly. Busbars located elsewhere not on the Top shall be accepted at the discretion of the Engineer after verifying the certification, site location, available space and considering other factors necessary for ease in operation and maintenance of the assemblies. Insulation barriers shall be provided at each cubicle division.
- (k) vertical busbars shall be fully enclosed in a separate chamber.
- (l) bus bars connections shall be identified by phase color marking and adequately supported by suitable supports designed to withstand the full fault capacity as specified herein.
- (m) connections from the main bus bars to MCCB's controlling main motor starters and outgoing distribution feeder shall be via solid copper bus bars.
- (n) Connections to busbars shall take the form of rigid bolted copper strips. Caliper sliding connections or similar movable contacts shall not operate directly onto the busbars or down-droppers.
- (o) The utilization of "Fault Free Zones" will be permitted for the connection between the busbar risers and functional units rated 32 amps or below. These may be of copper conductors of solid rigid manufacture or double-insulated flexible conductors provided that they are securely fastened, provided in both cases that under normal operating condition an internal short circuit is only a remote possibility. For all functional units the connections between the busbar and the functional units should be sized to the frame rating of the short circuit protection device in the functional unit and an ASTA/KEMA certificate for their short circuit let through ( $I^2t$ ) capability shall be provided.
- (p) bolted copper bus bar 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.
- (q) the temperature rise of busbars shall be limited to that which will not cause damage to the insulating material when carrying their rated current at the site ambient temperature and shall in any case not exceed 60°C reduced by the amount the site ambient temperature exceeds 40°C.
- (r) The neutral shall be solidly earthed at the MCC. The neutral-earth link shall be adjacent to the incomer, externally labeled and be easily accessible.

8 Instruments:

- (a) the Measuring Instruments shall include ammeters, voltmeters, kWh meters, selector switches and associated accessories as indicated on the Drawings and described herein as follows:
  - (i) Ammeter, Voltmeter and Power Factor Meter:
    - the measuring instruments shall be moving iron vane type, flush pattern with dust and moisture proof enclosure. Anti-glare glass front, anti-parallax scales and white faces with black numerals and marking shall be used. All instruments shall be of long scale 240 degree with full load indicating approximately at 180°
    - the dial size shall be 10 x 10 cm<sup>2</sup>.
    - accuracy shall be one percent of full scale values
    - moving elements shall be provided with zero adjustments located at face of dial.

- the ammeter shall be capable of withstanding twice of rated current for 10 minutes and overload sustained under fault conditions without damage or loss of accuracy.
- voltmeter shall have a measuring range from 0 to 500 V and shall withstand twice the rated full scale voltage for 1.0 minute without damage
- three ammeters or a single ammeter with selector switch shall be provided to read the current of each phase, as indicated on the Drawings
- the voltmeter selector switch shall be of the rotary type with cam operated contactor and shall have (7) positions off, R-Y, Y-B, R-B, R-N, Y-N, B-N
- single and poly phase power factor meters with associated current and potential transformers shall be provided as required and specified herein
- ammeters shall have maximum demand pointers.

(b) Current Transformers:

- (i) current transformers shall be of the bar primary type, air cooled and suitably insulated. The current transformers shall be of Class X accuracy for restricted earth fault protection and Class 1 accuracy for metering purposes, as stipulated in the QGEWC Regulations
- (ii) current transformers shall be rated not less than 5 VA and shall have thermal and mechanical rating at least equal to those of the main circuit breakers.
- (iii) following are the approved ratings of the current transformers (CTs) as approved by QGEWC.
  - 100/5
  - 200/5
  - 500/5
  - 800/5
  - 1200/5
  - 1600/5
  - 2000/5
  - 2500/5
- (iv) removable links shall be located on the main busbars of each phase and neutral to enable easy maintenance and replacement.
- (v) current transformers shall comply with BS 3938 and should be suitably rated and designed to carry out the appropriate function as indicated.
- (vi) The rated burden of the current transformers shall be 30% in excess of the sum of burdens of all relays, instruments and related loads.
- (vii) the short time rating shall not be less than 44kVA for 3 seconds.
- (viii) identification labels giving type, ratio's, rating output, manufacturer and serial numbers shall be fitted. Duplicate rating labels are to be fitted on the exterior of the mounting chambers suitably located to enable reading without removal of Any cover. Labels shall be supplied for multi ratio current transformers indicating the connection required for alternative ratios.
- (ix) bar type current transformers shall be provided in preference to those with wound primaries. Short time current factors shall relate to the full fault level for three seconds. For overcurrent protection the product of VA rated burden and rated accuracy limit factor shall be 150 unless otherwise agreed with the Engineer.

- (x) one secondary terminal of each current transformer shall be earthed through a removable link.
- (c) kWh Meters:
  - (i) the kWh meters shall be suitable for operation on 415/240 Volt, 3 phase, 4 wire, 50 Hz supply and shall conform to BS 37 Part 1 and BS 5685
  - (ii) the meters shall be dust-proof and vermin proof, protected from corrosion due to high humidity and compensated against the effect of temperature up to 55 °C
  - (iii) the meters shall maintain their accuracy over many years service under Qatar climatic conditions. The counter shall be of the cycle meter type with six figures, the lowest figure being unit. Pointer type counters are not acceptable
  - (iv) the meter cover and cases shall be of metal
  - (v) meters shall not have less than 5 mm diameter terminal holes and shall be operated through three current transformers and the counter of the meter should be calibrated to read the primary kWh. The current transformers shall be selected from the standard sizes stipulated in QGEWC Regulations
  - (vi) all meters shall be handed over to the Qatar General Electricity & Water Corporation for calibration prior to final installation and connection.
- (d) Power monitoring Unit (PMU):
  - (i) Power monitoring (PMU) shall be a true RMS digital instrument, with LCD display, capable of controlling and measurement highly non-linear loads accurately and able to detect voltage based disturbances.
  - (ii) The LCD unit combined with function keys, minimum IP54, shall be mounted locally on the Incomer cubicle door.
  - (iii) PMU shall be CE marked and confirm to EN 61010-1
  - (iv) The Power Monitoring Unit shall register all measured values and log current and previous measured values for reporting and printing purposes.
  - (v) The Power Monitor shall be supplied with software, user manual and associated interconnecting cables.
  - (vi) PMU shall be provided with user friendly software minimum windows 2000 based communication (fully supported by Latest Edition of Windows Based Operating System) program allowing easy access to all features with pull down menus
  - (vii) true RMS measurement of current and voltage
  - (viii) control and measurement of highly nonlinear loads
  - (ix) capable to detect voltage based disturbances
  - (x) interface capability with PLC/RTU/Circuit breaker
  - (xi) provide load shedding capabilities
  - (xii) provide interface with Power Factor Correction Control equipment
  - (xiii) RS-485 port
  - (xiv) modbus communication protocol
  - (xv) DNP3.0 Communication protocol



- (xvi) web enabled Ethernet capability
- (xvii) measurement of Harmonics
- (xviii) monitoring of disturbances in the power supply network
- (xix) continuous sampling at 128 times per cycle
- (xx) trending analysis for historical data collection
- (xxi) sequence of events
- (xxii) RMS current of each phase
- (xxiii) RMS voltage L1-L2-L3-N
- (xxiv) average system voltage (Vav)
- (xxv) average system current (Iav)
- (xxvi) real power (KW)
- (xxvii) reactive power (KVAr)
- (xxviii) apparent power (KVA)
- (xxix) power factor (cos phi)
- (xxx) peak demand
- (xxxi) frequency (HZ)
- (xxxii) temperature (T)
- (xxxiii) THD current (%Ithd)
- (xxxiv) THD Voltage (%Vthd)
- (xxxv) K-factor100

9 Restricted Earth Fault Protection.

- (a) Restricted earth fault protection shall be provided for main switchboards in accordance with the QGEWC Regulations.
- (b) 30 DC supply is required for tripping of the LV ACBs through D.C. shunt trip for restricted earth fault relay. Contractor to provide for this unit a trickle charger and long life nickel cadmium batteries. The unit shall be designed to operate on 240 volts, 1 phase & 50 Hz A.C. Supply and for continuous duty at an ambient temperature of 50 °C and 98% relative humidity. The capacity of the unit is to be determined by the manufacturer and based on number of trip unit , all to the approval of the Engineer and KAHRAMAA.

10 Anti-Condensation Heaters.

- (a) Anti-condensation heaters shall be provided inside each compartment in strategic positions. These shall be controlled by an internally mounted humidistat and an external overriding ON/AUTO switch
- (b) Heaters shall be of sufficient size to maintain the air temperature inside compartment at least 10 °C above the outside ambient.

**2.2.2 Motor Control Centres**

1 General:

- (a) Provide the metal enclosed motor control centres as indicated, specified and required
- (b) The motor control centres shall be switchboard type of enclosure construction as described for L.V. cubicle switchboards except as modified herein
- (c) The motor control centres shall be front access only
- (d) Shipment shall be made in sections to facilitate field handling, and the shipped sections shall be joined together to form a complete back-to-wall or back-to-back unit assembly as indicated
- (e) The motor control centres shall be free-standing or wall-mounted, as indicated in the Project Drawings.

## 2 Construction

- (a) Vertical sections shall contain adequate space for connecting the incoming power supply circuits, outgoing branch circuits, motor circuits and control circuits to terminals, horizontal and vertical power bus bars, horizontal earth bus, circuit breakers, magnetic starters, contactors, control stations, pilot lights, timers, terminals, transformers, panels, relays, ammeters, voltmeters, meter switches, earth leakage protection, space heaters, thermostats, fans, vents, screens, filters and switches
- (b) The vertical sections and separations within the MCC compartments shall be fabricated from heavy gauge steel (minimum thickness of 1.5 mm), with uniform surfaces
- (c) Unless otherwise indicated, the standard section shall be 800 mm wide (600 mm for equipment and components, 200 mm for vertical wire way) by 600 mm deep
- (d) Holes shall be provided in the structural base of each section for anchor bolts
- (e) Sections shall contain wireways, brackets, supports, plates, trims, barriers, gaskets, doors, base channels, lifting angles and hardware
- (f) Horizontal wireways (top and bottom) shall extend through the width of each section
- (g) Wire way openings shall be provided between sections with closing plates on the end sections
- (h) Each vertical section shall contain its own individual full height vertical wire way separated from the vertical bus by a metal barrier, and also separated from the individual control units by the side pan of the control unit.
- (i) Wire ties shall be furnished in the vertical wireways to group and securely hold the conductors in place
- (j) A separate cover shall be provided on the vertical wire way
- (k) Control units shall be isolated from one another by horizontal steel barriers
- (l) Front to rear bracing shall not interfere with the cable entrance areas
- (m) Hinged doors shall be equipped with screwdriver operated quarter-turn latches that catch automatically when the door is pushed closed. Large doors shall be equipped with additional latches
- (n) provision shall be included to add a vertical section on either end of the line up in the future

- (o) The power supply compartment shall be sized to accommodate the incoming power conductors. The compartment shall be located at the top or bottom of the vertical section as shown on the Drawings.
- (p) The power compartment shall be covered by a hinged door and shall be held closed with quarter-turn pawl type latches
- (q) busbars shall be provided for the power and earth systems. When shown on the Drawings, provide full length full capacity and insulated neutral bus and cable connectors. Bus joints shall be connected with bolts, nuts and spring washers. The main horizontal power bus shall be located in the centre or near the top of each section, joined together to form a continuous bus for the full length of the motor control centre. The horizontal power bus shall be copper and the current rating shall be as shown on the Drawings. The vertical power buses shall be copper full height and rated for the section total load. The minimum current rating for the vertical power buses shall be 300 amperes or as specified in the Project Documentation. Small openings in the vertical barriers shall permit the plug-on control unit contacts to pass through and engage with the vertical bus bars. Unused plug-on openings in the vertical barriers shall be equipped with plastic snap-in closing plugs.
- (r) each LV/MCC Incomer Section shall consist of: in addition to KAHRAMAA requirements
  - (i) 4 Pole ACB/MCCB (For Generator Incomer)
  - (ii) 3 Pole ACB/MCCB with solid neutral link (For Mains Incomer)
  - (iii) 1X Voltmeter 96X96, 240 degree scale for mains bus voltage live indication (For Mains Incomer)
  - (iv) 3X Voltmeter 96X96, 240 degree scale for generator bus voltage live indication (For Generator Incomer)
  - (v) 1X Voltmeter Selector Switch 7 Position (For Mains Incomer)
  - (vi) 1X Ammeter 96X96, 240 degree scale (For Mains Incomer)
  - (vii) 3X Ammeter 96X96, 240 degree scale (For Generator Incomer)
  - (viii) 6X Maximum Demand Indicator 96X96 (May be included with ammeter)
  - (ix) 1X Ammeter selector switch 5 position (For Mains Incomer)
  - (x) Power Monitoring Unit (PMU) for Main and Generator Incomers
  - (xi) phase failure/phase sequence relay for sensing the main incomer, generator incomer and busbar voltage.
  - (xii) 2X IDMTL overload relay (may be included in the circuit breaker)
  - (xiii) 2X IDMTL earth fault relay (may be included in the circuit breaker)
  - (xiv) 2X IDMTL restricted earth fault relay
  - (xv) 1X Frequency meter (45-55)Hz
  - (xvi) 3X Supply available and 3x supply on indicator lamps (for each phase for Main and Generator incomers)
  - (xvii) auto/manual changeover for MCC with two or more Incomers (See Metering Section below)

- (xviii) trip circuit healthy test facility in case of a circuit breaker designed to trip on fault through externally mounted protection devices e.g. IDMT (Inverse Definite Minimum Time relay), UV relay etc.
- (xix) control fuses
- (xx) open/close/trip indicating lamps
- (xxi) terminals etc.
- (s) the changeover function shall be fully automatic mains Generator on failure of power and vice versa.
- (t) a separate metering section shall be included in order to accommodate analogue meters, Power Monitoring Unit (PMU), control relays, timers, PLC, selector switches, push buttons, indicating lamps etc. as necessary for interlocking scheme for the incomers. All informations available in PMU shall be transferred to PLC/SCADA for monitoring.
- (u) an auto/manual changeover scheme shall be included unless specified otherwise, as a definite requirement for two or more incomers, fully wired and factory tested.
- (v) detailed drawings shall be prepared during the design stage and the same to be submitted to the Engineer for approval prior to the manufacturing.
- (w) installations requiring a mobile generator shall be provided with an appliance inlet socket outlet or junction box.
- (x) the appliance inlet shall be used for generators up to 125 A and be housed in a weather proof box fixed and located outside the MCC Room as shown on plant and equipment drawing. The junction box shall have detachable gland plate at the bottom facilitating easy connection and disconnection of the generator cable. For higher capacity generator ratings above 125 A, a weatherproof junction box shall be provided with solid copper links and ample space for terminating cables.
- (y) a separate section shall be provided to house the QGEWC kWh meter. The kWh meter compartment shall be provided with a 300mm X 300mm X 12mm thick plywood mounting board and a ten way terminal block in accordance with QGEWC regulations.
- (z) the kWh meter shall be CT operated for loads exceeding 100A.
- (aa) each outgoing starter, feeder or other functional unit shall be enclosed within its own section providing Form 4 type 7 (Gambica) segregation (or Form 4b as per IEC).
- (bb) Tree spare equipped feeder section (MCCB only) per MCC shall be provided as minimum. The rating shall be subject to the approval of the engineer.
- (cc) the Common Control section shall consist of the following controls and instruments as minimum for guidance purpose only subject to the approval of the engineer:
  - (i) non door interlock MCCB
  - (ii) 24 V DC regulated power supply
  - (iii) 24 V DC Ni Cd battery
  - (iv) 24 V DC Ni Cd battery charger
  - (v) power distribution MCBs for field instruments
  - (vi) programmable Logic Controller (PLC) – Refer to Instrumentation & Control Section 10 for specifications

- (vii) Video Display Unit where specified - Refer to Instrumentation & Control Section 10 for specifications
- (viii) pressure & level indicators - Refer to Instrumentation & Control Section 10 for specifications
- (ix) sounder complete with auto cut-off time and mute pushbutton as specified in the particular requirements.
- (x) flashing Beacon Light (mounted outside building) as specified in the particular requirements.
- (xi) local/off/remote or HAND/OFF/AUTO selector switch
- (xii) float/level selector switch
- (xiii) pumps Duty-Standby selector switch
- (xiv) push buttons for lamp test, fault-reset etc.
- (xv) status Indicating Lamps
- (xvi) control relays, timers and control fuses as required according to the logic + 20% as spares wired to the terminals.
- (xvii) zener barriers
- (xviii) hygrostatically controlled Anti-condensation heater
- (xix) standard and special terminals to suit the applications requirement
- (xx) terminal kiosk (A separate partitioned terminals arrangement clearly labelled identifying IN/OUT). [All wires to field devices and telemetry section must be routed through terminal kiosk].
- (xxi) 240V, 13 amp AC single phase 3 pin (flat) standard socket
- (dd) the telemetry section shall consist of the following controls as minimum for guidance purpose only subject to the approval of the engineer:
  - (i) Non door interlock MCCB
  - (ii) 24 V DC Ni Cd battery
  - (iii) 24 V DC Ni Cd battery charger
  - (iv) Remote Terminal Unit (RTU) – Refer to Instrumentation & Control Section 10 for specifications
  - (v) Interposing relays
  - (vi) Hygrostatically controlled Anti-condensation heater
  - (vii) Terminals, control fuses and surge protection etc.

### 2.2.3 MCCB Panel Boards

#### 1 General.

- (a) MCCB panel boards shall be manufactured to IEC 61439, factory assembled and type tested certified by an internationally authorising testing body
- (b) the panel board shall be suitable for operating on a 3 phase, 4 wire, 415 V supply
- (c) the symmetrical through fault rating shall be 25 kA for a duration of 3 seconds

- (d) if necessary, the panel board shall include a suitable hardwood backboard to accommodate the QGEWC metering equipment.

2 Construction.

- (a) the panel board shall be of robust construction, fabricated from heavy gauge folded steel angles strengthened by horizontal and vertical folded channels
- (b) the frame work shall be enclosed in self-supporting, screw -on front, rear and top covers of sheet steel with gaskets
- (c) the doors shall be lockable and have concealed hinges provided with gaskets
- (d) thickness of the steel sheet shall be not less than 1.5 mm
- (e) the panel shall be suitable for wall mounting.
- (f) the structure shall be protected from rust and oxidation before being given a coat of primer and finishing coats
- (g) the finished paint colour shall be to Engineer's approval selected from BS 381.

3 Busbars

- (a) the bus bars shall be of high conductivity, rectangular section, hard drawn copper, electrolytically tined suitably marked and colour sleeved coded in accordance with BS 158/159
- (b) the short circuit ratings of the bus bars shall be as stated above

4 Components

- (a) the switch boards shall comprise of the following components:
  - (i) incoming: suitably rated isolator/MCCB as indicated on the tender drawings and to comply with relevant Clauses of this specifications
  - (ii) outgoing: Moulded Case Circuit Breakers of 25 kA fault level with ratings as per the tender drawings and de rated for 50 °C ambient temperature.. All MCCB of rating 100 Amps and above shall have adjustable thermal and magnetic facilities
  - (iii) meters: 3 ammeters with dead pointer to indicate the maximum reading and 1 No. 0-500 Volt voltmeter with Off/ph-ph/ph-N selector switch, for incoming supply.

**2.2.4 Distribution Boards**

- 1 Distribution boards shall be provided to serve lighting, fans, socket outlets, and other appliances. Board shall be arranged in banks of ways as indicated on the schedule of points.
- 2 The Distribution Board shall be a part of the MCC cubicle assembly unless otherwise indicated in the project Documentation
- 3 Where there is Distribution Board stand alone, then:
  - (a) Distribution Boards shall be flush mounted type, or surface mounted type and shall be mounted separately from motor control centres or switchboards. The boards shall be totally enclosed, dust protected, vermin proof type. Distribution boards installed in all plant rooms and other process areas shall be corrosion resistant.

- (b) Enclosure shall be fabricated from robust galvanised sheet steel fully rust-proofed, stove enamelled, of minimum thickness of 1.5mm and shall be protected to IP 32 for internal use with neoprene gaskets for the doors.
  - (c) The distribution boards shall be provided with fixed cover and a hinged door with padlock which can be opened without any obstruction about 120 degrees and conduit knockouts from the top and bottom. The hinged door with a lock and key shall be integral part of the fixed cover.
  - (d) The cabinet shall be constructed so that it is necessary to open the door to operate Miniature Circuit Breakers or ELCB. Access to interior components and internal wiring shall be gained by removing a separate barrier within the enclosure.
- 4 All distribution boards shall be controlled by an adequately rated on-load main isolator or circuit breaker to interrupt the supply to the entire distribution board. This main isolator or circuit breaker shall be double pole for single phase DBs and triple pole for three phase DBs. Moreover, it shall be connected to the busbar directly without links whatsoever.
- 5 A circuit label shall be provided to indicate the area served by each MCB.
- 6 Busbars shall:
- (a) be of appropriate current carrying capacity at least equal to the rating of the main incoming isolator or circuit breaker.
  - (b) be of high electrical conductivity copper.
  - (c) Where the main isolator or circuit breaker is connected to bus bars then these bus bars shall be shrouded.
- 7 Each DB shall have separate earth and neutral bars having the same number of connection as there are for phase connections. A cable connection shall be made from earth bar to the incoming cable gland earth tag. All phase and neutral bars shall be sized to carry the full load current of the controlling breaker which shall be of flat tinned copper rigidly mounted, supported on shock-resisting, non-hygroscopic, high grade insulators with high resistance to tracking, not subject to mould growth or termite attack with adequate spacing and clearance.
- 8 Connection from the bus bars to the breakers shall be made by using solid circular insulated conductors or insulated and tinned copper strip neatly set and formed. Each connection to or from a phase or neutral bar shall have its own brass fixing screws, washers, butts and locknuts.
- 9 Each distribution board shall be fitted with an identification label on its front cover. The label shall be suitably inscribed stating the distribution boards reference number/letter, rating in volts & amperes and the number of ways in English and Arabic. In addition to the above a reference card shall be fitted inside the distribution board giving details of each circuit, MCB size, cable size and location. The reference card shall be affixed to the inside of the distribution board's door via a transparent envelope.
- 10 Distribution Boards (DB) located remote from the main switch boards shall be mounted at a height of not less than 1200mm from finished floor level to bottom of the DB and maximum height of this DB shall be 2200mm from finished floor level to top of DB.
- 11 All live terminals of parts and bus bars shall shrouded with insulating materials to ensure that it is impossible for any live metal to be touched while withdrawing or replacing MCBs.



- 12 The correct rating of breakers shall be fitted in each way to conform to the size of the final circuit conductor and its connected load in conformity with KAHRAMAA.
- 13 All breakers and DBs shall be of one make throughout the whole of the works.

## 2.3 INSTALLATION

### 2.3.1 General

- 1 The L.V./MCC cubicle switchboards shall be supplied and installed in the building or in a separate services building or in substations as indicated on the Drawings.
- 2 The Contractor shall submit details of proposed equipment and method of installation to the Engineer and QGEWC for approval prior to commencement of installation work.
- 3 Provide all the motor control equipment installations, wiring installations and tests, including connections and interconnections for the electrical controls as indicated, specified and required. Assure proper fits for all equipment and materials in the spaces shown on the Drawings.
- 4 Equipment shall be installed level and securely attached to the concrete foundations and walls with expansion anchors. The sections shall be joined together with bolts, nuts and washers to form a complete unit assembly. Floor standing equipment shall be installed on concrete plinths as shown on the Drawings.

### 2.3.2 Earth Bonding

- 1 Each LV/MCC switchgear panel or section shall be individually connected (at both end of the panel earthing bar) to two separate earthing pits through the main earth bar located in the electrical or cable basement rooms. Calculation for the earthing cable size shall be provided using professional dedicated, international recognized approved software subject of Engineer's approval.
- 2 Each panel section shall be cross bonded to adjacent panel section earthing terminal.
- 3 LV/MCC panel earthing conductor to earthing bar and earthing pit is to be sized for maximum earth fault current for 5 seconds with final conductor temperature not exceeding 160 °c or sized not less than 20 mm<sup>2</sup> per 100 KVA of transformer rating, and with a minimum of 95 mm<sup>2</sup>.

END OF PART