SECTION 6 MAINS & SUB-CIRCUIT DISTRIBUTION

1.0 GENERAL

1.1 WORK DESCRIPTION

Mains and sub-circuit distribution cablings of the LV System shall be as shown on the Drawings and as specified hereinafter.

All mains and sub-circuit cables shall be in conduits, trunking, cable trays and ladders as appropriate. Armoured cables shall be used for all circuits in open ground in trenches or on open trays and ladders. All the mains, sub-mains and final sub-circuits shall include insulated earthing conductor sized in accordance with BS7671.

The current carrying capacities and voltage drops of cables shall be in accordance with BS7671, with ratings adjusted to suit local conditions.

Cable joint is not acceptable for all cable installation.

1.2 SUBMISSIONS

All technical submissions shall be approved by the Engineer prior to the respective stages of construction.

1. Detailed schedule of cables and manufacturer's data, Manufacturer's type test certificates and testing documents shall be submitted for inspection. Detail requirement of cable schedule as specified in Section 5, Wire and cables;
2. Calculations of voltage drop of cables;
3. Calculations of the prospective short circuit current;
4. Co-ordinated drawings showing all cable routings;
5. Builder's works requirement;
6. Detailed control wiring diagram.

2.0 CABLE INSTALLATION

2.1 GENERAL

Cables shall be delivered on robust cable drums with cable ends treated to form an effective seal. When a cable is cut from a drum, the cable and the end left on the drum shall be immediately sealed in approved manner to prevent the ingress of moisture.

Cables shall be installed along the routes as indicated on the Specification and Drawings and shall be agreed in detail with the Engineer before any work is commenced. There is no cost adjustment to any routing of the cables as required to suit the installation and subject to site co-ordination.

All necessary precautions shall be taken to prevent damage to cables during installation.

Where cables are installed in situations where works by M&E Services are still incomplete, all reasonable precautions shall be taken to protect the cables against damages arising from the execution of such other works.
Cable laying shall be carried out by means of normal hand running off the cable drum. Roller guides shall be used all through and be drawn through by hands. No cable winches shall be employed.

Cable entries into buildings shall be hermetically sealed with an appropriate fire, heat and water-resistant, non-ageing, flexible material.

Cables shall be adequately protected against all risk of mechanical damage to which they may be liable in normal conditions of services.

Cables shall be installed in accordance with BS7671. In particular, the internal radius of every bend in a cable shall be such that as not to cause damage to the cable and not less than the appropriate value stated in BS7671.

Except for cables laid in ducts, all cables as specified herein shall run on cable trays/cable ladder, vertically and horizontally, and properly fixed in the prescribed manner. Where cables are laid on cable trays/cable ladder in the horizontal directions, nylon cable ties shall be used. Where cables are installed in the vertical direction, approved clips and saddles shall be used. The spacing of cable fixings shall be in accordance with BS7671.

Where three-phase power is run in single core cables, the cables shall be grouped in a trefoil formation and spaced from other cables. The relative position of the single-core cables of the trefoil group shall be changed through 120° at approximately one-third and again at two-thirds point of the entire cable route.

Not more than one circuit of single core cables or one multi-core cable shall be grouped together. The spacing between groups of single core cables or multi-core cables shall not be less than twice the diameter of the largest cable in the adjacent group of cables.

Where cables pass through structural elements such as floors and walls, the opening made shall be sealed with approved fire-resistant material of not less than two (2) hours fire rating or not less than the fire rating of the slab/wall to prevent the spread of fire.

Where cables pass through expansion joints, the cables shall be formed into a loop which shall be of such size that any movement in the joint shall not stress the cables.

2.2 FINAL SUB-CIRCUIT PVC CABLE INSTALLATION

In general, cables are to be run in zinc coated trunking to BS 467:Part 1 or galvanized steel conduit.

Unless otherwise in plant rooms, within false ceiling and boxed up riser, all final circuit wiring shall be in concealed conduit in concrete slab, wall, column, etc.

Cables in trunking shall be bunched in approved cable tie.

Trunking shall be properly sized to conform to IEE Regulations with minimum space factor of 45%.

BS Standard or relevant other Standards, name of the manufacturer, the voltage grade and the relevant BS number shall be printed on the outer sheathed insulation of the cables.
Cables for 3 phase, 4 wire system shall be colour coded – red, yellow, blue for phases, black for neutral and green/yellow for earth.

Minimum size of cable shall be 2.5mm2 for lighting, 4mm2 for power and 2.5mm2/4mm2 for earth continuity (depending on the phase cable) subject to a maximum volt drop of 2.5% of the nominal voltage.

The cable size shall be selected to ensure that it has adequate current carrying capacity and that the voltage drop at the apparatus supplied does not exceed the approved limit. Derating of cables shall also be taken into account for adverse conditions.

Connection of fixtures shall be by the "loop-in" & loop-out" method.

2.3 NON-ARMOURED MAINS & SUB-MAINS CABLE INSTALLATION

In general, the cables shall be installed on cable trays or ladders. They shall be installed to an acceptable way conforming to IEE Regulations to prevent losses in cables and performance of the current carrying capacity.

Proper labeling shall be installed at every 6 m interval.

Avoiding of overlapping of cable is necessary.

A three phase circuit cables shall be installed on the same tray.

The cables shall be terminated in suitably tinned copper compression connectors.

Cables shall be routed at high level on proprietary make horizontal cable trays or cable ladders (for large cables) and support systems similar to UNISTRUT or other approved equivalent system. All vertical runs including cabling to switchboards, etc. shall be secured on approved type cable ladder system. For horizontal runs, cables shall be secured neatly on the cable trays or ladders at close intervals by means of moulded polythene cleats similar to BICC "Telecleat" or other approved equal whereas claw cleats shall be used for securing vertical cables. Fixing shall be made with rawl bolts or other patented fixing devices of manufacturer details to the Engineer approval. Details of cable routes, terminations and support system shall be forwarded to the Engineer for review prior to installation.

2.4 FIRE RESISTANT (FR) CABLE INSTALLATION

Fire Resistant cables shall be installed on a separate cable tray without sharing with other sub-main/control cables.

Fire Resistant cables shall be installed in accordance with the maker's recommendations and instructions. Fire Resistant cables shall be run on proprietary make horizontal cable trays, vertical cable ladders, trunkings or conduits depending on the sizes. For horizontal runs, Fire Resistant cables of larger sizes shall be secured neatly on the cable trays or ladders at close intervals by means of moulded polythene cleats similar to BICC "Telecast' or other approved equal whereas fire resistant claw cleats shall be used for securing vertical runs.

All installation accessories shall be of manufacturer's standard products. Cable glands shall be of fire rating equal to the cable The bending radius of the cables measured from the inside of the bend shall be not less than eight times the diameter of the cable or to manufacturer's recommendation, whichever is more.

For emergency final circuit, the FR cables shall be installed in GI conduit in concealed slab, wall, etc. unless otherwise approved by the Engineer.

2.5 EARTH CONTINUITY CONDUCTOR INSTALLATION

Each circuit wire shall have its own protective conductor with adequately sized in accordance with BS7671 using stranded copper cable with green/yellow PVC insulation.

2.6 CABLE TERMINATION

A. Tee-off

1. Tee-off as required for tapping of power supply from the main riser cables to individual circuits shall be suitable for such purposes. Installation method must be submitted for approval prior to commencement of works. Under all circumstances, the conductors to be tee-off shall be secured by means of proprietary made compression type mechanical connectors, enclosed in plastic protective shell and filled with acrylic resin. No strand of a stranded conductor shall be cut away in making the tee-off.

B. Cable Termination

1. Cable shall be terminated using suitably chosen cable glands as specified.
2. A PVC shroud as specified shall be fitted to cover the gland body.
3. In the case of armoured cables, all armour and all faces of armour clamps of connectors making contact with them shall be thoroughly cleaned before termination and the clamps shall be adequately tightened to ensure good electrical contact.
4. Cable conductor terminations shall be by means of heavy duty solderless cable lugs. The lugs shall be of high conductivity copper electro-tinned and applied to the conductor by means of a hydraulic crimping tool unless otherwise specified. Heat shrinkable tapes shall be used for insulating the termination whenever possible.

C. Armour Earthing

1. Metallic sheaths and/or armour of all cables in the same circuit shall be solidly bonded together at both ends of their runs. The bonding shall extend from the earth lug or earth lug attached to the cable glands to the main earth system.
2. The cross-sectional area of the bonding conductor shall be selected in accordance to BS7671.
3. The bonding conductor shall be as short and straight as possible.

2.7 CABLE IDENTIFICATION

Cables shall be provided with identification markers, at each end of the cable, at entry and exit points of buried ducts, and in such other positions as are necessary to identify and trace the route at any cable. Where cables are not enclosed in ducts and are of multiple runs, markers shall be provided at 10 meter intervals

Cable identification shall be assembled from elliptical profiled plasticised PVC markers, carrier strip and nylon ties, the complete assembly shall be suitable for a maximum service temperature of 70°C.

Every single core cable and every core of a multicore cable shall be provided with identification at its termination in the form of tapes, sleeves or discs of appropriate colours.

SECTION 7 MEDIUM VOLTAGE CABLE AND ACCESSORIES

1.0 GENERAL

1.1 WORK DESCRIPTION

This section specifies the engineering, supply and installation of MV power cables, manufactured to the latest revision of IEC 502 and appropriate BS/EN.

The indicative routing of the major MV cable are shown on the Drawings. The Contractor shall be responsible for co-ordination with Local Authority, to determine the exact routes and quantities of the MV cable installation. The MV cable installation shall comply with Local Authority's requirement.

The Works shall include the supply and installation of all cable glands, cable lugs, racks, hangers, suitable fire rated cable enclosure if applicable, clamps, cable clips, cable brackets, cable ladders, etc. and the supply of all necessary labors, equipment and materials for laying, termination of power cable.

1.2 STANDARDS

The complete cable shall be engineered to manufacturer data and constructed in accordance with the latest revision of the following standards and the appropriate BS/IEC:

1. IEC 228 : Conductors of insulated cables
2. IEC 502 : Extruded solid dielectric insulated power cables for rated voltages from 1kV up to 30kV
3. IEC 540 : Test methods for insulation and sheaths of electric cables and cords (elastomeric and thermoplastic compounds).
4. BS 5468 : Cross-linked polyethylene insulation of electric cables.

The engineering of the cable to manufacturer data shall also conform to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this Specification and Drawings, whichever is the more stringent and approval to the Engineer.

In the adoption of standards and requirements, the Contractor shall take the following precedence:

1. Engineer's decision;
2. Local codes of practice;
3. Drawings;
4. Specifications;
5. International standards and requirements.

1.3 SUBMISSION

All technical submissions shall be approved by the Engineers prior to the respective stages of construction.

As a minimum requirement, the submission shall include the following:

1. Shop drawings of the complete cable routes (including the cable ladder, tray / pipes and cable support system, etc). Cable routes as shown on the Drawings are for general

guidance only; no variation will be entertained for cable route subject to adjustment of route and site co-ordination.
2. Equipment submission and sample submission;
3. Cable termination details for cable manufacturer;
4. Cable test reports for routine test, type test, and site acceptance test;
5. Testing and commissioning procedure of MV cables;
6. Builders work Requirement.

2.0 PRODUCT

2.1 MV POWER CABLE

A. Type

1. The cable shall be 3-core stranded copper conductor cross-linked polyethylene (XLPE) insulated, copper tape screened, PVC inner sheathed, double steel tape armoured (DSTA) and PVC oversheathed cable manufactured to IEC 502 and BS 6622.

B. Conductor

1. Conductor shall consist of plain annealed copper wires, compacted circular stranded, Class 2 of IEC 228.

C. Conductor Shielding

1. Conductor shielding shall be non-hygroscopic and free-stripping, semi-conducting tape applied over the conductor and also an extruded semi-conducting cross-lined polyethylene conductor shielding, which shall be firmly bonded to the inner surfaces of the insulation. The conductor shielding shall not be considered as part of the insulation.

D. Insulation

1. Insulation shall consist of extruded cross-linked thermosetting polyethylene (XLPE). The average thickness shall not be less than the specified nominal value of 3.4mm for 15kV cable
2. The minimum thickness at any point shall not fall below the nominal value by more than 0.1mm plus 10% of the nominal value.

E. Insulation Shielding

1. An extruded semi-conducting compound shall be applied over the insulation and firmly bonded to the outer surface of the insulation. A non-hygroscope and free-stripping, semi-conducting tape shall be applied over the extruded semi-conducting compound. The semi-conducting compound for conductor shielding, cross-linked, polyethylene for insulation and semi-conducting compound for insulation shielding shall be applied by three in tandem extrusions in a single pass and followed by vulcanization in a dry process continuous vulcanizer. The insulation shielding shall be removable without damaging the insulation, leaving no conducting material, which cannot be readily removed.

F. Core Screening

1. Metallic screen shall consist of two layers of plain annealed copper tape helically applied with a suitable overlap. The metallic portion of the screen, together with the armouring, shall be engineered according to manufacturer data to carry the prospective earth fault current of the system. A non-hygroscopic filters and a non-metallic binder tape(s) shall be applied over the screen.

G. Separation sheath

1. Separation sheath shall consist of extruded black PVC. The minimum thickness at any point shall not fall below the nominal value stipulated in IEC 502.

H. Armour

1. Armour shall consist of double layers of galvanized steel tape helically applied with gap. The outer tape shall be approximately central over the gap of the inner tape. The gap between adjacent turns of each tape shall not exceed 50% of width of the tape.

I. Outer Sheath

1. Outer Sheath shall consist of extruded RED coloured PVC. The minimum thickness at any point shall not fall below the nominal value by more than 0.2mm plus 20% of the nominal value.

J. Core identification

1. Core identification shall be carried out by coloured narrow tape longitudinally applied between the insulation and the metallic screen. The coloured code shall be red, yellow and blue.

K. Cable Marking

1. The marking shall be applied throughout the length of the cable for details on number of cores, conductor size, voltage rating, manufacturer's name and year of manufacture.

L. Length Marking

1. Sequential length marking starting from zero shall be printed on the outer sheath at 1 meter intervals, with the lowest number marking innermost on the drum.

2.2 SEALING AND DRUMMING

The cable shall be sealed and drummed in accordance with BS 6480 Part 1. Immediately after fabrication and testing, both ends of every length of cable shall be sealed enclosing them with tight fitting approved caps, adequately secured to prevent ingress of moisture.

The ends of the factory lengths of cable shall be marked 'A' and 'Z', 'A' being the end at which the sequence of core numbers is clockwise and 'Z' the end at which the sequence is anti-clockwise. The end which is left projecting from the drum shall be consistently 'A' or 'Z'.

Cable ends shall be protected against damage in such a manner that the enclosure cannot be easily removed during handling while in transit.

Each length of the cable shall be wound on a non-returnable strong and seaworthy drum lagged with wooden battens.

The cable end projecting from the drum is to be adequately protected to prevent damage during handling and in transit, and a thick PVC wrapper shall be placed over the cable to prevent the ingress of dirt, dust and grit, etc. Cable drums shall be lagged with closely fitting batten. Each drum is to be assigned a distinguishing number which is to be branded with hot irons or neatly chiseled on the outside of one flange. A painted identification number will be accepted.

Particulars of the cable, i.e. voltage, length, conductor size, number of cores, and gross and net weights shall be clearly shown on one flange of the drum. In addition, the words "Running End 'A' or "Running End 'Z'", as appropriate, shall be marked on the flange and the direction for rolling shall be indicated by an arrow.

2.3 PILOT CABLES

All pilot cables provided in the project shall comply with Local Authority requirement and compatible with the relay manufacturer recommendation.

3.0 EXECUTION

3.1 ERECTION OF CABLES

Notwithstanding the cable routes indicated on the Drawings the Contractor shall be entirely responsible for the supply of correct lengths of the cables to be installed and for all allowances for connecting and terminating the cables to the switchgears and transformers respectively

The Contractor shall submit proposed cable routes including details of supports for the cables for approval before installation. The cable shall not be run in places other than corridor, passageway, electrical riser or other designated areas subject to the Engineer's approval. The cost of support shall be deemed to have included in the Contract.

3.2 CABLE PULLING

Winching of cables through ducts/pipes shall only be carried out with the approval of the Engineer in which event a pulley eye shall be attached to the conductors. Cable shall be run in neat and orderly manner to allow space for future cabling and maintenance and under no circumstances and cable shall be run diagonally across a room, cable basement, corridor, etc.

A cable sheath stocking may be employed or cables where no undue stress in the sheath is likely to occur.

Care shall be taken to ensure that the draw strain is applied to the armouring and protected during drawing against damage.

3.3 CABLE LAYING

The Contractor shall lay all cables under supervision of qualified/accredited personnel.

All cables laid shall be in full length, unless otherwise permitted by the Engineer.

All cable terminating materials and tools required to complete the above shall be of the type recommended or manufactured by the cable manufacturer.

The Contractor shall have sufficient men on site for pulling and lying of cables. When short lengths of cables are laid the number of men on site may be reduced at the discretion of the Engineer.

All changes in gradient and discretion shall be made in gradual and cable bends shall have radii of not less than twelve (12) times the cable overall diameter or those recommended by the manufacturer.

Where cables are drawn around corners suitable rollers shall be placed to confirm with the specified radii.

Rollers shall be placed at intervals of not more than 3 meters on horizontal pulls to prevent the serving and armouring from being damaged by scrapping on the ground. The approximate routes of all cables are as shown on the Drawings and the Contractor may be required to deviate from these routes as and when directed by the Engineer at no additional cost.

Cables shall not cross in straight runs of trench or in any other position except where a cross in impracticable to avoid by advance planning of the laying of cables.

The Contractor shall provide cable supports, cable trays, cable ladders, etc. throughout the run of the power cables. Cable supports shall be fabricated from fittings of hot-dipped galvanized C-channels in general; conductors and cables shall be supported and terminated so that no strain is imposed on the terminals of the equipment or the cables.

Crimping lugs shall be used on all power cables. The type and makes of all crimping lugs and their associated hydraulic crimping tools are subjected to the approval of the Engineer.

Power cables and control cables shall be run in separate ladders/trays.

All cables shall be laid in neat, one-layer parallel runs and shall be securely clamped by alloy cable clamps. Cable clamp shall be subjected to the approval of the Engineer. A minimum spacing of one time of the cable diameter shall be maintained for the power cables.

All cables shall be clearly labeled at both ends and at regular intervals if cables are fun on cable ladder/tray or in riser using “Hellerman” or equivalent labeling with 5mm high black lettering on yellow background.

Termination of cables shall be carried out by the Local Authority accredited and full experienced jointers and evidence of this shall be produced to the satisfaction of the Engineer before termination of cables is being carried out.

3.4 AUTHORITY INCOMING CABLES

The Contractor shall render all assistance to the Local Authority during the laying of the incoming cables.

The Contractor shall provide all termination kits, coordinate with Local Authority and terminate the incoming power and pilot cables at the incoming MV switchboard side.

The Contractor shall provide cable supports for all incoming cables.

3.5 FACTORY TESTS

Each type of cable specified shall be fully type tested according to IEC 502 and the appropriate British Standards. The types and sizes of cables required are shown on the Drawings.

Should the Engineer require it, the Contractor shall submit reports issued by a national or international testing authority on type test that have been successfully performed on the cable for his approval.

The type test shall include the following test:

1. Partial discharge test;
2. Bending test, plus partial discharge test;
3. Tan δ measurement as a function of the voltage and capacitance measurement;
4. Tan δ measurement as a function of the temperature;
5. Heating cycle test plus partial discharge test ;
6. Impulse withstand test, followed by a power frequency voltage test;
7. Medium-voltage alternating current test;
8. Type test (non-electrical) as stipulated in IEC 502, Table VI.

Cable routine test shall be conducted at factory in accordance with IEC 502 for the following tests:

1. Measurement of the electrical resistance of conductors.
2. Partial discharge test,
3. 4-hour MV test.

3.6 SITE ACCEPTANCE TEST

The Contractor shall supply all necessary testing equipment for site testing. When required, these testing equipments shall be calibrated at the expense of the Contractor at a recognized national laboratory.

The Contractor shall engage an Authorized Medium Voltage Testing Engineer who is recognized by Local Authority to perform all site tests.

In addition to Local Authority's requirements and those recommended by the manufacturer, the following tests shall be carried out:

1. Continuity test,
2. Earth test,
3. Polarity test,
4. Insulation resistance test,
5. DC high voltage test. The test voltage shall be in accordance with Local Authority's requirements and Engineer's approval.

SECTION 8 CIRCUIT BREAKER

1.0 GENERAL

1.1 SCOPE

Circuit breaker including Air-circuit breaker (ACB), Moulded Case Circuit Breakers (MCCB), Miniature Circuit Breakers (MCB) and Residual Current Circuit Breakers (RCCB / RCD) shall be provided according to this specification.

All breakers shall be capable of withstanding the electrical, mechanical and thermal stress of the prospective fault level experience. The prospective fault levels of the various breakers shall be verified according to result in short circuit/co-ordination study specified.

1.2 STANDARDS

The circuit breakers shall be engineered and constructed in accordance with the latest revision of the following standards:

1.	BS EN 60898 IEC 898	:	Circuit breakers for over current protection for household and similar installations.
2.	BS EN 60947-2 IEC 947-2	:	Low-voltage switchgear and control gear, Part 2 circuit breakers.
3.	BS 5419	:	Air-break switches, air-break disconnectors, and fuse combination units for voltage up to and including 1000V AC and 1200 VDC.
4.	BS 5486	:	Low-voltage switchgear and control gear Part 1 assemblies. Part 1 requirement for type tested and partially type tested assemblies.
5.	BS 4293	:	Residual Current Circuit Breaker

BS/IEC or other National standards not mentioned above but are applicable to this installation shall also apply.

1.3 SUBMISSION

A component list and catalogues.

Factory and site testing procedures and report formats shall also be included.

2.0 PRODUCTS

2.1 AIR CIRCUIT BREAKERS

Air circuit breakers shall be metal clad, flush mounted, horizontal draw out isolation, air break type complying to IEC 60947-2: 1995. Air circuit breakers shall have a rupturing capacity of not less than short circuit current experienced at location of installation for 3 seconds certified by ASTA or other recognized testing authorities.

All air circuit breakers (ACBs) shall be of draw-out type encased in metal clad housings. The

manufacturing of the breaker shall be such that there is no compulsory safety clearance imposed around the breakers, in order to optimise the switchboard space requirement.

The ACBs shall be so manufactured that they comprise of main and arcing contacts of adequate ratings and housed in reinforced polyester casings, offering double insulation from the front face and ensuring no possibility of "Flashover" between phases. The main contacts shall have double-actions in each pole and all contacts shall be silver-plated and replaceable.

Arc chutes with stainless steel filters shall be provided on each pole of the breaker as an efficient means of arc control. The filters must be effective to minimize the diffusion of ionized gas outside the breaker when the contacts open on short circuits. This manufacturing detail must be effective at all levels of current for which the breaker is manufacture to operate. Any arc created as a result of the opening of the breaker's contacts during fault conditions shall be completely contained in the chute without any possibility of a "Flashover" between poles or to adjacent earthed metallic parts.

The draw out version of ACBs shall have three indicated positions as follows:

1. Connected : The breaker is fully racked-in with all the main & auxiliaries engaged.
2. Tested : The breaker is racked out and with the main disconnected, but all auxiliaries are still connected.
3. Disconnected : The breaker is fully withdrawn and all circuits disconnected.

A clear means of Positive Contact Indication (PCI) shall be provided by a mechanical flag marked "ON" or "OFF" to indicate the circuit breaker's contact positions. The stored energy mechanism shall also have clear indications marked "CHARGE" or "DISCHARGE" to reflect its status.

Safety shutters shall be provided to all drawout breakers in order to inhibit inadvertent access (degree of protection IP20) to the "live" clusters when the breakers are in the "Test" or "Disconnected" positions. It must be possible to padlock the safety shutters in the SHUT position.

Auxiliary switches shall be equipped for each breaker for indication, alarm and control purposes. Auxiliary switches shall be robust, with double break-action, easily accessible for maintenance and having adequate current ratings to carry the connected load. Each breaker shall have provision for extending the number of auxiliary switches to cover future alarm or signalling circuit requirements. All auxiliary circuitry wiring shall be connected on the front face of the breaker on a set of disconnecting terminals to facilitate the automatic disconnection of auxiliary circuits when the breaker is in the "Disconnected" position.

Circuit breakers shall be manufactured for optimum performance with minimum maintenance. The mechanical endurance (C-O cycles) without maintenance shall be at least 12500 cycles for breakers up to 1600A, 10000 cycles for breakers from 2000A to 4000A and 5000 cycles for 5000A and 6300A breakers. The electrical endurance (C-O cycles) at 440V without maintenance shall be 10000 cycles for breakers up to 1600A, 8000 cycles for breakers of 2000A, 5000 cycles for breakers of 2500A to 4000A and 1500 cycles for 5000A and 6300A breakers.

The circuit breakers shall be equipped with electrical motor operating mechanisms for

automatic charging of the stored energy spring mechanism. However, this shall not prohibit the breakers to be operated manually, if required. Closing operations can be initiated either from the local push button on the front face of the circuit breaker or by remote control. The closing coils shall be rated at 23OVac. After closing, the stored energy spring mechanism shall immediately be recharged automatically by the motor, so as to be ready for next closing operation when the breaker trips.

Normal manual opening of the circuit breaker shall be accomplished either from the local push button on the front face of the circuit breaker or by means of a trip coil. The trip coil must be capable of carrying continuous rated current, i.e. being permanently energized, for electrical interlocking purposes. The tripping mechanism shall be robustly built and stable without possibility of being inadvertently operated by shock or jerk. The trip coil shall be manufactured such that the plunger operates immediately when activated, without having undue delay for the building up of the coil's magnetic field. Regardless of all circumstances, the speed of closing and opening shall be independent of the operator.

The operating mechanism, carriage and hinged panel shall be so interlocked that it is not possible to withdraw the circuit breaker while it is in the closed position. Closing of circuit breaker in between service and disconnected position is also not possible and vice versa.

Provision shall be made so that it is possible to operate the circuit breaker mechanism when it is in the disconnected position.

The main circuit breakers for the incoming supply and the bus-tie (couple) breaker shall be mechanically and electrically interlocked such that only two of the three circuit breakers can be closed at any one time. The mechanical interlock shall be achieved be means of Ronis keys and electrical interlock by means of a permanently energized coil. The system shall be so arranged that the withdrawal of any one circuit breaker shall in no way effect the operation of the others.

Pad locking facilities shall be provided for each breaker so that breaker operation can be locked in a particular position if so indicated.

The tests to verify the characteristics of circuit breaker shall include type tests, routine tests and special tests.

1. Type test shall include:
   a. Verification of temperature rise unit
   b. Verification of dielectric properties
   c. Verification of rated short-circuit making and breaker current
   d. Verification of mechanical operation and endurance
   e. Routine test shall include:
   f. Mechanical operation tests
   g. Calibration of releases
   h. Dielectric tests

Other tests, which are to be carried out on request of the relevant authorities, shall be done on the Vendor's account. Vendors must submit type test certificates issued by ASEFA, ASTA or other recognized testing authorities together with the Technical documents or upon request.

2.2 MOULDED CASE CIRCUIT BREAKERS (MCCB)

The MCCB shall comply with IEC 947-2:1995. The MCCB shall be provided with overcurrent protection by means of thermal and magnetic tripping element.

All MCCB tripping mechanism shall be ambient temperature compensated. MCCB of frame sizes greater than 150 amps shall be equipped with continuously adjustable magnetic pick up setting. MCCBs used for incoming main feeders shall in addition be provided with continuously adjustable rated current settings in the range of 60 to 100% rated current.

The MCCBs shall have quick make and quick break mechanism independent of the operating speed. The tripping mechanism shall be mechanically "trip free" from the handle so that the handle cannot be closed against fault conditions.

The MCCB shall be provided with door interlock handles. All handles shall be large and robust to carry out the switching operation with ease. The handle shall clearly indicate the "ON", "OFF" and "TRIP" positions. The handle shall be able to be locked in the "ON" or "OFF" positions. When locked in the "ON" position it shall still be possible for the handle to indicate "TRIP" when the MCCB has tripped. An interlock release mechanism shall be provided to enable the door to be opened when the MCCB is locked in the "ON" position.

Multi-pole MCCB shall have a common-trip bar so that a fault condition on any one pole of the MCCB will cause all poles to trip simultaneously.

The MCCB interrupting capacity shall be not less than that indicated on the drawings unless alternative scheme using cascading protection or other schemes are utilized.

MCCBs of ratings 200A and above shall be of busbar termination type, adaptable for use with bolts and cable lugs.

Automatic change over MCCBs shall be of the motorized type, fully withdrawable, with both mechanical and electrical interlock. The transfer operation shall be controllable by an adjustable time delay of between 0.1 to 30 sec. The actual transfer time of the MCCBs shall not exceed 2 sec. The motor mechanism shall utilize universal motor with electro magnetic clutch and shall be equipped with full handles to allow manual operation of the MCCB. All automatic change over MCCBs shall have a minimum mechanical life of 10,000 operations.

MCCB when used for motor protection shall have characteristics suitable for the motor starting. Standard range MCCB shall not be substituted for motor protection circuits.

All fully withdrawable MCCB shall have interlocks to prevent withdrawal when the MCCB is "ON".

All main moulded case circuit breaker shall be provided with at least 2 pairs N/O and N/C auxiliary contact.

2.3 MINIATURE CIRCUIT BREAKERS (MCB)

MCBs shall comply to IEC 898:1995. They shall be of the current limiting type having a sealed ambient temperature independent thermal magnetic tripping mechanism providing overload and short circuit protection. All MCBs shall be of 35mm D/N symmetrical rail mounted type.

The breaking capacity of MCBs shall be at least equal to the prospective fault level at the point installation, unless back-up by a current limiting upstream breaker of the same make.

The MCB 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 of the automatic resetting type.

The individual operating mechanism of each pole of a multi-pole MCB shall be directly linked within the MCB casing and not be the operating handles.

The operating handle shall be of the toggle type with possibility for mounting of padlocking facility.

Each pole shall be provided with bi-metallic thermal element for overload protection and magnetic element for short circuit protection.

. It shall be possible to* fit on site auxiliaries like shunt-trip coil, under-voltage release, ON/OFF switch or alarm switch.

2.4 RESIDUAL CURRENT CIRCUIT BREAKERS (RCCB)

RCCB shall comply to BS 4293 and shall be of the current operated type.

The RCCBs shall be manufactured to trip within 0.1 second for 30 mA.

The RCCBs shall be of 2-pole construction for single phase and 4-pole construction for 3 phases.

All RCCBs shall be complete with test buttons.

All RCCBs shall be batch tested and bear the appropriate test label of approval to Local Authority's requirement.

All RCCBs shall be of high sensibility type as appropriate and as specified in the drawing. They shall be of surge proof manufacture to prevent nuisance tripping due to transient over voltage.