<u>GENERAL</u>

1.0 APPLICATION

The provision of this section of the Specification are supplementary to and are to be read in conjunctions of contract shall be from a part of this Specification, as fully and completely, to all intent and purposes as though all the clauses therein had been embodied in this Specification.

2.0 DESCRIPTION OF PROJECT

The whole of the Works may be briefly described as CADANGAN MEMBAIKPULIH, MENAIKTARAF SERTA KERJA-KERJA BERKAITAN DI BANGUNAN BLOK A DAN SEBAHAGIAN BLOK B UNTUK UNIVERSITI TEKNOLOGI MARA DI UITM KAMPUS JALAN OTHMAN, PETALING JAYA,SELANGOR DARUL EHSAN

3.0 EXTENT OF WORK

The work shall comprise the whole of the labour and, unless otherwise indicated, all materials to form complete installation and such tests, adjustments, and commission as are prescribed in subsequent clauses and as may otherwise be required to give an effective working installation to the satisfaction of the Superintendent Officer which herein after known as 'S.O'.

The words "complete installation" shall mean not only the major items of plant and apparatus conveyed by this specification but all the incidental sundry components necessary for the complete execution of the works and for the proper operation of the installation, with their labour charges, whether or not these sundrycomponents are mentioned in detail tender documents issued in connection with the contract.

The words "as indicated", "were indicated" and "unless otherwise indicated" refer to items or requirement elsewhere in the tender documents issued in connection with the contract, e.g. for the drawing, supplementary specification or in the Schedule.

4.0 RULES AND REGULATIONS

- **4.1** Works carried out under this Contract shall be completed with all necessary equipments for satisfactory control, operations and maintenance and shall comply with Rules and Regulations, Laws and By Laws of:
 - a) Energy Commission Act 2001.
 - b) Electricity Supply Act 1990 (A 2001) and Electricity Regulations 1994.
 - c) Tenaga Nasional Berhad
 - d) Akta Kesihatan dan Keselamatan Pekerjaan.
 - e) The Fire Department.
 - f) Suruhanjaya Tenaga
 - g) Others relevant Law and Regulation

- **4.2** The work shall also be carried out in accordance with the relevant parts of the current Edition of: -
- a) Malaysian Standard IEC 364.
- b) JKR Cawangan Elektrik Standard Specifications.
- c) Energy Commission Act 2001.
- d) Electricity Supply Act 1990 (Amendments 2001).
- e) Electricity Regulations 1994.
- f) Wiring Regulations and Regulations for the Electrical Equipment of building from Institution of Electrical Engineers latest edition.
- g) Licence Supply Regulation 1990
- h) 16th Edition IEE Wiring Regulation for Electrical Installation of Buildings
- **4.3** All electrical materials supplied should have been previously approved by the Energy Commission Subject to such exceptions as the Energy Commission may expressly allow, the Specification for the time being enforce issued by the British Standards Institution for the design of apparatus shall be confirmed to.

5.0 SCHEDULE OF WORK

The successful Tenderer, before proceeding with the work shall prepare in cooperation and to be approval of the S.O. The Contractor shall prepare Schedule of Work based on the time requirements of the electrical installation schedule. This schedule shall be kept up to date as the work progress.

The schedule of work shall clearly indicate the sequence of operation required completing the work of the contract, also the commencement and completion dates of each section of the work.

6.0 COMPLIANCE WITH INSTRUCTIONS

The successful Tenderer shall promptly re-installed rewired, replace, make good and complete rectifying any unsatisfactory work to the approval of the S.O.

Should the Contractor fail to comply with the Instruction of the S.O within seven days or some longer time specifically given with the instruction, then provided the period is, according to good trade practice, a reasonable time to permit compliance with the instruction, the Contractor will be forfeited the right to further payment until he has so complied.

Failure of the Contractor to comply with the instruction in the time stated will give the S.O the right to appoint others to perform the stated task at the cost of the Contractor and without vitiating the Contract and or in any way relieving the Contractor of his responsibilities and guarantee.



7.0 CONTRACTOR SUPERINTENDENCE

The Contractor shall provide a suitably qualified and competent Superintendent whose name shall have been communicated previously, by the contractor inwriting to the S.O, fully experienced in the type of work being carried out, during the execution of the works and as long thereafter as the S.O may consider necessary for proper fulfilling of Contractor obligations under this Contract.

A National Language or English-speaking Engineer, Foreman or any other representative of the Contractor as may be necessary and approved of in writing by the S.O (whose approval may it any time be withdrawn) shall be constantly at the site of the works, and shall give his whole time to Superintendence of the works. If such approval be withdrawn by the S.O, the Contractor shall, as soon as is practicable after receiving written notice not thereafter employ him agent or Representative approved by empowered to received and execute on behalf of the Contractor directions and instructions from the S.O representative.

8.0 BUILDER'S WORK

The Contractor shall inform of all cutting away, as early as possible to that hole, etc, may be cut or formed as the building work progresses and so avoid the additional expenses of cutting away and making good, finished work.

9.0 WORKMEN LIVING ON SITE

The Contractor shall not permit his workmen to live on the site at any time throughout the contract period.

10.0 CONTRACTOR SHEDS

The Contractor is to erect, if necessary for his own use, and for such materials as he may require, an approved type of office, workmanship and lock-up storage sheds, the number and position of these buildings shall be approved by the S.O. These temporary buildings are to be removed on the completion of the Contract works and the site cleared to the satisfaction of the S.O.

11.0 DAMAGE TO PROPERTY

The Contractor shall make good at his own expense any damage to property caused by his workmen, plant, or transport weather such or not be in his control.



12.0 PACKING AND TRANSPORT

The Contractor is to bear all expenses in connection with the importation and transportation of all equipment, materials, and things necessary for the purpose of the Contract including warehouse rent, handling, and other charges.

Suitable precautions shall be taken in the packing of all materials to ensure the safe arrival of each consignment having full regard to the distance to be travel, the amount of handling required and the destination being in a tropical climate as specified.

13.0 COMMISSIONING AND TESTING

The complete installation or any section there of shall be tested both before and after being connected for services, to the requirements of the S.O as stated later. If TNB electrical supply is not available on time, the Contractor must provide a temporary supply, using Generator set for testing. The Contractor shall produce a licence from Energy Commission for the period of using the Generator Set and any fees shall be bond by the Contractor.

14.0 GUARANTEE PERIOD

The Contract shall include the guarantee of the whole of the works for the period of 12 months from the date of the issuing of the Taking Over Certificate. During this term, the Contractor shall remedy and/ or replace all defective parts or items and correct any omissions certified by the S.O. The Contractor will also be held liable for any cost of dismantling or re-erection if may have to be undertaken to replace defective parts.

15.0 PERFOMANCE GUARANTEE

The Contractor shall guarantee that the equipment supplied when operated in accordance with the instruction supplied by him shall be capable of satisfying the requirements as specified for a period of not less than 24 months from the date of handing over.

16.0 MATERIALS AND WORKMANSHIP GUARANTEE

The Contract shall guarantee that the materials and workmanship of the equipment installed by him under the specification are new and first-class in every respect and that he will make good any defects, not due to ordinary wear and tear or improper use or care which may develop with in, one year from Data or Handing Over.



17.0 DEPARTURE FROM THE SPECIFICATION

The Contractor shall comply entirely with the specification where applicable modified by the deviations listed in the Schedule of the Contract.

18.0 PREVIOUS WORK

The Tenderer or Contractor is required to complete the Schedule provided giving details of previous installation of a smaller nature he had undertaken and successfully completed.

19.0 CLEANING UP

The Contractor shall remove all rubbish and scrap materials resulting from his work and shall leave each section of the installation tidy as soon as he has completed it.

20.0 PROGRESS REPORT AND MEETINGS

The Contractor shall attend Progress Meetings when requested by the Superintending Officer (S.O).

The Contractor shall keep a diary recording the day today progress of the works and details of all instruction received. This diary shall be at the disposal of the S.O.

21.0 QUALITY OF MATERIALS

Every effort shall be made by the Contractor to obtain all components as quicklyas possible. All other things being equal, alternative makes or types of components may be suggested for approval, particular if delivery is likely to be improved. The whole of the works shall be executed with the materials indicated in this Specification. Where such material is not specially described they shall be of the best of their respective types.

No substitution of specified material will be permitted except by permission of the S.O in writing and which will only be given when it can be proved that specified material is not available either by reason of delay in delivery or other like circumstances.



22.0 DEFINITIONS OF "SUPPLY", "PROVIDE" AND "APPROVED"

The words "supply" and "provide" in this specification shall be deemed to include in each case the term "fix" as usually understood, unless otherwise stated. The word "approved" used in conjunction with a defined make of equipment or material, shall mean that the tendered shall include for the supply of the equipment or material mentioned and shall, if he desires, submit alternative makes or equal quality which the S.O shall accept or reject at his option.

23.0 MEASUREMENT OF WORK

All measurement of variation work shall be carried out by the Contractor to the S.O approval.

24.0 DUTIES

The Contractor shall pay all Malaysian Customs Duties and all other taxes which may be payable on all materials and equipment imported for used in the works.

25.0 MAINTENANCE EQUIPMENT, TOOLS, AND SPARES

Within one month of receiving the letter of intent or instructions to proceed the Contractor shall submit to the S.O in duplicate a detailed and itemised list of equipment the Employer should hold the stock. The list shall be compiled based on a yearly maintenance programme and consideration shall be given to the remoteness of the site from the nearest available stock list of such spares and each item shall be priced separately for delivery to site.

26.0 ELECTRICITY SUPPLY

Unless otherwise indicated all apparatus and wiring shall be suitable for use with a 3-phase, 4-wire, 415 / 240V, 50Hz, earth neutral system.

27.0 SUPPLY AUTHORITY FORMALITIES

The Contractor, before commencement of work shall submit the necessary application forms, and details for permission to install and final connection as required by the Supply Authority in the area concerned.



28.0 SAMPLES

The Contractor shall provide a sample if necessary, of each item to be installed on site to the S.O four (4) weeks prior to the installation taking place.

29.0 REGISTRATION OF INSTALLATION

The Contractor shall ensure that the installation is to be registered with:-

- (i) Energy Commission.
- (ii) Department of Environment.
- (iii) Jabatan Bomba.
- (iv) Department of Safety and Health.
- (v) Other relevant Government Bodies.

Before the handing-over of the project.



SPESIFIKASI TEKNIKAL (SEKSYEN 2)

DRAWINGS AND INVENTORY LIST

1.0 TENDER DRAWINGS

The layout shown on the drawings are to be considered diagrammatic and approximate only. The Specifications and drawings are intended to be mutually explanatory and complete, and the Contractor shall provide everything necessary for the proper execution of the works according to the true intent and meaning of the drawing and specifications taken together whether the same may or may not appear, be particularly shown and if the Contractor finds any discrepancy therein, he shall immediately and in writing refer the same to the S.O who shall decide which shall be allowed. The exact positions of all fittings and fixtures shall be as shown on the plans and drawings.

2.0 INVENTORY LIST

The Contractor shall provide inventory list all electrical items, wiring and installations within one month after the issuance of CPC. All particulars given in such inventory list shall be binding upon the Contractor. All lists shall be in hard and softcopy.

3.0 AUTOCAD RECORD DRAWING.

Autocad record drawings of the complete installation shall be prepared by the Contractor and complete sets of the approved "as installed" drawing(schematic and layout) shall be presented to the S.O by installing it in the Computer Compact Disk.

The Contractor during the course of the works, shall maintain a fully detailed record of all changes from the Autocad Record Drawing to facilitate easy and accurate preparation of the 'as installed' drawing to ensure that these drawings are in all respects a true record of the installation.

4.0 RECORD DRAWINGS

Record drawings of the complete installation "as installed' shall be prepared by the Contractor. The Contractor shall submit three (3) complete sets of prints, one (1) complete set of softcopy of the approved "as installed' drawing shall be presented to the S.O not later than one month after the issuance of CPC.

Failure of the Contractor to submit the "as installed' drawings within the stipulated period shall entitle the S.O to have such drawings prepared by others at the expense of the Contractor.



SPESIFIKASI TEKNIKAL (SEKSYEN 2)

Each drawing shall give the following particulars in the bottom right-hand corner:

- a) Name of Owner.
- b) Contract Number.
- c) Title of Drawing and Name of Project.
- d) Drawing Number and Date.
- e) Name of Contractor.

Each drawing shall be linen print of similar form and scale to the Tender drawing. The Contractor during the course of the works, shall maintain a fully detailed record of all changes from the Tender drawing to facilitate easy and accurate preparation of the "as installed" drawing to ensure that these drawingsare in all respects a true record of the installation. The following detail shall be included: -

- i) Position of new and lighting pole.
- ii) Size and type of all HDPE Corrugated/conduit/ trunking and number of cables enclosed therein.
- iii) Lighting fixtures details
- iv) Control panel circuit diagram.
- v) Routes of all cables run undefrground and positions of any jointing.
- vi) Control panel details
- vii) Schematic and wiring diagram are covered by the main installation drawings.



GENERAL REQUIREMENTS FOR L.V ELECTRICAL SYSTEM INSTALLATION.

1.0 GENERAL

The Contractor shall note that the specification is intended to set out the basic minimum performance requirements and characteristics for the complete L.V Electrical System Installation and the required standards of workmanship and materials in the design, manufacture, supply, installation, testing and commissioning of the systems. It is the responsibility of the Contractor to meet and full fills the basic performance requirements of the specifications and provides additional benefits in term of simplicity of the system.

The Contractor shall be required to perform in accordance with the specification provided to enable him to prepare a complete set of working drawings. All drawings are required to submit to the S.O for checking and approval. The installation and operation of the system shall be able to meet the design parameters and criteria as list in clause (section 1).

2.0 SCOPE OF WORK

The work under this specification comprises: -

- i) To supply, installation and delivery to site, the complete L.V Electrical Equipment, materials, and installation accessories.
- ii) The installation of the complete Electrical Installation including testing, commissioning, and handling over in approved working order maintenance thereafter for a period of 12 months.

The works to be carried out shall include all necessary labour and the whole of the materials necessary for the completion of the installation in every detail ready for the continuous and economic operation and performance of the systems as specified whether such be directly or un-direct mentioned in this specification.

The Contractor shall provide all the necessary plans and tools including lifting gear required to carrying out the installation.

The Contractor shall liaise with the S.O for all openings in floors, walls, partition, doors ceilings, concrete plinths, and foundations for equipment, ductwork, and pipe work.

The Contractor shall include supply of labour and materials, delivery, storage, installation, testing and commissioning of all materials and equipment including minor and incidental works to ensure the complete and satisfactory for the project operation of L.V electrical system. This work shall include but not necessarily be limited to the following: -



SPESIFIKASI TEKNIKAL (SEKSYEN 3)

2.1 Electrical & Telecommunication Installation

- i) New Electrical Boards Main Sub Switch Board, Sub Switch Board, Distribution Board, Termination Board and Weatherproof Control Panel
- ii) New Electrical fixtures lighting, switches, socket outlets, etc
- iii) New Underground Cable for compound lighting
- iv) New Submain Cabling for each boards, etc.
- v) New wiring final circuit
- vi) New Lightning Protection System
- vii) New earthing system.
- viii) PABX System
- ix) Door Access System
- x) All Reports, etc
- xi) Testing and commissioning including all cost of electrical and telecommunication prior to handing over.

2.2 Cleaning up

Cleaning up, painting, and labelling of all equipment, outgoing and accessories installed.

2.3 Making good

Making goods of all surface, patching, holes, opening and furring of incidental work directly undertaken in this contract.



3.0 Submission

Submitted of shop drawings, as installed drawings, test result, maintenance operating/ instruction manuals of all equipment and services installed.

One (1) year comprehensive maintenance and attendance during the defect liability period.

4.0 Permits and inspection fees

The Contractor shall anticipate any provisions in this Tender for any costs and fees payable to authorities, overtime payment and all other charges and costs necessary to complete the works within the construction programme.

All equipment shall be suitable for operating 11kV, 415V, 3 phase and, or 240V, single phase at 50Hz with minimum tolerance limit +10%, -5% for the Voltage. Equipment with lower rated operating Voltages shall not be used unless otherwise approved by the S.O. Should Contractor propose to be using other than the specified equipment, operating Voltages he shall have: -

- a) Obtain necessary approval from the S.O in writing before ordering of the equipment. The S.O reserves the right to accept or reject the request for alternatives subject to indication of satisfactory technical performance data.
- b) Supply necessary transforming device without any additional cost and without substantial increase in power consumption.
- c) Submit manufacturers test data and warranty certificates to indicate the operating tolerance unit and suitability of operation.

5.0 Registration of installation

The Contractor is responsible to register the installation with relevant bodies as prescribe by the Law. The cost of registration fees will be bonded by UiTM.



6.0 Painting of Substation and Feeder Pillar

The Contractor shall paint the sub-station according to official colour code of corporate signature as follows: -

COLOUR	PANTONE	ICI	HEXIS
Biru UiTM	275 C	TWILIGHT ZONE 91BB 07/263	E 5274
Ungu UiTM	2607 C	PURPLE FIRE 42 RB 14/320	E3527
Kuning UiTM	130 C	MARIGOLD BLOSSOM 05YY42/727	E 305
Kelabu Cerah UiTM	400 C	SUTTON PALCE 30YY54/030	E 3430
Kelabu Gelap UiTM	404 C	QUAKER GREY 30YY25/026	HEXIS



GENERAL ELECTRICAL SERVICES.

1.0 MAIN DISTRIBUTION BOARD

Each low voltage Distribution shall be of the self contained, extensible, cubicle, industrial or floor pedestal mounting type as indicated on the Drawings Specification, metal clad, flash fronted type for front and rear access. Each Distribution Board shall be built up from completely enclosed units housing air circuit breakers, contactors, moulded case circuit breakers, indicating lamp, meters, busbar couplers, anti condensation cubicle heaters complete with indicating lamp, switches, relays, and other necessary item of equipments as shown in the Drawings Specification.

Each Distribution Board shall be suitable for indoor services in ambient temperature of up to 400°C with 100% R.H. at maximum continuous rating without exceeding the maximum temperature permitted by the relevant B.S.S to which reference is made by herein for operation on a voltage and frequency as specified on the Drawings Specification also with solidly earthed neutral.

Each Distribution Board shall be capable as a whole of withstanding without damage the electrical, mechanical and thermal stresses produced under short circuit conditions equivalent to the M.V.A ratings as shown on the Drawings Specification and relevant to B.S.S.

Special attention shall be given to insulation and finish of all items and no linseed oil varnish, sponge, fibre, or hygroscopic material shall be used in any position and all components shall have a tropical finish including electro tinning of operating coils.

All items of equipment of similar design and dimensions shall be, where possible, made to jig and be fully interchangeable with each other and care shall be taken to ensure that all parts fit accurately.

Each Distribution Board shall be factory assembled and test before delivery to site sections and of suitable sizes for installation in the situations as shown on the Drawings Specification.

2.0 CUBICLE CONSTRUCTION

Each cubicle framework shall be fabricated from rolled steel single sections and shall be self supported when assembled and of standard size, uniform in height and depth from front to back. The cubicle roof, side panels and doors shall be of not less than No. 12 S.W.G sheet steel with turned edges to the front panels and so framed as to provide a clean, flush, and pleasing appearance and rigid construction without welded cross struts.

Full access shall be provided to control equipment inside cubicles by means of suitable doors with car type handle and integral cylinder lock and two keys which, except in the case of distribution board/ lighting contactor cubicles shall be mechanically interlocked with the main isolator to prevent any door being opened with the isolator in "ON" position. The front, top and back of all cubicles shall be



finished to a colour to be selected by the Engineer with end plates and heads of any external fixing bolts or set screws similarly finished except those steel parts normally left bright which shall be cadmium plated and operating parts finished semi-gloss black.

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

3.0 BUSBARS AND SECONDARY WIRING

Busbar makings and arrangement connections and grade of copper shall comply as appropriates with B.S 158, 159, 1433 and 1977.

Each Distribution Board shall be so arranged that the busbars run horizontally through each sectionalised length and shall comprise bars fabricated from hard drawn high conductivity copper **fully insulated** rigidly mounted on non-hygroscopic insulators with connections from the busbars to the switches effected by means of copper bars or rods securely clamped to the bars and identified by means of coloured plastic sleeved painting to indicate the phase colours.

Ratings for the main phase and neutral busbars shall be as shown on the Drawings Specification.

All secondary wiring shall be of not less than 1.5mm² or sectional area or 1.5mm² in stranding, insulated with P.V.C and shall be fixed securely without strain by cleats of the compression type. For identification different insolent colours shall be provided to distinguish the various circuits and each connection shall terminate at the approved type of terminal block places in an easily accessible position for testing at side with coded ferrules of an approved type at both ends of each conductor. No connectors or soldered joints shall be permitted in the wiring. The wiring shall be formed in a neat and systematic manner, with cables supported clear of panels and without crossovers. Bushes shall be necessary to prevent chafing of cables.

4.0 METERS AND RELAYS

Meters and relays for external panel mounting shall be of the flush pattern, Inverse Definite Minimum Time (IDMT) with square escutcheon plates finished matt black and pressed steel case. Indicating instrument, integrating meters shall be to B.S 37, Part 1 and 2 and Part 4 with cyclometer registers and protective relays to B.S 142.

All relays shall be a heavy-duty pattern, unaffected by external vibration and capable of operation in any position. Meter panels shall be hinged to provide ready access to connections and small wiring shall be enclosed in flexible plastic conduit. All meters and relays shall be completely insulated, and potential circuits shall be suitably fused or MCB.

5.0 INDICATING LAMP

Indicating lamps shall be adequately ventilated and easily removed or replaced from the front of the panel without the used of extractors. Lamps shall be clearand fit into accepted standard form of lamp holder.

The colour in coloured lamp glasses shall be inn glass and not an applied coating. Transparent synthetic materials may, however, be used instead of glass, nomaterial flow or discoloration takes place due to head from lamps provided.

6.0 CABLE ENTRY ARRANGEMENT

The main Distribution Boards shall be located over the floor on channels as shown on the Drawings Specification and shall be designed for cables entering and leaving the Distribution Board vertically from below unless otherwise stated on the Drawings Specification. The cable entry must be fully enclosed to avoid anyexcess from the bottom of main Distribution Board.

7.0 MAIN DISTRIBUTION BOARDS EARTHING

A suitable earthing terminal shall be provided on the frame of each Distribution Board for connection of copper tapes to the earthing system.

8.0 DISTRIBUTION BOARDS

Each Distribution Boards shall comply with B.S 214 and shall be fabricated from sheet steel, boundaries and finished stove enamel outside to a colour selected by the Engineer and matt white inside complete with hinged cover, the free end of which shall be secured by captive knurled thumb screw, gaskets, car type door handle lock, solid type concealed hinged, removable un-drilled end plates fitted top, bottom and external wall fixing lugs arranged to provide a small air gap between back of board and the wall.

Distribution Boards shall so far as possibly utilise a frame of standard dimension in depth, length and heights and the front shall present a flush, clean appearance.

Each Distribution Boards shall be completed with neutral bar having two pinch grip screw terminal connections for each single-phase way on the board and for conductors larger than 6mm² cross sectional area cable sockets or four screw cable clamp pattern terminations shall be provided. A similar arrangement shall apply for earthing terminals.

Distribution Boards shall be fixed 1800mm above floor level unless they from part of a Main Distribution Boards unless otherwise specified.

All control and other wiring shall be carried out, fixed in a neat and systematic manner, terminal at low voltage shall be segregated and clearly labelled.

Labels should be provided inside of covers indicating circuit way, fuse rating, brief description of location of the protected, etc.



9.0 SERVICES CONTACTORS

Contactor shall comply with B.S 775 with un-interrupted ratings (U.R), mechanical duty class 11 and making breaking category A4.

Contacts shall be renewable butt type, solid copper hard silver faced, fully shrouded main and auxiliary contacts and the design shall be such as to ensure effective freedom from contact bounce and sticking of the fixed and movingportions of the magnet assembly. Auxiliary contacts shall be provided as required by the Specification.

Contactor coils shall be fully tropicalised and wounded for the continuous operation at phase voltage with class 'E' insulation to B.S 2613.

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

10.0 <u>LABELS</u>

All panel doors shall be appropriately labelled to indicate the service. Labels shall also be provided to identify all items of equipment, circuits, cable, and where applicable current rating of fuses and setting of relays. Labels on the exterior of equipment shall be clear Perspex, reserved engraved, filled flush with black (or red as suitable) filling and the back painted the same colour as the equipment. Labels shall be attached by means of machine screws and nuts driven into drilled and tapped holes.

11.0 SAFETY ARRANGEMENT AND WARNING LABELS

All terminals, connections, relays, and other component may be alive when the front access doors are open shall be adequately screened and suitable warning labels shall be fitted to eliminate the possibility of any accidents. Component within the cubicles shall also be adequately labelled to facilitate testing.

Isolators or links shall be clearly labelled, installed in such positions, and connected so that maintenance can be carried out with the maximum safety. This particularly applies to control circuits fed from a remote position. Where it is necessary to maintain certain components in a cubicle in a live condition when theisolator is in the 'OFF' position, such apparatus shall be so screened and labelled as to eliminate the possibility of any accident.

A black rubber mate of 13mm, 1250mm wide and length equal to the length of each switchboard shall be supplied and installed under this Sub-Contract.

12.0 CABLE TERMINATION

Cable boxes, glands, gland plates and all other apparatus necessary to terminate all incoming and outgoing cables shall be included under this contract.



13.0 CABLING

All cabling for sub-mains distribution comprising respective types of cables, cabling to electrical equipment, control panels, sub-circuit wiring to lighting and power points and all necessary materials to form a complete installation shall be provided, installed, and connected as detailed in this Specification and as shown on the Drawings Specification.

14.0 <u>PVC CABLES</u>

PVC insulated cables shall comprise high conductivity stranded copper conductors of the sizes shown on the Drawings Specification to B.S 3360, PVC insulated to B.S 2004 and 2746 as applicable.

All flexible cables shall be of the minimum 23/.0076 flexible cords and the cables shall be coloured throughout the length in the insulated for phase, earth, and neutral identification.

Insolent colours shall be in accordance with table B.5 of the 16th Edition of the IEE Regulations for the Electrical Equipment of Buildings.

15.0 INSTALLATION OF PVC CABLES

The installation of the wiring system shall comply with the relevant requirements of the current edition of the Regulation for Electrical Equipment of Buildings issued by the Institution of Electrical Engineers and the British Standard Code of Practice for Electrical Wiring System (General) C.P 321.10.

All cables shall be terminated in cable sockets of suitable size to the cableemployed without excessive clearance. Cable socket shall be manufactured to B.S 91 and shall be brass casting, machined on the lug faces and suitable for the conductor size.

The spacing of cable supported shall be determined by the size of cable and in the case of cables of less than 25mm in overall diameter. The spacing shall not exceed 750mm.

All cables shall be supported in such a manner as to ensure that they do not sag after erection and their means of support shall be to the approval of the Engineer. Fixing shall be made with rawl-bolts, rag bolts or other patent fixing device of design approved by the Engineer.



16.0 ERECTION OF CABLES

Rates for erection of cables shall include the following above: -

- (a) All measuring, marking off and cutting length.
- (b) Supply, delivery and erection of all racks, clamps, saddles, trays, supports, bushes, and other items for erection and fixing of cables, including excavation where necessary.
- (c) Design, provision, erection, and painting of all additional supporting steelwork.
- (d) Sheath bonding in the case of single core cables including supply of necessary materials.
- (e) Forming of necessary bends, surface fixing at intervals as specified herein.
- (f) Sealing of cables in pipes or ducts.
- (g) Tests at site on completion including continuity, phasing out and insulation resistance between the conductors and sheath employing a 1000Volt Insulation Tester.

A record shall be kept of all joints and terminations made and shall include the name of the jointer and mate, the date of making, the date of testing and the weather conditions by the Contractor are to be supplied to the Engineer.

17.0 CABLE TESTS DURING LAYING

Where required by the Specification and as required from time by the Engineer, of the cable installation to voltage tests to prove the soundness of the conductor insulation and the soundness of the protective servings.

18.0 CABLE DRUMS

Cables shall be supplied in maximum drum length. No drum shall contain more than one length of cable.

19.0 <u>CONDUIT</u>

All conduits, fittings and accessories shall be galvanised and shall comply with B.S 31. Conduit shall be screw and welded Class 'B' and fittings shall be manufactured from steel or malleable cast iron. Conduits shall be concealed in walls and floor or run on the Drawings Specification.

20.0 INSTALLATION OF CONDUITS

Concealed conduits shall be fixed securely to prevent movement before casting of floor slabs, floating of plaster and casting of columns and beam.

All conduit and accessories shall be painted with one coating of red lead wherever the exposed galvanised surface has been cut or otherwise damaged including exposed threads and connections after erection. The whole of the conduit system shall be electrically continuous and mechanically sounded throughout and in



SPESIFIKASI TEKNIKAL (SEKSYEN 4)

addition in a separated earth continuity conductor shall be provided in all metal conduits. Further all conduits shall be earthed at the terminations.

Flexible metal conduit shall be used as the sole means of providing earth continuity and a separate earth continuity conductor complying with the appropriate requirements of the current Edition of I.E.E. Regulations for the Electrical Equipment of Buildings shall be provided for every part of a system formed by such conduit.

Conduits sizes shall be selected carefully for the number and sizes of cables and shall be arranged with an adequate number of boxes, accessible for the life of the installation so as to allow easy draw in or draw out of any one or all of the cables at anytime and shall not in any circumstances be less than 20mm. The number of cables drawn in shall not be greater than the appropriated number permitted in Table B5 of the current Edition of the I.E.E. Regulations for the Electrical Equipment of Buildings.

Cables for power and lighting circuits for low voltage system shall not be drawn into the same conduit. Lighting and power final sub-circuits shall be run in separate conduits.

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

The inside surface of all conduits and fitting used in therewith shall be smooth and free from signs of corrosion, burrs and all other defects. The ends of conduits shall be cut square, filled and reamer out after screwing. Takes care to ensure removal of cutting oil of swarm.

All corners shall be turned by easy bends or sets made cold on bending machines without deformation of the section or opening of beams and the inner radius of any bends shall not be less than 3 times the outside diameter of the conduit. Where it is impracticable to set the conduit, normal or half normal bends may be permitted but no circumstances shall solid or inspection elbows or tees pieces be used.

Holes in sheet metals shall be made with a suitable cutter and the Engineer should approve the tools before any bended are made and holes are cut.

All switches, socket outlets, accessories and other fittings shall be mounted in conduit boxes of suitable size and where for reasons of construction the box face is not reasonably flush to the finished surface of wall or ceiling purpose made extension rings shall be employed of the same construction and diameter as the box.

When conduits terminate at a metal base, distribution board, adaptable box, motor starter, terminal box or other fitting to provided with screwed E.T conduit entry a socket shall be screwed to the end of conduit and a smooth bore male brass bush screwed into the socket entered from inside the metal case which shall be drilled with a clearance hole for bush. The end of the conduit should butt together with the bush after has been pulled up tightly against inside of the case.

Where looping pattern boxes are used for lighting points, outlets etc. they shall be circular pattern with an appropriate number of back outlets. Conduits shall be terminated in these boxes by means of screw sockets and male bushes asspecified above. Ceiling boxes shall be standard circular deep pattern with long internally taped spouts.

Conduits termination to apparatus subject vibration or movement shall be made off in flexible metallic conduit which shall be heavy gauge, weatherproof type P.V.C sheathed overall and sweated into heavy brass adaptors with a male thread for connection to the rigid conduit system at each end. Reliance shall not be placed upon the flexible tubing as an earth terminal at one end and isolating switch earth terminal at the other end.

All boxes shall be fixed securely to walls, ceilings etc. by means of at least two screws correctly spaced and all conduit runs shall be straight and run either horizontally or vertically; diagonal runs will not permitted.

On straight runs the conduit shall be supported by saddles at intervals not exceeding one (1) metre in addition to support provided by any structure, box or fittings included in the run except that for 38mm conduit and larger, saddles may be spaced at intervals of not more than 1.22mm apart.

Bends in all cases must be supported on each side by two saddles as near thereto as possible and a draw in box shall be provided after two bends and after not more than 9 metre of straight run. All conduits run shall be planed by the Contractor and shall be indicated or marked out on site for the Engineer's approval before installation commenced.

Where conduits cross expansion joints, they should be installed so as not resist relative movement of the sections. A suitable crossing shall comprise conduits telescoped one inside the other with the free end or ends projecting immediately to one side of the crossing. Earth bonding of the telescoped end, which shall be suitably bushed, shall be effect inside the box to maintain earth continuity of the system.

Immediately on completion or erection of any conduit during building construction all exposed switch, socket, conduit risers shall be plugged effectively against the ingress of water and dirt particularly where concrete will be poured. Such seals shall be maintained in good order for such time if necessary to complete wiringand connection of fittings and switches. The conduit system shall be bushed at outlets to prevent abrasion of cables.

On completion of the installation, all exposed conduits shall be painted with two coats, the quality approved sunrise orange paint.

21.0 CABLE TRUNKING

The trunking shall be completed as required with bolted flanged outlets, blank ends, reducers, outlet bushes, bends, tees, sleeve couplings, intersection four

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way boxes and fittings adaptors. Bridge pieces to act as cable retainers shall be readily removable, but positive fixing by machine screws for the cover shall be provided.

The inner radius of any bend shall not be less than 2.5 times of the minor dimension of rectangular section trunking.

A 25mm x 3.2mm copper tape shall run throughout the whole length of trunking to provide earth continuity.

Trunking shall be supported adequately by suitable bracket fabricated from galvanised mild steel flat.

22.0 CABLE TRAYS

Cable trays shall be perforated hot dipped galvanised mild steel, not less than 16 s.w.g with sunrise orange colour PVC overcoat.

Trays shall be of appropriate width but not less than 9 inches wide, with an up turned flange on both sides with 20mm long radius bends, tees and foxing brackets fabricated from galvanised mild steel flat.

Trays shall be employed in order situations at the discretion of the Contractor in order to carry multiple runs of cable and multi-core cables as and alternative to fixing by saddles to the structure.

If trunking or cable trays are used in lieu of conduits, carefully be taken to ensure that all trunking, cable trays and cable run in areas known to contain corrosive vapours, painted with an approved type of anti-corrosive paint that shall be deemed that the cost of such painting has been included in the Contract.

23.0 FIRE RESISTING BARRIERS

Fire resisting barriers of asbestos or other approved material at slots, openings in floors, openings in concrete beams and walls used for the distribution system, also provided under this Contract.

24.0 EARTHING SYSTEM

A complete earthing system comprising cables, conduit, copper tape, electrodes and earth connections necessary to bond effectively and permanently to earth all non-current metal parts, cable sheaths and earth bars of the electrical system shall be supplied, erected and connected.



25.0 EARTHING POINTS

Each earthing point shall comprise of an extensible type 16mm diameter hard drawn, solid copper or steel cored copper rod with internal screw and socket joint, hardened steel tip, driving head and connector clamp.

Where two or more electrodes are driven to form a group, the heads or the electrodes in the group shall bonded to each other by means of 25mm x 3.2mm copper tape, laid at 635mm underground.

Where ground conditions are favourable for the use of the rod in parallel to form a group, the distance between the rods should be at least equal to twice the driven length.

All joints in exposed sections shall be protected against corrosion and the ingress of moisture by application of two coats of an approved anti-corrosion paint.

The necessary number of earths point and inter connection to obtain a resistance as required by Clause D. 22 of the latest Edition of the I.E.E Regulations for the Electrical Equipment of Buildings shall be provided under this Contract.

Earth chamber and chequer plate covers shall be provided under this Contract the Contract shall include for the driving of all earth electrodes, connecting to the main earth bar and testing to the satisfaction of the Engineer with insulation tester provided by the Contractor. The earthing system includes for measuring, marking off, cutting, fitting and erection, supply of necessary clamps and rag bolts complete with all fixing screws and rivets for fixings and jointing of the copper tapeincluding the necessary lugs, consumable stores, and use of bolts jointer.

26.0 <u>COMMISSIONING TEST AND SITE</u>

The complete installation or any part thereof shall be tested, both before and after being connected to the requirements of the Engineer.

The Contractor shall be responsible for all electrical tests at the site and shall be represented by a capable the Competent Person during the whole of test period required.

All materials and equipment supplied or erected under this Contract which fail the tests shall be replaced or rectified at once by the Contractor without cost to the Purchaser and the test shall be repeated.

All tests shall be conducted in the presence of, and to the satisfaction of the Engineer. The Contractor shall supply all necessary instruments, apparatus connections, skilled and un-skilled labour required for the tests to the satisfaction of the Engineer.

The Contractor shall make accurate records of all tests and shall furnish test certificates and schedule of the results in an approved form. Four copies such schedules and of each test certificate will be required.

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The minimum of site tests to be carried out on each completed section of the electrical installation shall be as follows: -

- i) Soil resistivity tests, electrode, and earthing system tests.
- ii) Insulation resistance tests.
- iii) Continuity tests.
- iv) Oil tests.
- v) Test to prove correct operating of interlock, tripping and closing circuits, indication etc.
- vi) Vector group, phasing and synchronising tests.
- vii) Operation of all protective gear circuit by primary injection and system fault tests to sensitivity and stability checking.
- viii) Protection gear timing tests as may be necessary.
- ix) Rotational test on all motors.
- x) Polarity tests.
- xi) Ring circuit test.
- xii) High Pressure Test

27.0 RELIABILITY TESTS

When the commissioning tests have been concluded successfully and the Contractor has notified the Engineer, the installation shall be required to operate within the specified limits of the rating either continuously or intermittently as may be convenient without failure of any kind for a period of one-month calendars before Taking Over Certificate will be issued.

The installation will be under the charge of the Purchasers maintenance staff during this period, but the Contractor may have his representative present.

Should any failure occur due to, or arising from faulty equipment, materials, or workmanship but not otherwise sufficient to prevent the commercial use of the installation, the reliability test period of one calendar month shall be recommence after the Contractor has remedial the cause of failure to the satisfaction of the Engineer.

The ones of proving that any failure is due to any other cause shall rest with the Contractor.



28.0 POWER FACTOR

The capacitor used should be of the oil impregnated and oil cooled paper dielectric type to B.S 1650. The capacitor should always run cool, and the temperature rise should not be more than 15°C above ambient temperature. Therefore, the capacitors should always install in a well ventilation locations and of the tropically rated type of capacitors. The capacitor supplied for this contract should be of total capacity as indicated in drawing on 3 phase operation.

Automatic control equipment capacitors

The control equipment should be of the integral multi-stage automatic control relay type as indicated on the drawing. The automatic control equipment of power factor correction capacitors shall ensure that the amount of correction in circuit at any time is commensurate with actual requirements. Thai is capacitors or sections of capacitors are switched in or out of circuit accordingly. The main methods of automatically controlling capacitor should be of VAr sensitive (or reactive VA)relay type.

Capacitor Tolerance

The actual reactive output of capacitors does not differ from the rated value by more than 10% + 10% for capacitors of 1kVar and above. For capacitors of less the 1kVar output the tolerance is within $\pm 20\%$ for single phase operation.

Permissive Overloads:

a)	Voltage	:	The maximum rms. voltage applied should not exceed 110% of the rated rms. Voltage.
b)	Current	:	The increase in rms. Current of capacitor above the current that would flow at rated sinusoidal voltage. and rated frequency does not exceed up to 660volts.
c)	Reactive output	:	Should not exceed 30% above the reactive output of the capacitor, including any due to the flow of the harmonic current.

Electrical Tests for Capacitors

Routing tests: These are carried out in following order:

- a) Output and or capacitance.
- b) Over-voltage test of 2.15 times nominal rated voltage, for 10 seconds between terminals.
- c) An appropriate voltage test between terminals and case, as in Table 5 of B.S 1650: 1963.
- d) Insulation resistance test between terminals and container.
- e) Discharge device test.

Type tests:

These tests prove the design of the capacitor and demonstrate its compliance with appropriate specifications: -

- a) Dielectric loss angle.
- b) Capacitor losses.
- c) Stability test.
- d) Impulse voltage test between terminals, and case.
- e) Power factor temperature tests.
- f) Capacitance temperature tests.

29.0 EARTHING

All units shall be efficiently bonded, connected and labelled to an earth bar/ chamber.

Each earth bar/ chamber shall be connected and labelled by adequate size of bar located in Main Switchboard.

30.0 <u>WIRING</u>

All wiring shall be arranged in a regular manner with bends set at 90°C and securely held in position with suitable clips and where convenient shall be installed in the uprights an, or back-stays, insulating bushes being used where necessary.

Meter wiring of the switchboard shall be carried out in PVC insulated flameproof switchboard cable of size not less than 1.5mm². All meter wiring shall be similar colours to those of the respective busbars, etc., to which connections. The cable termination shall be made with approved type lugs.

Wiring shall be carried out in such manner as to make circuits and connections easily traceable. Cable marking ferrules or similar shall be used at each termination. Terminations shall be designed an approved manner.

All terminals shall be fitted with brass washers and securely fixed with lock nuts.



31.0 **IDENTIFICATION**

Colours and symbols used for busbars connection and wiring shall comply with B.S 158.

Each circuit, equipment and instrument of the switchboard shall be clearly identified and designed according functional. The designation labels shall beengraved in lettering not less than 1 inch high. The names shall correspond with those given on the appropriate drawing.

Small rating plates giving serial number and data in accordance with the relevant British Standard, are required on each item supplied, namely, circuit breakers, MCCB, switch fuses, isolators, current transformer, etc.

32.0 <u>TEST</u>

32.1 **Type Tests:**

In addition to details of type tests for making and breaking capacity, as required under this Clause of the Specification, the Contractor shall submit certified details of type tests for mechanical endurance and temperature rise for each switching equipment included in the contract, such tests to be carried out in accordance with the requirements of their relevant British Standard Specifications.



32.2 Routing Tests:

The Contractor shall submit certified test sheets showing details of all routine tests applied, during manufacturer, to the switchboards and the individual components thereof. Without in any way effecting the generality of this Clause such tests shall include the following Clauses reliant to switchgear:

- a) Demonstration that all equipment installed, and all wiring connected, so that board functions as required.
- b) Test of accuracy of all measuring instruments.
- c) Insulation resistance across breakers in all circuit breaker, with the breaker open and with all equipment installed.
- d) Insulation resistance between phase, between each phase and neutral, and between each phase, neutral and earth with circuit breakers closed.
- e) Power frequency voltage tests, in accordance with Clause 63 of B.S 116: 1952.

Copies of test sheets, showing the results of all tests carried out in accordance with this section of the Specification shall be submitted in duplicate to the Consulting Engineer.



11KV HIGH VOLTAGE CABLE

1.0 <u>11KV XLPE/SWA/PVC COPPER CABLES</u>

This specification applies to the design manufacture, inspection, testing, delivery to site, installation, testing and commissioning of 185mm², 11KV, 3Core, XLPE/SWA/PVC copper cables detailed hereinafter.

2.0 SYSTEM AND FAULT LEVELS

The cables are designed for continuous operation under the following conditions: -

NO.	DESCRIPTION	11KV CABLE
a.	Rated Frequency	50Hz, 3-Phase
b.	Nominal Voltage r.m.s	11KV
C.	Maximum Voltage r.m.s	12.1KV
d.	Impulse Withstand Level Peak	75KV
e.	Maximum Symmetrical Fault Level	20KA
f.	Rated Short Time Current (3 sec.)	20KA

The 11KV system neutrals are effectively earthed, i.e. the rated voltage to earth (Eo) rated line voltage between conductors (E) ratio is 6.35/11KV as defined in B.S 6480.

3.0 DESIGN OF 11KV. 3CORE. XLPE/SWA/PVC CABLES:

3.1 <u>General</u>

This section of the Specification applies to single core and three cores' cables with an extruded solid dielectric. They shall be generally manufactured in accordance with the International Electro-Technical Commissioning Publication 502. B.S. 5468 - 1977, IPCEA, S-66 - 524 where applicable.



3.2 <u>Conductors</u>

Conductors shall consist of stranded annealed copper or aluminium wires. They shall comply with B.S. 6360-1981, B.S. 6791-1969, or IEC

Publication 228 or IPCEA S-66-524, non-circular conductors shall be prespiralled and compacted.

3.3 Conductor Shield

The conductor shield shall consist of an extruded semi-conducting thermosetting compound (non-metallic nature) applied over the conductor with two layers of semi-conducting tapes applied lapped between the conductor and the extruded conductor shield.

The conductor shield shall be of a material compatible with the conductor metal and shall be uniformly and firmly bonded to the overlying insulation and shall be free stripping from the conductor.

3.4 Insulation

The insulation shall be of high quality, heat, moisture, ozone, and coronaresistant cross-linked polyethylene compound free from porosityvisible to the eye with not more than 5 times magnification. It shall be suitable for operation in wet or dry locations and complying with the Physical and Ageing requirements of paragraph 3.7 of IPCEA S-66-524.

The dielectric constant and power factor of the insulation when measured at a conductor temperature of 90°C and rated voltage to ground shall not exceed 2.5 and 0.1 percent respectively.

Average thickness	:	not less than 3.6 mm (11kV Cables)
Minimum thickness of insulation at any point	:	not less than 3.4 mm (11 kV Cables)



3.5 Insulation Shield

The insulation shield shall consist of a semi-conducting cross linked polyethylene compound simultaneously extruded onto the cable with the conductor shield and insulation. It shall be firmly and totally bonded to the insulation by the virtue of the simultaneous cross linking of the shield and underlying insulation.

The shield shall be easily removable by application of controlled heat, for splicing and terminating without damage to the insulation.

3.6 Metallic Shield

The metallic shield may be of any of the following form and be capable of carrying fault current for 3 seconds: -

a. The concentric round wire shield shall consist of 14, 12 or 10 AWG, solid for 11kV cable, uncoated copper wires helically.

Applied with a length of lay of approximately 10 times the calculated diameter over the wires. A suitable separator tape shall be applied over the concentric wires.

- b. The concentric flat wire shield shall consist of uncoated annealed flat copper wires with rounded corners having a thickness of not less than 0.5mm and a width of not greater than 13.0 mm, helically applied with a lay of approximately 5 to 7 times the calculated diameter over the wires. The number, width and thickness of the flat wires shall be such as to satisfy thefault current requirements. A suitable separator tape shall be applied over the concentric flat copper wires.
- c. An uncoated, annealed copper strip of suitable thickness and of such width that after corrugation the edges shall overlap not less than 13.0 mm when the strips longitudinally formed singly over the shielded core. The corrugations shall be at right angles to the axis of the cable and shall register at the overlap. A suitable tape shall be applied longitudinally over the shield overlap.

The tenderer shall supply calculations to show that the design offered is entirely suitable to carry the designed fault current.

3.7 <u>Armouring</u>

The armouring shall consist of aluminium wire for single core cable and galvanised steel wire for three core cables of suitable diameter.



3.8 Outer Covering

The outer protective covering shall be extruded continuous black PVC sheath over the metallic and separator tape. The PVC compound shall be type TMI in accordance with B.S 6746/1976 or equivalent IEC Standard. As a protection against termite attach, the outer coverings shall preferably contain an evenly dispersed mixture of aldrin and dieldrin in the ratio of 0.25 percent aldrin and 0.25 percent dieldrin by weight of PVC. The outer surface of the PVC shall have a hard baked- on carbon black conducting layer to facilitate periodic testing of the integrity of the anti-corrosion PVC sheath.

3.9 Manufacture's Identification

A marker or identifying tape shall be placed on the cable. It shall show the rated voltage, conductor size, the year in which the cable was manufactured, the name of the manufacturer, and consecutive series. number for phase identification purposes at intervals of not more than 300mm.

3.10 Sealing and Drumming

Immediately after the Works Tests, both ends of each cable's length shall be sealed against the ingress of moisture, dirt and insects and the end projecting from the drum shall be adequately protected against mechanical damage during handling and transit of this specification. Each drum shall bear a distinguishing number either branded with hot iron or neatly chiselled on the outside of one flange.

Particulars of the cable, i.e. voltage, length, conductor size, number of cores, gross and net weights, etc. are to be clearly shown on one flange of the drum. An arrow shall conspicuously indicate the direction of rolling.

4.0 JOINTS. TERMINATIONS & ACCESSORIES FOR XLPE CABLE:

4.1 Joint Accessories

The design of straight-through joints, termination, etc. to have been subjected to type approval tests. The impulse voltage withstand level of these accessories shall not be less than 90KV peak (11KV cable).

All jointing accessories for standard copper conductor may be designed for soldered ferrules, indentation or compression ferrules. Stranded aluminium conductors shall be jointed with indentation ferrules or by a welding process. Conductor temperature during welding shall be monitored by means of a thermocouple. The temperature shall not exceed the value stated in the Schedule of Particulars and guarantees. Compression type ferrules are not approved for stranded aluminium conductors.

4.2 Bonding

The metallic shield should be solidly bonded at both ends.

4.3 <u>Copper Earthing Connectors</u>

Bonding leads shall be of sufficient cross-sectional area to carry the maximum imposed short circuit level, dimension of which shall be submitted with the Tender.

4.4 Jointing Instructions

All joints, connection and termination must be done by a competent person holding a Cable Jointer certificate (with Restriction of 11 KV

XLPE Cables) from Suruhanjaya Tenaga and shall produce the certificate at any time required by the Engineer. Test certificates for all joints, connection and termination must be submitted to the Engineer after the task is carried out. Copies of all instructions to be issued to the cable joint accessory included under this Sub-Section are to be submitted to the Consulting Engineer for approval before work is commenced at site. Further copies as may be required by the Consulting Engineer are to be supplied at the completion of Contract.

4.5 <u>Cable Lenghts</u>

The Purchaser shall however state the drum length of the cable after the award of the tender. The ends of the cable shall be sealed by an approved method and firmly secured to prevent movement. Cable drums shall comply with the requirements of Clause 1.27 of this specification.

4.6 Joints & Termination

Jointing or splicing and termination accessories of approved types including termination box and entirely suitable for the optical cable shall be supplied under this Tender. Full technical details are to be included in the Tender.



LOW VOLTAGE SWITCHBOARD AND DISTRIBUTION BOARD

1.0 <u>GENERAL</u>

All low voltage switchboards, distribution boards and starter panel boards complete with the necessary items of equipment shall comply with this Specification and the Drawings Specification.

2.0 AIR CIRCUIT BREAKER

Air Circuit Breaker shall be of the motorized, break horizontal withdrawal pattern and shall complete with B.S 116 B.S 3659 as appropriate.

Air Circuit Breakers shall be provided with trip free mechanisms, mechanical "ON/ OFF" and "SPRINGS CHARGE/ SPRING FREE" indication.

Air Circuit Breaker shall be constructed, insulated, and protected to be capable of clearing any fault condition, which may occur in the electrical system without damage to the equipment or danger to personnel. The rating and symmetrical breaking capacities shall be as specified on the Drawings Specification and the Contractor will be required to re-submit evidence of appropriate certification of these ratings, as necessary. The Air Circuit Breaker shall have a rupturing capacity of not less than 31MVA at a service voltage of 415V at 50Hz in accordance with the above specifications certified by ASTA or other recognised testing authority.

Interlocks shall be provided to ensure that: -

- (i) The circuit breaker cannot be plugged in, isolated or withdrawn while in "ON position.
- (ii) The circuit breaker cannot be closed until it is fully plugged in, or completely isolated.
- (iii) No cover can be removed unless the circuit breaker is in the fully isolated position.
- (iv) Mechanical and electrical interlock must be installed to avoid switching the bus coupler on live.

Facilities shall be provided for testing the circuit breaker operation in the isolated condition.

Contacts shall be of adequate rating to ensure carry continuously fully ratedwithout overheating, damage or deterioration and shall be individually spring loaded, hard silver plated, of the magnetically 'blown on' type so arranged that electro-magnetic forces arising under short circuit conditions do not tend to reducecontacts shall be provided with renewable are resisting alloy tips arranged to closebefore and open after the main contact. Units shall be completed with bolted type neutral link with provision of links for bolted transformer neutral.



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earthing and connection, fixed busbar and feeder isolating contact, arc chutes with baffle and splitter plates and efficient electromagnetic blow out contactor, direct current shunt trip coil energized through relay contacts 'Close' and 'Trip' push buttons.

3.0 **MOULDED CASE CIRCUIT BREAKER**

Moulded Case Circuit Breakers (MCCB) with overload and short circuit protection scheme shall be provided to form part of a switchboard or enclosed as individual shown on Drawings Specification.

The unit shall incorporate arc extinguishers and shall be provided with 'toggle' operating mechanism of the quick make, quick break type and the breaker shall be trip free. The MCCB shall have "ON/ OFF" indications and the operating handle shall also indicate the trip "TRIP" position halfway between the "ON" and "OFF" positions. After a trip breaker shall be reset table by moving to the "OFF" position before switching "ON".

In the case of MCCB which shall from part of a switchboard panel the cable terminals shall be suitable for rear terminations and the assembly shall be such that no live are accessible when the front panel of the cubicle is opened.

4.0 **STARTERS**

All starters shall be of 1 phase 240volt or 3 phase 415volt, 50Hz cubicle automatic contactor type motor starters manufactured to B.S 587 and B.S 775 each incorporating shroud flush mounting start/ stop buttons, indirect type release, magnetic type overload protection complete with adjustable time delay hand reset overload trips and separate single phasing relays.

All starters shall be provided with 'on-load' integral isolating switch mechanically interlocked with access door, HRC back up fuses to B.S 88 auxiliary contacts, motor heater control contacts, red pilot lamps to indicate motor 'running' control circuit fuses and anti-condensation heater controls.

Starters for motors of 7.5HP rating and above shall also be provided with a temperature sensitive device in order that the motor shall be isolated should and excessive temperature in the motor windings be detected by the embedded element.

All starters shall preferably be supplied by one manufacturer and shall be ofrobust construction suitable for minimum maintenance.

All motor contactors and their associated apparatus shall be of robust construction suitable for minimum maintenance.

Contactors shall be mounted in ventilated metal cubicle. Unless otherwise approved the metal surface of the cubicle wall adjacent to the contactor shall protected by fireproof insulating material. The cubicles shall be completed with all.



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locks, busbars, internal wiring, terminal board and accessories. All secondary wiring to be arranged and protected as to prevent its being damaged by arcing.

All motors contactors and their associated apparatus shall be capable of operating without overheating for a period of five minutes if the supply voltage falls for the period to 75% of the normal value at normal periodicity.

All starter cubicles shall be fitted with heaters to maintain the temperature within the cubicle above dew point. Thermostatically controlled heaters shall generally be in the bottom of the cubicle, with the thermostat at the top.

5.0 START/ STOP

All start/ stop buttons shall be of the shrouded insulated and weatherproof.

6.0 UNIT D.O.L STARTERS

Unit starters of the D.O.L type for motors of $1\frac{1}{2}$ HP and less (i.e. when they do not form part of a starter panel).

NOT require the motor heater control contact, red pilot lamps an anticondensation heater control as called in clause 5.4 of this section.

7.0 NO VOLT RELEASE & EARTH LEAKAGE PROTECTION

All starters shall be provided with no volt release in accordance with Suruhanjaya Tenaga.

In Addition, all motors of 30HP and above shall be provided with starters incorporating each leakage protection relay.

8.0 MECHANISM HANDLE

All distribution boards and MCCB's shall incorporate handle mechanism with combined door locking and breaker operation. Safety padlock with 3 keys for each distribution boards shall provide.

9.0 <u>SHUNT TRIP</u>

Where indicated in the drawings, shunt trip devices in distribution boards shall be provided. These facilities tripping of the main breaker in the board are on operation of the emergency remote push button stations.



10.0 EARTH LEAKAGE CIRCUIT BREAKER (ELCB)

Where earth leakage circuit breakers are specified, the following applies.

To provide earth leakage protection, current operated earth leakage circuit breakers shall be supplied and installed where indicated on the drawings. The ELCB shall be capable of three protective functions. These are protection against earth leakage, over current and short circuit protection in a single unit compactly built in a moulded case.

Where is not possible to have these protection features incorporated into a single unit, separate MCB or MCCB or adequate size shall be used in conjunction with the ELCB for short circuit and over current protection.

The earth leakage tripping devices use either a holding magnet or 'solid state' amplifier or earth fault. All ELCB shall be provided with test push button for checking of tripping device operation. Selection of ELCB shall take into consideration the protective co-ordination for selective interruption in respect of operating time and sensitivity. The characteristics of the ELCB are as follows :-

Rated Current	43A	63A
Rated Voltage	240V	240V
Rated sensitivity Current (mA)	100	100
Rated non-tripping. Current (mA)	15	15
Tripping time (sec.)	Below 1sec.	Below 1sec.
Interrupting Capacity	1.5	5.0

a) Two (2) Poles - 240Volt A.C

b) 3 and 4 Poles - 415V0lt A.C

Rated 40A Current	63A	100A
Rated Voltage	415V	415V
Rated Sensitivity Current (mA)	100	100
Rated non-tripping. Current (mA)	15	50
Tripping Time (sec.)	Below 1sec.	Below 1sec.
Interruption Capacity	2.5	5

11.0 CURRENT TRANSFORMER

- **11.1** Current Transformer (CT's) supplied and fixed by the Contractor in switchboard or control panels for the operation of ammeters, earth fault & over current relays for tripping devices of circuit breakers, power factor indicators, KWH meters etc. shall be of ring type with appropriate current ratios, burdens and class as indicated on the Schematic Diagrams.
- **11.2** All current transformers shall be of correct dimensions for fixing in busbars and shall be manufactured to B.S 3938.

12.0 MEASURING INSTRUMENT

Wherever instrument for measuring or indication are required to be incorporated in switchboards, control panels or distribution boards for the contract works, the Contractor shall provide such instruments confirming to the following requirements:-

- **12.1** All instruments (except for KWH meters) shall be provided with square dials and be flush mounted in their respective switchboard and control panels.
- **12.2** The instrument shall be manufactured to the relevant B.S or other Standard approved by Suruhanjaya Tenaga for the main LV Switchboard and he emergency switchboard, the instruments shall be fitted with 144mm x 144mm dial frames. In all other control boards and switchboards, dial frames of instruments mounted thereon shall be 96mm x 96mm size.



12.3 Voltmeter

Each voltmeter shall be of M.I.S.C type, be of suitable range to suit the circuit concerned and of a high degree of accuracy. The voltmeter shall be connected in circuit with a seven (7), position selector switch and protective cut-outs fitted with miniature circuit breakers (MCB).

12.4 Ammeters

Every ammeter shall be of the M.I.S.C type, of suitable range to suit the current rating of the circuit means operate on through current transformers. It shall have a high degree of accuracy and be connected to three (3) busbar-connected current transformers of the correct ratios, burden and class as stated on the relevant Schematic Diagram. The ammeter shall also be connected in circuit with a four (4) position, selector switch.

12.5 **Power Factor Indicators**

Each power factor indicator shall be of M.I.S.C and be suitable for measurement of 3-phase, 4 wire, un-balanced loads through current transformer (for the voltage coil circuit protection, HRC fuse-links shall be used). The indicator shall be scaled to read from 0.5 capacitive to 1 and from 1 to 0.5 inductive circuits.



TIME SWITCHES 13.0

Where time switched are required in the Contract works for automatic timecontrolled operation of lighting and other circuits, the Contractor shall provide and fix such switch in switchboards or control panels, or distribution boards (wherever fix such switchboards or control panels, or distribution boards) as indicated in the Schematic Diagram to confirm the following requirements: -

- 13.1 The time switches shall be of the synchronous type fitted with 36 hours spring reserve and 24 hours dial switches (switches to provide with adjustable levers for two "ON" and two "OFF" operation.
- 13.2 The switches shall be suitable for flush mounting on switchboard or control board panels and be suitable for operating on 240V, single phase and 50Hz AC supply.
- 13.3 The operating DP contacts of the time switches shall be rated at not less than 10A for operation in circuit with operating coils of switching contactors. Means shall be provided for test or manual operation of a time switching.



LIGHTNING PROTECTION SYSTEM

1.0 <u>GENERAL</u>

The lightning protection system for the building shall comply with the recommendations of the British Standard 6651:1990 "The Protection of Structures against Lightning". The system shall comprise: -

- (i) Air termination network
- (ii) Down conductors
- (iii) Earth termination network

2.0 AIR TERMINATION NETWORK:

The air termination network shall consist of roof conductors run along the ridges of pitched roofs and on the parapet walls or as shown in the drawings. Air termination shall be on a closed loop roof conductors and spaced at or within0.6m of roof edges or around the perimeter of lat roofs. The type of materials usedshall be as shown in the drawings and the maximum size unless otherwisespecified shall be copper tape of size 2.5mm x 3mm.

3.0 DOWN CONDUCTORS:

Down conductors shall be of the same size and type of materials as used for the air termination network. Down conductors shall be securely clamped to the roof conductors and to the earth electrodes at ground level.

Down conductors shall run outside of the building at positions shown in thedrawings and shall be secured at 2m intervals by specially made clips and saddles. Down conductors shall be as direct and vertical as possible. Right angle bends are not permissible. All bends must be made with a large bending radius aspossible.

A test joint shall be provided at 0.5m above ground level at every down conductor. PVC conduits from 2.4m downwards to ground shall protect all down conductors.

4.0 EARTH TERMINATION NETWORK:

The earth termination network shall comprise of an earth system electrode of 16mm diameter "Copper-weld" rods driven into the ground and 25mm x 3mm copper tapes shall be used for interconnection between earth electrodes. Down conductors shall be connected to the earth electrodes with brass clamps and taped with corrosion resistant tape. A re-in force concrete earth chamber completewith cover shall be used to protect each earth electrode and for future inspection and testing. The connection to the earth electrode must be clearly and permanently labelled **"SAFETY LIGHTNING CONNECTION – DO NOT REMOVE"**. Earth electrodes shall be installed as close as possible to the down conductors. Sufficient earth electrodes shall be installed such that the general earth resistance does not exceed 10ohms.

5.0 <u>JOINTS:</u>

Joints shall be avoided as far as possible. Where un-avoid as far as possible. Where un-avoidable, conductors shall overlap (not less than 75mm) and clamped at least at 2 points. For copper/ copper overlap, these must be tinned.

Joints of dissimilar metals shall be protected from moisture by an inert, tenacious material.

6.0 <u>BONDING</u>

All metallic parts of the building within 3m of the lightning protection network shall be bonded to the lightning protection network. Where dissimilar metals are bonded together steps shall be taken to avoid electrolytic action. Bonding to structural framework of building shall be provide



SPECIFICATION FOR LOW VOLTAGE UNDERGROUND CABLE

1.0 GENERAL

This section of the specification described and specification requirements for the supply, delivery, installation, testing, commissioning, handing over in approved working order and maintenance during the defect liability period of the underground cablings works in accordance with the specification, supplementary notes, bill of Quantities, conditions of contracts, drawings etc.

2.0 TYPES OF CABLE

This specification shall cover the following types of cables.

- a) XLPE/SWA/PVC CABLE Cable shall be manufactured and tested in accordance to BS 5467 or IEC 60502 and shall have high conductivity plain copper stranded conductors, insulated with cross cross-linked polyethylene (XLPE), suitable for a voltage of 600/1000 V laid together and bedded extruded PVC and sheathed with PVC, armoured with galvanised steelwires and sheathed with PVC.
- b) XLPE/PVC CABLE Cable shall be manufactured and tested in accordance to BS 5467 or IEC 60502 and shall have high conductivity plain copper stranded conductors, insulated with cross-linked polyethylene (XLPE), suitable for a voltage of 600/1000 V laid together and bedded with extruded PVC and sheathed with PVC.
- c) PVC / SWA / PVC CABLE Cable shall be manufactured and tested in accordance with MS 274 or BS 6346 and shall have high conductivity plain copper stranded conductors insulated with PVC suitable for a voltage or 600 / 1000 V laid together and bedded with PVC, armoured with galvanised steel wires, and sheathed with PVC.

3.0 CABLE ROUTE

Cables routes shown in the drawings are for tendering purpose only. The electrical contractor shall, after consulting the S.O's representative, peg out the cable routes for the approval of the S.O's representative prior to excavation of the cable trenches. The program of work for excavation of cable trenches, laying of cables reinstatement of trenches etc shall be submitted to the S.O's representative for approval one week before the execution of the work.



4.0 LENGTH OF CABLE

The length of cables each indicated in the drawings and/or bill of quantities is for tendering purpose only. The electrical contractor shall ascertain the length of each cable required before ordering. Actual length of each cable installed shall be measured on site and the electrical contractorshall be paid according to the rate on the contract. However, the rates quoted shall include wastage due to cutting to length, termination etc.

5.0 **CABLE TRENCHES**

Unless otherwise specified, cable trenches shall be 750 mm deep. The trenches shall be sufficient width to enable provision of adequate spacing between cables but in any case, shall not be less than 450 mm wide.

Trenches shall be kept as straight as possible and shall have vertical sides which. shall be timbered where necessary so as to avoid subsidence and damage. The bottom of the trenches shall be firm and of smooth contour and any other objects likely to damage the cable sheathing shall be removed. The material excavated from the trenches shall be placed or removed so as to prevent nuisance or damage to adjacent areas or buildings.

The trenches excavation and filling in shall be so executed that all roads, walls, sewers, drains, pipe, cables, structures etc be reasonable secured against risk of subsidence damage.

Provision shall be made during excavation and until interim restoration has been completed, for reasonable access of persons and vehicles to the areas of buildings adjacent to the trenches.

The electrical contractors shall provide pumps and other appliances for the necessary pumping required for the disposal of water so as to prevent any risk of the cables and other materials to be laid in the trenches being detrimentally affected where necessary, bailing shall be provided.

Where trenches pass from a footway to a roadway or at other positions where a change of level is necessary, the bottom of the trench shall rise or fall gradually.



6.0 CABLE DUCTS

At road crossing, sewerage pipe crossing, water pipe crossing, paved area, concrete area and where specified by the S.O's representative, cables shall be protected by galvanised steel pipes buried to a depth of 900 mm below finished ground level. The pipes shall be heavy duty type, complying with BS 1387 and complete with screwed and socketed joints. Unless otherwise specified, the pipes shall be 150 mm in diameter. Where is necessary to cross drains, culverts or similar obstruction which is too deep for the cables to be buried below, galvanised steel pipes as specified above shall be provided. Thepipes shall be supported at each end in a concrete block and shall project through the blocks to the ground at a depth of at least 750 mm. All ducts shall be extended at least 600 mm beyond paved areas, concrete, drains, road crossing, pipe crossing etc.

Cables entering a building shall be protected by pitch fibre ducts of 150 mm diameter, complying with BS 410B, completed with bend pieces, buried to a depth of 900 mm, and encased with 75 mm of concrete all round. The ducts shall be installed with a gradient so as to drain away any water in the ducts. Allducts passing through walls should be effectively sealed and made watertight.

Unless otherwise approved by the S.O's representative , the number of cable installed in each ducts shall be that the space factor shall not be less than 60%. A drawn wire shall be provided for each duct.

Unless specified to be provided by others, the above galvanized steel pipes and / or pitch fiber ducts shall be provided by the electrical contractor whether they are shown in the drawings or not.

7.0 CABLE LAYING AND INSTALLATION

All cables shall be handled, laid and installed according to this specification, the IEE wiring regulation 16th edition, cable manufacturers recommendations and ERA reports by using proper installation equipment. All cables shall be supplied in complete length to suit the circuits they serve and no straight through joints shall be used. Straight through joints in the cable will only be permitted in very exceptional circumstances such as arising from unavoidable limitations in manufacturing length. If straight through joint or other approved joints is permitted by the superintending officer, the cost of suchjoints shall be borne by the electrical contractor. No joints in the cable will be allowed unless approved in writing by the S.O's representative.

The minimum bending radius of the cable shall be in accordance with the IEE wiring regulation 16th edition. Wherever cables are cut, the ends shall be immediately sealed in an approved manner unless it is intended to proceed with cables jointing or termination straight away. Unless otherwise permitted by the S.O's representative, no cable shall be laid and covered up in the absence of the S.O's representative.

8.1 CABLE LAID DIRECT IN GROUND

Before cable is laid, the trench shall be thoroughly inspected, and any debris and sharp objects shall be removed. The bottom of the trench shall be covered with a layer of 75 mm of clean sand. The cables shall then be laid on this bedding in an orderly manner without over-tapping and crossing each other. After laying the cables, a layer of 75 mm of clean sand shall cover the cables and carefully spread over the trench before placing, the cable protective covers.

The cable protective covers shall be of clay bricks. The bricks shall be new, well burnt and in complete pieces. They shall be laid lengthwise from end to end along the entire route of the underground cable if the table size more than 120 sq. mm. For cable size more than 120 sq. mm, more than one row of bricks shall be laid. Each cable shall be safely protected by these bricks and the cover shall have at least 25 mm overhang on each side of the cable.

The trench shall then be backfilled with earth and shall be consolidated after every 150 mm of backfilling using a mechanical rammer. An orange colored, multi-strand nylon rope of minimum 6 mm diameter shall be laid at a depth of 300 mm along the trench to identify the cable route. At every 10 meters interval, an extra 2 meters length of nylon rope shall be coiled and laid. The finished surface shall be left pround by 50 mm to allow for subsidence and the electrical contractors shall be responsible for the removable of any surplus to a positions indicated by the S.O's representative.

8.2 CABLE INSTALLED IN PRE-CAST CONCRETE TRENCHES

Methods of installation of cables in pre-cast concrete trenches shall be in accordance with type L, type M or type N of table 9A of the IEE wiringregulation 16th edition. However, W the method is not specified, the cable shall be installed as directed by the S.O's representative.

Cables laid on bottom of the trenches shall be in accordance with method type L of the IEE wiring regulation 16th edition. Cables installed on the trench walls shall be in accordance with method type M or method type N of the IEE wiring regulation 16th edition and means of saddles at suitable intervals. In the case of single core cables, whether secured individually or in group to the cable tray, nonferrous saddles shall be used.

The cable trays shall be fabricated from perforated hot dipped galvanized finished in an orange enamel. The minimum thickness of the sheet used shall be 1.5 mm for cable tray with width up to 300 mm and shall be 2.0 mm forwidth exceeding 300 mm. The cables tray shall be supported at least 25 mm from the trench wall by mild steel by mild steel brackets at 6W mm intervals. The bracket shall be anti-rust treated and painted with one coat of primer. A sample of the cable tray and bracket shall be submitted to the S.O's representative for approval prior to installation.

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To provide electrical continuity, all cables joints shall be bridged by means of tinned copper tape of dimension not less than 25 mm x 3 mm. All saddles for cables-on-cables tray shall be installed by bolts, washers, and nuts. All tees, intersection units adaptor units etc. shall be factory manufactured unless otherwise approved by the S.O's representative. The trench inside the building shall be filled with clean sand up to a level above the cable ducts.

8.3 CABLE RUN ON WALLS AND UNDER FLOOR SLABS

Cables run on walls and under floor slabs shall be mounted on perforated hot dipped galvanized sheet steel cable trays. The construction and finishing of the cable tray and the way of installation of the cables on the cable tray shall beas described in item 8.2 above.

The cable tray shall be suspended from floor slabs by hangers or mounted on wall by brackets at 600 mm interval. The materials and finishes of the hangers, brackets and other suspending structures shall be as that described for brackets in item 8.2 above.

Where cable tray pass through floors or fire-resistant walls, the surrounding hole shall be sealed to full thickness of the floor or wall with non-hygroscopic fire resisting material of minimum 2 hours fire rating approved by Jabatan Bomba Malaysia.

9.0 CABLE TERMINATION AND JOINTING

Unless otherwise permitted, all cable termination and jointing works shall only be carded out in the presence of S.O's representative. A plate engraved with details such as size of cable, number of cores date of commissioning, date of jointing, length of cable, distance of cable joints etc shall be securely fixed near the termination.

9.1 TERMINATION OF PVC INSULATED ARMOURED CABLES

PVC/SWA/PVC Cables shall be provided with compression cable gland for termination. The cable gland shall be of gunmetal sheath of the cable and so designed that any strain on the cable is taken by the steel wire armoured, which shall be effectively sealed between the gland itself and the outer cable sheath.



9.2 CABLE JOINTING

The type of cable boxes, compound and jointing materials used shall be of an approved type. Every cable joint shall be started and finished on the same day. Wherever cables are to be joined in the open during wet weather dims, the electrical contractors shall take all necessary precautions to prevent moisture getting into the cables.

When cable sheaths are used as earth continuity conductors, the glands must have the necessary contact surface to provide a low resistance path under fault conditions. Phasing and insulation resistance tests shall be taken beforejointing is commenced.

Core numbers printed on the papers shall be observed when jointing and wherever possible such numbers shall be maintained throughout the systems. Core number '0', '1', '2' and '3' shall denote as neutral, red, yellow, and blue phases respectively. In the case of two core cables, number '1' shall denote the phase conductor, and 'G' the neutral. Crossing of cores in the boxes shall be avoided wherever possible but connections shall be consistent with the



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foregoing requirements. The Mounting of cable shall be undertaken only by a competent and fully experienced jointer.

10.0 **CABLE MARKERS**

Cable markers with lettering and sign shall be provided by the electrical contractor at every change in direction of underground cable routes and at every 15 m on straight run. Cables marker shall be of heavy duty reinforced concrete construction and approved by the S.O's representative.

The cable markers shall be of trapezoidal block with 100 mm square top face, 150 mm square bottom face and 400 mm in height. The top face shall be indented with bold lettering 'L.V' and direct in sign indicating the direction of the cable route. The cable marker shall be buried to a depth of 300 mm or any other depths as directed by the S.O's representative. Cable joint marker of similar construction but with the lettering and sign shall be provided and installed at every cable joint in the similar manner.

SYSTEM OF WIRING

The system of wiring shall be either surface wiring, concealed wiring, surface conduit wiring or concealed conduit wiring as indicated in the drawings and/or Bill of Quantities.

All wiring shall be run neatly and in an orderly manner. They shall be routed parallel to the building wall and column lines in a coordinated manner with other services. The wiring throughout shall be on the 'looping-in system' and no 'tee' or other type of joints are allowed. No reduction of the strands forming the conductors is allowed at all terminals. All strands shall be effectively secured by approved means.

Wiring which is not embedded in concrete or concealed behind plaster shall run in an accessible manner on the beam's underside of the slabs or below pipes, ducts. Down drops shall be run on the surface of columns or walls. Concealed wiring shall be installed in such a way that plaster can be applied over their thickness without being subjected to cracking. Cables serving different operating voltages and functions shall be segregated.

Opening on floor, wall on partition through which cable trunking, conduit, or other wiring passes through, shall be sealed according to the appropriatedegrees of fire resistance after the installation.

Chipping and cutting of concrete are not allowed unless otherwise approved by the S.O's representative. The electrical contractor is required to work in conjunction with the building contractor for the provision of openings, trenches, care-holes, chases etc. as the building construction work progresses.



11.0 SURFACE WIRING

Surface wiring shall be carried out with PVC insulated PVC sheathed cables of 600/1000 V grade to MS 4.12 or BS 6004. The conductors shall be of stranded plain concealed copper to BS 6360. The insulation shall be suitable for continuous operation at a maximum cable temperature of 70 C and comply to BS 6746.

The cable shall be run on the surface of the walls, floor slabs and in the ceiling spaces. The cables shall be secured by lead alloy saddles. Not more than 10 cables shall be cleated together using the same saddles. For wiring onplaster or brickwork the cables shall be run on 'treated' hardwood battens secured on the surface with brass screws spaced at not more than 600mm apart and at places where necessary. Cables crossing metal surface shall be enclosed in PVC conduit or PVC casing. Saddles shall be fixed by brass nails as spaced at not more than 150mm apart. Wiring in ceiling spaces shall be protected by galvanised steel conduit. Down drop from the ceiling rose to luminaire shall be of 3 core PVC insulated sheathed flexible cord of size no lessthan 0.75mm to MS 4.16 or BS 6500.

12.0 CONCEALED WIRING

Cables used in concealed wiring shall be similar to that described in item 7.1 above.

The cables shall be concealed behind the plaster of walls and ceiling slabs or run in the ceiling spaces. The cable shall be secured by lead alloy saddles or cleats. Not more than 10 cables shall be cleats together using the same saddle or cleat. Saddles or cleat shall be fixed by brass nails and spaced not more than 150mm apart. Where cable is run in ceiling spaces they shall be protected by galvanised steel conduit and wired as in hem 7.1 above. A spare concealed conduit shall be provided from the distribution board to the ceiling spaces for future extension. The spare conduit shall be plugged at the ceiling end with removable plug.

13.0 CONDUIT WIRING (SURFACE OR CONCEALED)

Cables used in conduit wiring shall unless otherwise specified, be PVC insulated cable of 600/1000 V grade to MS 4.12 or BS 6004. The conductors shall be of stranded plain annealed copper to BS 6360. The insulation shall be suitable for continuous operation at a maximum cable temperature of 70 C and comply to BS 6746.

Cables above false ceiling shall be run in conduit or trunking as directed. The conduits shall generally be run on the underside of the floor slabs or suspended from the floor slabs by mild steel brackets. The trunking shall be suspended from the floor slabs on mounted against the walls by mild steel brackets. The mild steel brackets shall be anti-rust treated, painted with a primer, and finishedin an orange enamel. The suspension structure shall be robust in construction and adequately installed such that the conduits / trunking will not sag. Conduit for lighting point shall be terminated in a junction box complete with diecast cone shaped metal cover so that down drop to luminaire. Shall be carried out

through flexible steel conduit up to the luminaire. Ceiling fan points shall be run in the similar way.

Flexible conduit shall be used for termination of equipment, which are subjected to movement or vibration. However, the length of this flexible conduitshall not exceed 400 m unless approved by the S.O's representative.

For concealed conduit wiring, a spare conduit shall be provided from the distribution board to the ceiling space for future extension. The spare conduit shall be plugged at the ceiling end with removable plug.

Capacities of conduits and trunking shall be in accordance with the IEE wiring regulations 16th edition.

14.0 MINERAL-INSULATED CABLES

Mineral-insulated cables shall be manufactured to BS 6207: part 1 and shall comprise of pressure packed magnesium oxide insulation contained within a solid drawn ductile seamless copper sheath with solid high conductivity conductors. For general lighting and power points final circuits, unless otherwise specified, cables of 600 V insulation grade may be used. For main circuits and major power points, the cables used shall be of 1000V insulation grade. They shall be installed strictly in accordance with manufacturers recommendation and instruction.

Termination shall be of cold seal type. Silicon rubber sleeve insulation shall be used to replace copper sheath stripped off near the termination for temperature not exceeding 150 C. for temperature exceeding 150 C, varnished glass sleeve insulation shall be used.

Cables installed on walls shall be fixed by means of copper clips or copper saddles at appropriate spacing. The clips or saddles shall be secured by means of brass screws. Where cables are installed on cable trays, they shall be chipped at appropriate spacing by means of copper saddles. The saddles shall be secured by means of brass bolts and nuts. Where single core cable is used on multi-phase distribution work, the cables shall be laid in three phase groups whether flat or trefoil. Where single core cables pass through ferrous orother magnetic materials, the area surrounding the cables shall be replaced with copper plate of appropriate dimensions. Adequate bonding shall be provided where cables break formation to enter terminating positions. The minimum bending radius shall be not less than six times the cabal diameter and saddle spacing not more than 60 times the cables diameter or 500 mm whichever is less.

Connections to motors, generators, transformers, and other similar equipment shall be by one of the two methods listed below:

a) The cable shall be clipped at the appropriate spacing up to the point adjacent to the equipment and an unsupported anti-vibration loop shall be left in the cable.

b) The cable shall be glanded into a suitable terminal box adjacent to the equipment and connection to the equipment being affected by means of mechanically protected flexible cable of adequate cross-sectional area.

Insulation and continuity tests shall be carried out before and after the cable is terminated. The insulation test reading shall be 'infinity'. A blow lamp may be used for drying out cable ends. If it is impracticable to cut to waste, in which event the cable should be brought to cherry red heat at about 600 mm from the end and moisture driven carefully towards the cut end.

It is absolutely essential that great care shall be taken to maintain earth continuity and to ensure that hands and all materials are perfectly dry and cleanwhen terminating the cables. Dirt and metallic particles in the compound and any loose traces of dielectric left at the face of the sheath after stripping shallbe removed prior to sealing. Cold sealing compound shall be forced down one side of the pot only until slightly 'overfilling' in order to avoid trapping of air atthe base of the pot and to ensure that when the sealing disc is entered before crimping a completely solid insulation barrier is affected.

All other necessary accessories such as tap-off units, joint boxes, brass compression ring glands, screw-on brass pots, earth tails seals, coloured sleeving for phase identification, cone shape beads, fibre disc, brass locknuts etc. required for the proper installation work unless otherwise approved by the S.O's representative, shall be of the type manufactured by the cable manufacturer.

15.0 GALVANISED STEEL CONDUITS

Steel conduit shall be of galvanised, heavy gauge Class B, screwed type complying with BS 31 or BS 4568 and finished with two coats of approved standard orange paints.

The conduits shall be fitted with brass bushes at the free ends and expansion devices at appropriate intervals. The ends of each length of conduit shall be properly reamed. All steel conduits shall be effectively earthed.

Underground conduit shall be buried at a minimum depth of 450 mm below ground level or 100 mm below floor slab or hard standing.

Junction boxes, outlet boxes etc shall be of galvanised steel or alloy material. The covers shall be galvanised sheet steel with thickness not less than 1.2 mm. Junction box down dropping to luminaire shall have diecast cone-shaped metal cover.



16.0 CABLE TRUNKING

Cable trunking shall comply with BS 4678. They shall be fabricated from hot dipped galvanised sheet steel. They shall be equipped with removable covers at suitable intervals. They shall be supplied in length to suit the installation and shall have the following minimum wall thickness.

Nominal size (mm)	Minimum wall thickness (mm)
50 x 50 and below	1.0
75 x 50 to 100 x 100	1.2
150 x 50 to 300 x 150	1.6
Above 300 x 150	2.0

The trunking shall be supported by fixing brackets so that the trunking will not be in contact with the walls or floor slabs. The bracket shall be installed at intervals no greater than 1.5 m for vertical runs and no greater than 1.0 m for horizontal runs. The bracket shall be de-rusted, finished in a primer and coated with a standard orange enamel.

Wherever the trunking passes through a floor or a fire-resistant wall, fire resisting barrier shall be provided. At these positions the cables shall be sealed with non hygroscopic fire resisting material of minimum 2-hour fire ratingapproved by Jabatan Bomba of Malaysia. In addition, the floor openings and wall opening shall be sealed with similar type of compound.

Cable running in the trunking shall be supported by split hard wood racks securely fixed at the base of the trunking and spaced not more than 600 mm apart. Cables for each final circuit shall be properly bunched together and labelled.

Where conduit is tapped off from the trunking, suitable brass type smooth-bore bush shall be fitted at all conduit terminations.

Unless otherwise specified, all trunkings shall have either tinned copper tape of dimension not less than 25 mm x 3 mm as circuit protective conductor or earth cable of appropriate size. In the latter case, all trunking joints shall be bridged by means of tinned copper tape of dimension not less 25 mm x 3 mm.

17.0 CABLE TRAYS

Cable trays shall be fabricated from perforated hot dipped galvanised sheet steel complete with all necessary bends, tee pieces, adaptors, and other accessories. The minimum thickness of the sheet steel shall be 1.5 mm for cable trays with width, up to and including 300 mm and 2.0 mm for cable trays with width exceeding 300 mm.

Cables tray may either be suspended from floor slabs by hangers or mounted on walls or vertical structure by bracket at 600 mm intervals. However, where the above methods of installation are not feasible or practical, suitable floor-mounted mild steel structures shall be provided. All construction and adequately installed to cater for the weight of the cables and trays supported on them so that cable trays and cable will not sag. All supports, hangers, brackets, and structures shall be dedusted, finished in a primer and coated with a standard orange enamel.

Fixing clips and cleats for cables on trays shall be installed by means of bolts, washers, and nuts. All tees, intersection units, adaptor units etc shall be the type manufactured by the cable tray manufacturer unless otherwise approved by the S.O's representative.

Wherever cable tray passes through a floor or a fire-resistant wall, fire resisting barrier as mentioned in item 8.6 above shall be provided.





CALIBRATION, TESTING AND COMMISSIONING

1.0 SITE TESTS

The complete Works or any part thereof shall be tested, both before and after being connected to the requirements of the S.O.

The contractor shall be responsible for all electrical tests at the site and shall be represented by a Competent Personnel during the whole of the period required for the tests.

Testing must be carried out Electrical Services Contractor registered with Suruhanjaya Tenaga (ST). The result must be endorsed by Electrical Services Engineers.

The Contractor shall supply all necessary instruments, apparatus, connecting, skilled and un-skilled personnel, materials as may be requisite and may be reasonably demanded to carry out such tests efficiently and shall make accurate records of all tests in an approved form and furnish all test certificates to the S.O for information.

The minimum electrical site tests to be carried out in each complete section of the works shall be as follows: -

- **1.1** Calibration of Over Current, Earth Fault and all Protection Relays also testing all protective gear circuits.
- **1.2** Insulation resistance, polarity, and continuity tests.
- **1.3** Earth Resistance tests.
- **1.4** Test to prove correct operation of interlocks, tripping and closing circuits, control system, etc.
- **1.5** Testing of all equipment, electrical fittings, and accessories.
- **1.6** Other testing is determined by S.O.

2.0 COMMISSIONING

Upon successful testing of the electrical installation, the Contractor shall be represented by a competent personnel commission the Works and shall put into operation within the specified limits of its rating either continuously or intermittently as may be required without failure of any kind.

The Contractor shall arrange with the supply authority for connection of all meters. The Contractor is responsible for submission of all necessary forms and drawings to the authority leading to the meter installations. The meter deposits are to be paid by others, but the Contractor is responsible for obtaining and advising the employer the amount of deposit required by the authority and arranging for their payment on the employer's behalf.