



Appendix A

GENERAL ELECTRICAL INSTALLATION

Electrical Installation General Specification Document

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A.1) SCOPE

This specification details the requirements for the design, manufacture, installation, testing and commissioning of all electrical installations.

A.2) APPLICABLE DOCUMENTS & STANDARDS

SANS 10142: Code of Practice for the Wiring of Premises

OSHA (Act85): Occupational Health & Safety Act

SANS 0114: Interior Lighting

SANS 162: Metal Conduit

SANS 1507-1: Electric Cables with Extruded Solid Dielectric Insulation for Fixed Installations (300/500V to 1,900/3,300V) Part 1: General

SANS 1507-2: Electric Cables with Extruded Solid Dielectric Insulation for Fixed Installations (300/500V to 1,900/3,300V) Part 2: Wiring Cables

SANS 1507-3: Electric Cables with Extruded Solid Dielectric Insulation for Fixed Installations (300/500V to 1,900/3,300V) Part 3: PVC Distribution Cables

SANS 1507-4: Electric Cables with Extruded Solid Dielectric Insulation for Fixed Installations (300/500V to 1,900/3,300V) Part 4: XLPE Distribution Cables

SANS 1507-5: Electric Cables with Extruded Solid Dielectric Insulation for Fixed Installations (300/500V to 1,900/3,300V) Part 5: Halogen-Free Distribution Cables

SANS 1507-6: Electric Cables with Extruded Solid Dielectric Insulation for Fixed Installations (300/500V to 1,900/3,300V) Part 6: Service Cables

SANS 97: Electric Cables - Impregnated Paper-Insulated Metal-Sheathed Cables for Rated Voltages 3,3/3,3kV to 19/33kV (Excluding Pressure Assisted Cables)

SANS 1339: Electric Cables - Cross-Linked Polyethylene (XLPE) Insulated Cables for Rated Voltages 3,8/6,6kV to 19/33kV

SABS 1411-1: Materials of Insulated Electric Cables & Flexible Cords Part 7: Conductors

SABS 1411-2: Materials of Insulated Electric Cables & Flexible Cords Part 8: Polyvinyl Chloride (PVC)

SABS 1411-3: Materials of Insulated Electric Cables & Flexible Cords Part 9: Elastomers

SABS 1411-4: Materials of Insulated Electric Cables & Flexible Cords Part 10: Cross-Linked Polyethylene (XLPE)

SABS 1411-5: Materials of Insulated Electric Cables & Flexible Cords Part 11: Halogen-Free, Flame-Retardant Materials

SABS 1411-6: Materials of Insulated Electric Cables & Flexible Cords Part 12: Armour

SABS 1411-7: Materials of Insulated Electric Cables & Flexible Cords Part 13: Polyethylene (PE)

Where any document or standard is referenced, it shall be deemed to be the latest version of that document.

A.3) REQUIREMENTS

A.3.1) GENERAL

The supervision of all electrical work carried out by the Contractor shall be done by qualified licensed and competent personnel.

A list of key personnel and their CV's shall be submitted to the Engineer at the time of tendering, for his approval.

A sufficient complement of such personnel shall be maintained on site. Changes to key personnel shall only be done with the written consent of the Engineer.

The full time presence on site of the above approved supervisory personnel is required.

The Contractor will be responsible for:

- The Supply of Tools, Material & Equipment Required for Construction
- Transporting, Offloading & Storage of All Above to Site
- The supply, delivery, installation, termination and testing of all cabling. This cabling includes all power reticulation cabling, both MV and LV as well as all internal wiring required.
- The design, supply, delivery and installation of all cable trays according to routes indicated.
- The supply, delivery and installation of all conduit and power skirting according to routes indicated.
- The supply, delivery and installation of all small power distribution boards, conduit and conduit fittings, luminaries, switches, switched socket outlets, trunking, cable and wire, termination kits and all other paraphernalia required to effect a fully operational small power installation.
- QA & Test Certification as Required & Detailed Elsewhere
- Final Documentation as Detailed Elsewhere in this Document

In the absence of a compulsory site visit, the tenderer shall ensure that he has satisfied himself of the prevailing site conditions. No claims in this regard will be entertained.

The tenderer will allow for any items not specifically mentioned in the BOQ, but which are obviously required for the successful completion of the job.

Where a serious omission is noted by the Contractor, he will communicate his concerns to the Engineer as soon as he becomes aware of such an omission.

Where a Contractor intends to deviate from this specification, he will communicate his intention to the Engineer. Such deviation will only be allowed at the discretion of the Engineer. Where no such notice of deviation is received from the tenderer, it will be assumed that his offer meets all requirements of this specification.

A.3.2) COMPLIANCE WITH REGULATIONS, STANDARDS & SPECIFICATIONS

The complete Electrical Installation shall satisfy all National and Local Laws, Standards and By-Laws as applicable to the area where the installation is to take place.

The installation shall be carried out in strict accordance with the current Rules and Regulations of OHSA Act 85 and the local Fire Regulations.

An Electrical Certificate of Compliance (COC) shall be issued by the Contractor upon completion of his work.

Where the installation is in a hazardous environment, all relevant SANS codes shall apply. The Contractor will be provided with the relevant Hazardous Area Classification by the Engineer. He will ensure that he installs equipment which is correctly rated for the area.

Equipment shall be installed so as to ensure that:

- Inspection, Maintenance, Cleaning & Replacement is Easy to Perform & at Minimum Cost
- Safe Operation Under Site Conditions is Ensured

All Client enforced safety standards shall at all times be observed and adhered to by the Contractor. All site personnel will be required to attend the Client's safety induction training. The Contractor will accordingly provide for this in his submission.

Where a Contractor is barred from site by the Client appointed safety personnel, no claim for standing time will be entertained.

The Contractor will at all times maintain and keep up to date a safety file and present it on demand, for inspection, to the Engineer or the Client's Safety Officer.

A.3.3) SAFETY & SWITCHING

At no time will any circuit be powered up without the prior written approval of the Client's Electrical Engineer. The Contractor will inform the Engineer of his program in good time so that the necessary permission can be issued and the appropriate safety steps taken.

A.3.4) COMMUNICATION WITH THE RELEVANT SUPPLY AUTHORITY

The Contractor will be responsible for communicating to the Relevant Supply Authority, be it a Local Authority or the Client himself, all requests for switching.

The Contractor will be responsible for ensuring that a circuit is safe to work on when it is switched off.

A.3.5) QUALITY OF MATERIALS & WORKMANSHIP

Only new and unused materials of best quality shall be used. Materials shall, where applicable, comply with SANS specifications and where possible be of South African manufacture. This applied in particular to electrical cable.

Jointing of cores is not permitted. Joints in cable are only allowed when the length of cable exceeds the standard manufactured length of cable on a drum. Joints will only be made using an approved jointing kit and by qualified personnel. Buried joints will be clearly marked and noted on "as built" drawings.

The trimming of strands in order to fit a cable core into a lug is not permitted. Where a connection is required to be made using a nut and bolt, the nut and bolt shall be high tensile steel and appropriately treated against corrosion. Spring washers are not permitted. Cup washers will be used. The bolt and nut shall be torqued to manufacturer's specifications.

The storing, transporting, handling and laying of cables shall be carried out in accordance with approved and accepted practice. When cable is rolled off a drum, it shall be adequately supported to prevent twisting, undue tension and subsequent damage. The Contractor will have at his disposal all tools and equipment required to lay and install cable correctly.

Before any cables are laid, the Engineer or his representative will inspect all cable trays, supports, trenching and routing in general.

Installation of instruments and other equipment shall be installed in accordance with the manufacturer's specifications and project requirements.

Shoddy workmanship will not be permitted.

All cabling points of entrance or egress from buildings will be adequately sealed against the adverse effects of weather and vermin. ROXTEC or expanding foam will be acceptable.

All cables, including spares should be terminated and marked in accordance with Client requirements.

Any work not conforming to the specification, or general requirements of good workmanship shall be made good or replaced at the discretion of the Engineer.

A.3.6) CABLE TRAYS/RACKING/TRUNKING/POWER SKIRTING

The Contractor shall supply and install the appropriate cable trays as required by the cable routes. Provision should be made for 30% extra space in the width of the cable trays for future expansions.

Cable racks will in general be medium to heavy duty perforated, galvanized and of local manufacture. Mesh type racking may be acceptable in light application and above false ceilings.

Racking shall be supported at maximum centers of 1,5m, depending on the load and span. Racks shall also be supported at each change of direction. Supports may be fixed either from a wall and/or ceiling; rawl bolted or clamped whichever is applicable. Minimum distances between walls/ceilings and cable racks will be 150mm.

Trunking/sleeving should have the capacity to cater for at least the same amount of cable already installed, or as otherwise specified.

Where the Contractor is required to weld or drill any existing structure in order to affix cable supports, this will only be carried out with the approval of the Client.

Power skirting will in general have at least two compartments or as otherwise specified. Power circuits will be tapped every 500mm and the looped wire left inside the trunking, if not immediately connected to a socket outlet.

A.3.7) CONDUIT

Conduit installed in areas designated as office space will be flush mounted. PVC conduit is acceptable.

Conduit installed in workshop or other industrial areas will be steel. All metal conduit will conform to SANS 162-2011.

A3.7.1) METAL CONDUIT

Metal conduit shall be of heavy gauge solid drawing or welded steel, bearing the SABS mark. Except where otherwise stated, all conduits shall be galvanized.

All cast metal conduit accessories shall be of the malleable iron inspection type.

Metal conduit shall be assembled by means of the "BOSAL" system of threadless conduit fittings. All accessories used on the "BOSAL" system shall be cadmium plated.

Mechanical earth continuity must be ensured at all points.

A3.7.2) PVC CONDUIT

PVC conduit is permitted in offices and other non-industrial areas.

A3.7.3) SURFIX CABLE

Surfix cabling will be allowed where specified on the electrical drawings and single line diagrams.

A3.7.4) FLEXIBLE CONDUIT

All flexible conduit shall be of the type with a flexible galvanized shell core, with a black watertight oil-resisting PVC sheath.

Termination fittings for the conduit shall be of the watertight screwed type, fitted with nylon sealing rings and screw-in earth continuity cones. Flexible conduit shall be equal and similar to "Sealtite" or "Hydratite" manufacture.

A.3.8) CONDUIT INSTALLATION PRACTICE

A3.8.1) GENERAL REQUIREMENTS

Lighting and plug circuits are to be run in separate conduits and not more than one circuit will be allowed in a conduit, except where otherwise specified.

Likewise, each point shall be wired through a conduit dedicated to that power point only, except where otherwise specified.

Conduit installed in ceiling in roof spaces shall be run parallel and at right angles to roof members and not at random and is to be securely saddled at intervals not exceeding 1,5m for metal and 1.0m for PVC. Conduit installations for confined spaces of less than 1,0m clearance or where the space will after completion of the work be inaccessible, shall be carried out from outside such space.

Metal conduit terminating in boxes, trays, etc., shall be finished off with lock nuts and brass bushes.

Except in the case of concrete slabs, conduit terminating in ceiling points is to be taken to the face of the ceiling and finished off under the fittings with a brass or plastic bush depending on the type of conduit used. Conduit shall be firmly supported at these points.

All conduit joints are to be tightly assembled. Screwed running joints with long threads are to be provided with a lock nut to ensure a mechanically strong and electrically continuous joint.

The entire conduit system is to be electrically and mechanically continuous throughout.

A3.8.2) CHASING & BUILDING IN

The Civil Contractor will be responsible for the building in of all conduit, switch boxes, distribution boards etc., which are to be built in as work progresses. It is however the responsibility of the Electrical Contractor to ensure that conduits are correctly positioned and he must ensure at all times that the conduit is placed in position in good time. The Electrical Contractor will be held responsible for any delays or damage caused by failure to observe this clause. Where by arrangement with the Civil Contractor, the Electrical Contractor is required to chase conduit, all such work and consequent damage as well as the making good thereof, shall be for the Electrical Contractor's account.

A3.8.3) CONDUIT IN CONCRETE

Conduit shall be installed as close as possible to the neutral axes of concrete beams or slabs. Conduit and outlet boxes shall be securely fixed to shuttering to obviate displacement during the pouring of concrete.

Conduit shall drop to the lower face of concrete and terminate at outlet boxes only at points where such boxes are to be installed. On existing concrete structures, conduit shall be run only in approved positions and where required, the depth of chasing of such structures shall be approved.

The Contractor will liaise closely with other Contractors and providers of other services in order to ensure that clashes with other equipment are kept to the bare minimum.

The Electrical Contractor is to be present during the casting processes so as to ensure that no damage or displacement occurs to conduit.

Immediately after each section of shuttering has been stripped, the Electrical Contractor shall by means of steel tape establish whether all conduit boxes are accessible and all conduit runs intact and clear. Any shortcoming detected at this juncture must be immediately rectified in an approved manner.

A3.8.4) CONDUIT ON SURFACE

Where surface work is permitted, conduit runs shall be perfectly straight and level.

After completion of surface work, no exposed thread shall show, except where running joints occur. The latter shall only be resorted to where absolutely unavoidable and must be fitted with a sliced coupling as a lock nut.

Saddles shall be fixed by means of approved patented wall plugs. Screws used will be plated or passivated.

All saddles shall be galvanized hospital type spacer saddles.

A3.8.5) BENDS & DRAW BOXES

Normal bends or elbows will not be allowed except where specifically approved. All sets shall have a radius of at least five times the outside diameter of the conduit and conduit showing signs of flatter or cracking shall be rejected.

Draw boxes shall be installed in approved positions so that not more than two bends occur between one end of a run and draw box or between boxes. Draw boxes shall be arranged so as to be accessible after the completion of the building and must be provided with cover plates, which shall finish neatly and flush in the final surface, except where the surface is finished in paneling, in which case a door to match the paneling shall be provided at the expense of the Electrical Contractor.

Draw boxes shall, where possible, be located in inconspicuous places allowing for a common cover and rectangular shall be square with respect to walls.

A3.8.6) REAMING

The ends of all conduits shall be cleaned internally by means of a reamer of all burrs and rough edges in compliance with the Wiring Code.

A3.8.7) WALL BOXES

Wall boxes for socket outlets, switches, micro-gap isolators, etc., shall be of the heavy gauge pressed steel galvanized type, provided with lugs and shall be drilled and tapped for fixing screws. Where appropriate and permitted, boxes of rigid plastic, bearing the SABS mark, may be employed.

Knock-out conduit entry holes shall be provided on all sides, including the back.

All steel wall boxes shall be treated with "Anodite" red oxide primer before installation, applied by brush or by dipping, as an added rust proofing agent. Before applying the primer, all surfaces shall be cleaned with a suitable emulsion type galvanized iron cleaner.

The normal dimensions of wall boxes shall be as follows:

- Singe Switch Units: 50x100x50
- Two Switch Units on Common Cradle: 50x100x50
- Switched Socket Outlets (Single or Double): 100x100x50
- Plug & Special Miniature Single Pole MCCB: 100x100x50

Not more than one circuit shall appear in any one wall box except where otherwise specified. The Electrical Contractor shall supervise the building-in of wall boxes to ensure correct positioning.

A3.8.8) EXPANSION JOINTS

Where conduit installed in concrete crosses a building expansion joint shall be provided with a conduit expansion joint in the conduit run, without loss of earth continuity.

A.3.9) FLUSH-MOUNTED DISTRIBUTION BOARDS

Care must be taken to make sure that expanded metal to the rear of bonding trays are spot-welded properly where installed in 115mm walls.

Panels must be fixed to the architrave frame by means of two fixed locating pins and two chromium-plated screwdriver or square key quick-release and quick-loss catches. Self-tapping screws are not acceptable.

A.3.10) WIRING OF CONDUIT

A suitable rated 3 phase 4 wire 50Hz supply will be available from the local LT supply main DB to the subsequent DB's. Available voltages may vary from site to site. The Contractor will be informed of the voltages in the RFQ document.

Circuits shall consist of the following wire types:

Phase	Neutral	Earth
• Lighting (General)	2.5mm	2.5mm
• Lighting (High Bay)	4mm	2.5mm
• 16A Socket Outlets	2.5/4mm	2.5mm
• Console AC Units	4mm	2.5mm
• UPS 16A Socket Outlets	4mm	2.5mm
• Welding Plugs	6mm	4mm

All wiring shall be carried out in a 600V Grade PVC insulated wire. Wiring of any circuit shall only be carried out after the whole of that particular circuit conduit installation has been installed and fixed into positions.

It should be possible for wires to be drawn through the complete conduit installation without any undue strain.

Not more than five 2.5mm² or four 4.0mm² together with earth wires where applicable will be allowed in 20mm tubes, or in accordance with SANS 10142.

All conductors shall be in colours selected to facilitate identification of circuits, black being reserved for neutral conductors, and green/yellow for insulated earth conductors. Three phase circuits shall be colour coded to identify phases.

All metal conduits must be earthed and bonded to form effective earth continuity conductors. In addition a bare copper earth continuity conductor shall be drawn into each conduit serving apparatus which is required to be earthed in terms of the Standard Regulations for the Wiring of Premises.

Earthing clips or straps are to be made of copper.

A.3.11) CABLE ROUTES

Supply and install cables on underground or surface routes as indicated on the drawings. The cable schedules, if provided, indicate provisional route lengths which are to be used for tendering purposes but the actual lengths required are to be measured on site and these lengths submitted to the Engineer for approval before ordering. Any variation between tendered and measured lengths will be covered by price adjustments in accordance with the Contract variation rates.

NOTE:

Where parallel cables are specified the cable lengths are to be calculated by multiplying the route length by the number of parallel cables.

A.3.12) CABLE SPECIFICATION

No damaged or previously used cable will be accepted.

Cable shall be manufactured and supplied on one length to the lengths specified unless these lengths exceed a standard drum length, in which case a ruling shall be obtained from the Engineer. Under no circumstances will joints be allowed unless specifically directed in writing by the Engineer.

A3.12.1) LOW VOLTAGE PVC CABLES

All electrical cables must be sized according to load current and voltage drop as required by SANS 10142.

If not elsewhere specified all power cable supplying three phase units shall be either three or four core, with the black conductor serving as neutral, PVC PVC SWA PVC to SANS 1507.

The minimum cable size shall be 2.5mm².

A3.12.2) MEDIUM VOLTAGE PAPER-INSULATED LEAD-COVERED CABLES

Cables shall be manufactured in accordance with SANS 97 and shall come only from fresh stocks.

The cable construction shall be impregnated paper-insulated/lead alloy E sheathed type with an extruded PVC impermeable bedding for protection against electrolysis/double steel tape or galvanized steel wire armoured/outer PVC sheath.

The conductors shall be of high conductivity, annealed, stranded copper that may be shaped or circular.

The conductor insulation shall consist of impregnated paper tapes, either pre-impregnated or mass-impregnated with a non-draining compound.

The bedding shall consist of an extruded layer of PVC and the sheath shall be lead alloy E. The serving shall consist of watertight extruded black PVC to eliminate electrolytic corrosion of the cable.

Where the cables may be subject to severe vibration, the lead sheath shall be alloy B instead of alloy E. (Roadway crossings, bridges or near railway tracks).

Armouring shall consist of double steel tape of galvanized steel wire. It should be noted that a cable with wire armour has a much higher earth fault rating than a cable with tape armour and that in vertical installations only wire armoured cable shall be used.

The cable insulation shall be suitable for the supply voltage specified and the cable must be suitable for a system with an unearthed neutral.

At the request of the Engineer, tests shall be carried out on production runs of the cable in accordance with SABS 97.

A3.12.3) MEDIUM VOLTAGE CROSS LINKED POLYETHYLENE CABLES

Cables shall be manufactured in accordance with SANS 1339 and shall come only from fresh stocks.

The cable construction shall be of cross linked polyethylene dielectric (XLPE) type with conductors and core screens, bedding tape, copper tape screens, binder in the case of multi core cables, extruded bedding, armouring (steel wire or aluminium as specified) and an outer PVC sheath.

The conductors shall be of high conductivity, annealed, stranded copper or aluminium in accordance with SABS 1411: Part 1.

A semi conducting screen shall be provided on each conductor, either extruded or taped. The dielectric shall be in continuous adherent contact with the conductor screen and be itself covered with a semi-conducting core screen and a metallic screen. Semi-conducting bedding tape is required.

The core screen may be semi-conducting tape, overlapping, or extruded, as allowed in SABS 1339-2010. The metallic screen shall be annealed copper tape as allowed in SABS 1339-2010.

Cables shall be either single core type A1 or A2, three core type A, type B or type C as specified.

Where subject to environmental conditions deleterious to the dielectric, a lead alloy sheath (alloy B or E as specified) and heat barrier in accordance with SABS 1339-2010 may be specified.

PVC bedding for armoured cables is required. Armouring shall be steel wire armour (SWA) in the case of 3 core cables and where required and shall be hard drawn aluminium (AWA) in the case of single core cables and where required.

The outer sheath shall be PVC, colour as specified and U/V stabilised where specified.

At the request of the Engineer (and if specified), tests shall be carried out on production runs of the cable in accordance with SABS 1339-2010.

A3.12.4) INSTALLATION OF CABLES IN TRENCHES, SLEEVES & DUCTS

The storing, transporting, handling and laying of cables shall be carried out in accordance with approved and accepted practice. When cables are rolled off the drums, it shall be adequately supported to prevent twisting, undue tension and subsequent damage. The Contractor must have at his disposal enough and adequate equipment and labour to prevent damage to the cables during these operations.

Before any cables are laid, all trays shall be inspected by the Engineer or his representative.

Except where otherwise specified, trenches for cables up to 1,000V shall be 600mm deep, whilst trenches for cables in excess of 1,000V shall be 900mm deep.

Trenches shall be wide enough to accommodate all cables of like voltage in one horizontal plane, separated by at least twice the diameter of the largest cable.

Danger tape shall be provided and laid by the Contractor, 200mm above cables.

Properly sifted bedding soil shall be placed in the bottom of the trench to a depth of 50mm. The cables shall be covered with a further layer of sifted soil to a depth of 100mm. The soil used will not be river sand but will match the soil removed during excavation of the trench.

Prior to any trench being closed, the Contractor will call the Engineer to inspect. In laying and covering underground cable, due cognisance should be taken of the theft risk associated with cables lying exposed and uncovered.

Cable markers shall be provided and installed by the Contractor at the beginning and end of a cable trench as well as any direction change.

A3.12.5) EXCAVATIONS & TRENCHING

- a) Hard Rock shall mean granite, quartzitic sandstone, slate and rock of similar or greater hardness, solid shale and boulders over 300mm in diameter. For the purpose of applying representative rates for trench excavations this definition may be further subdivided into rock that may be dislodged and loosened by machine, e.g. jackhammer, ripper, etc. and all rock so firmly cemented as to present all characteristics of solid rock which can only be removed by drilling and blasting.
- b) Soft Rock shall mean rock that can be loosened by hand-pick and includes hard shale, compact ou-klip and boulders from 75mm up to 300mm in diameter.
- c) Earth shall mean ground that can be removed by hand-shovel and includes loose gravel, clay, make-up ground, loose or soft shale, loose ou-klip and boulders less than 75mm in diameter.

NOTE:

Notwithstanding that a formal site inspection may or may not have been held, all excavations and trenches shall be priced in accordance with the rate applicable to Soft Rock. It shall be determined at the time of executing the work which category actually applies, or if differing conditions are encountered, what quantities of each category apply and the Contract shall be adjusted accordingly.

In trenches made in soft and hard rock, the cables shall be laid on a 75mm thick bed of sieved sand and be covered with a 150mm layer of sieved sand before the trench is filled. The first 300mm of backfilling above all cables shall be completely free of stones.

NOTE:

For the purposes of the Tender it shall be assumed that neither sieving of sand nor importing of sieved sand shall be required. A rate shall, however, be provided for sieving excavated material and for importing sieved sand so that the Contract may be adjusted according to the actual requirements.

The Contractor shall, before excavations commence, familiarize himself with the route and conditions on site and it shall be his responsibility to obtain the necessary information with regard to other plant along the route and every effort shall be made to avoid damage to this plant.

The exact positioning of trenches shall be approved on site by the Employer and/or Engineer and excavations shall not commence until approval has been received.

The cable trenches shall be excavated to a depth of 1 000mm and 600mm below ground level for MV and LV cables respectively and shall not be less than 300mm wide for one or two cables, and the width shall be increased where more than two cables are laid together, so that the cables may be placed at least 150mm apart throughout the run. The bottom of the trench shall be level and clear, and the bottom and sides free from rock or stones liable to cause damage to the cables.

Tenderers may, with the permission of the Principal Contractor and with the approval of the Engineer obtain information regarding the water table on the Site. The cost of excavation shall include for removing water from the trenches. The Tenderer should satisfy himself on this matter and may carry out tests on Site.

The Contractor shall take care to avoid damage to buried pipes such as earthenware drain and effluent pipes, etc.

A3.12.6) CABLE INSTALLATION

All cables to be installed by qualified personnel having the necessary skill, training and experience.

Cable bend radius to be at least twelve times the diameter of the cable over armouring. Sufficient slack to be left to relieve stresses.

All ends shall be sealed off immediately after cutting to prevent moisture absorption.

The Contract Price shall not include making good concrete or macadamized surfaces.

Should any cable routes cross any roads or railways, these crossings must be sleeved by 150mm diameter reinforced concrete pipes which are to be supplied and installed by the Principal Contractor. In each case a spare sleeve is to be provided for possible further additions. Only one cable is to be installed in a cable pipe duct or sleeve except in the case of very small cables if there are insufficient ducts for all cables.

Cables in trenches shall be laid with sufficient slack to relieve stresses. The cables shall be clamped where necessary to relieve the stress on joints of the lead sheath.

The Contractor shall provide all necessary equipment and labour for handling cables and for drawing into ducts, etc. All bends shall be in easy sweeps and no twisting of cables shall take place. All ends for drawing into sub-stations, building, etc., and overlaps for jointing shall be allowed. All cutting, capping and depressing of cable ends must be carried out by the Contractor. Cables must be handled with care to ensure that the insulation will not be damaged. In all cases where long lengths are pulled a purpose-made cable sock and cable rollers shall be used.

The Contractor shall take the necessary precautions to avoid injury or damage as a result of the excavations and the Contractor will be held liable in the event of claims arising from such injury or damage. Tenderers are advised to include for taking out a suitable insurance policy.

Prior to laying the cables in the ground the trench shall be inspected thoroughly to ensure that it is free from all objects likely to damage the cable either during or after cable laying operations.

Except where ducts, tunnels or pipes are provided and unless instructed to the contrary, the Contractor shall lay the cables direct in the ground.

Cable rollers shall be used at all times whilst laying cables, but they shall have no sharp projecting parts liable to damage the serving on the cables. They shall be placed in the trench in such a manner as to prevent the cable being dragged along the bottom of the trench or ground.

Where cables have to be drawn around corners, skid plates or cable rollers turned on edge shall be used for this purpose. The skid plates shall be well lubricated and must be securely fixed between rollers and must be constantly examined during cable laying operations.

The Contractor shall ensure that during laying operations the minimum bending radius is not exceeded. Particular care should be taken where the cables are "flaked" for ease of laying.

When more than one length of cable is laid between two points, the cable shall be laid in one direction only to avoid cross-over of phase cores in joints.

In the event of the Contractor having to extend an existing cable, it shall be his responsibility to obtain the existing cable phase rotation to ascertain in what direction he has to lay the new cable.

Where the Contractor has to lay two cables for a future "cut-in" to an existing cable, he shall at all times lay the first cable in the one direction and the second cable in the opposite direction.

Every precaution shall be taken to maintain paper-insulated cable moisture-free during any jointing or terminating operation, and when cables are cut the ends shall be immediately lead capped to exclude moisture and are to remain sealed until they are to be made off. No temporary sealing will be permitted.

A3.12.7) BACKFILLING & REINSTATEMENT

All excavations made shall be backfilled in 300mm layers, the earth in each layer being well tamped and consolidated and sufficient allowance made for settlement.

The refilled trench shall be maintained by the Contractor at his expense, in a thoroughly safe condition for the duration of the Contract.

All backfilling of road crossings shall be preferably consolidated with a mechanical power-driven compactor.

Surplus excavated material shall be disposed of by and at the cost of the Contractor who shall leave the trench and adjacent area in a clean and safe manner.

A3.12.8) CABLES LAID IN PIPES, DUCTS & CABLEWAYS

Where specified, cables to be laid under railways or roads shall be laid in Pitch Fibre or Fibre Cement Pipes. (Pipe sleeves by others).

The Contractor shall ensure that all cable pipes are sound, clean and free from "rag" before drawing cables therein. Where numerous pipes are to be installed, they shall be installed in banks with a maximum of three banks. The minimum clearance between the uppermost pipe and the finished road level shall be 750mm. Where spare pipes are installed, their ends shall be blanked off with suitable "End Caps" after they have been cleared of any soil, etc., that might have entered at the time of installation. After the cables have been laid the ends of the pipes shall be sealed with a weak mix of coarse builder's sand and cement, the price of which shall be included for in the unit price for laying the cable pipes.

A3.12.9) BURIED CABLE MARKERS

All buried cable routes shall be marked with approved concrete slab type cable markers at intervals of not more than 20m and at every change of direction. The positions of all cable markers are to be approved by the Engineer and the actual location of the cable markers is to be recorded accurately by the Contractor on drawings. The exact information recorded on the cable marker is to be decided in conjunction with the Engineer.

A.3.13) JOINTING & TERMINATING OF CABLES

Connection of cables to switchgear shall always be effected in such a way that the various phases, seen from the front of the switchgear shall be in the following positions:

No. 1 Conductor: Left (red) (A)

No. 2 Conductor: Centre (white) (B)

No. 3 Conductor: Right (blue) (C)

Exposed armouring shall be covered with bitumen-base paint.

All cable ends shall be supplied with the necessary earth connection.

A channel or other approved means of support shall be provided to remove mechanical stress from the glands.

Cable cores shall be marked with heat-shrunk sleeves where necessary to identify the phases.

The current-carrying capacity and breakdown voltage of the cable end shall be the same as for the complete cable.

Cables shall be terminated in accordance with the recommendations laid down by the manufacturers of the cables and glands employed.

It is a definite requirement that the Contractor shall only employ personnel fully conversant with cable manufacturer's recommendations for joining and terminating cables.

A3.13.1) HEAT SHRINKABLE MATERIALS

Heat shrinkable materials may only be used in exceptional circumstances with the written permission of the Engineer.

The complete kit shall be packed in a container that is marked for the type of cable insulation and construction as well as the voltage range for which the materials are suitable.

An illustrated set of instructions for the installation of the materials shall accompany every kit.

The joints and terminations shall make minimal, if any, use of insulating or stress relieving tapes. The use of electrical stress control and insulating tubing that is heat-shrunk onto the termination or joint is preferred above other methods.

The materials shall comply with VDE 0278 and the supplier shall be called upon to confirm this aspect before acceptance of the materials or installation.

The heat-shrinkable and other materials used for the terminations and joints shall be of a high quality and shall retain their electrical and mechanical properties without deterioration.

a) Terminations with Heat-Shrinkable Materials

- i. Terminations shall be made of a material that gives lasting protection against ultraviolet radiation.
- ii. The cores of all cables terminated outdoors and the cores of 3,3kV and higher voltage cables terminated indoors, shall be completely covered with a shrunk-on protective layer against surface tracking, ultraviolet radiation and weathering.
- iii. Outdoor terminations shall be designed to prevent flashover under wet or contaminated conditions and to ensure additional mechanical strength. This shall be achieved with shrunk-on insulating spacers and rain shields.

b) Joints with Heat-Shrinkable Materials

- i. The electrical continuity of all the conductors, screens and armouring shall not be impaired by the joints and the earth continuity shall be accomplished within the joints, i.e. no external earth continuity conductor that will be subject to corrosion, is acceptable. The joints shall be completely covered by a watertight sheath to prevent corrosion.
- ii. In the case of joints in cables with an outer PVC anti-electrolysis sheath, the joints shall be subject to the same electrical insulation test as the outer sheath of the cable.

c) Resin Filled Joints

- i. The resin filled joint kit shall comprise a self-sealing plastic mould of high mechanical strength having sufficient connector space.
- ii. The exact amount of cold hardening resin shall be provided in a two-compartment plastic bag.
- iii. The resin shall have absolute minimum shrinkage.
- iv. The mould and resin shall be completely waterproof and non-hygroscopic and shall be resistant to ultraviolet radiation.
- v. Joint kits shall be of "SCOTCHCAST", "CELLPACK" or similar.

d) Cable Box Joints

- i. Cable box shall be manufactured of die cast aluminium material for normal conditions or glass fibre reinforced thermosetting compound where exposed to corrosive conditions.
- ii. The lid shall provide an absolute moisture barrier.
- iii. Boxes shall contain 2, 3 or 4 entries as required.
- iv. Unused entries shall be sealed with watertight blanking plugs.
- v. Earth continuity shall be maintained through the box by means of the material of the box in the case of aluminium boxes or by means of earth straps and studs in the case of glass fibre reinforced boxes.
- vi. Cable boxes shall be of "PRATLEY", "CCG HANDIFIT" or similar manufacture.

A3.13.2) TERMINATIONS OF PAPER-INSULATED CABLES

The ends shall be terminated in cable end boxes field with bituminous, cold filling or resin oil semi-fluid compound or heat shrinkable terminations in accordance with clauses 3.14.1 above.

a) Testing For Presence of Moisture

Before terminating or joining paper-insulated cables, a test to establish the presence of moisture must be carried out.

The following procedure should be followed:

- Place an adequate quantity of cable impregnating oil in a suitable container and heat up to 130°C +/- 5°C
- Cut a small length (±300mm) of the cable concerned and remove the armouring and sheath, taking care not to handle the dielectric in any way.
- Dip a section of the outer insulating impregnated paper (belt paper) in the heated oil, taking care not to contaminate the tapes with moisture from the hands. If frothing appears on the surface of the oil, this is a clear indication of the presence of moisture in the paper.
- The same procedure should than be repeated on the insulating impregnated paper around the cores (especially those layers closest to the cores). Frothing will also indicate the presence of moisture.
- Should only a small number of bubbles appear on the surface of the oil, this is an indication of air bubbles on the paper and not moisture since the presence of moisture will result in a series of bubbles rising to the surface of the oil for a number of seconds, until all moisture has been removed.

The armouring shall be bonded to the main earth bar of the switchgear or transformer.

The lead sheath shall be wiped against the conical wiping gland.

All cut cables ends which will be exposed to the atmosphere for more than two hours shall be sealed and wired to prevent penetration of moisture.

b) Cable End Boxes

Cable end boxes shall be suitable to accept paper-insulated lead covered cables.

The cable end boxes shall be of the metal clad type suitable for indoor or outdoor use as required for the specific application. Only inverted type boxes shall be supplied for outdoor use. The insulators of the inverted type boxes are angled downwards.

The boxes shall be equipped with armour clamps and brass or gunmetal conical wiping glands.

The cable boxes shall be suitable for filling with bituminous, cold filling compound or resin oil semi-fluid compound.

The cable boxes for resin oil semi-fluid compound shall be equipped with a sight glass for compound level indication.

c) Cable End Box Filling Compound**d) Bituminous Compound**

The compound boxes shall be suitable for filling metal clad cable end boxes.

The compound shall comply with BS 1858, shall be non-hygroscopic and shall have a high dielectric strength and insulation resistance.

The compound shall have good adhesive properties and shall not be susceptible to cracking.

The compound shall be suitable for use in high ambient temperatures and system voltages of up to 22kV nominal.

e) Resin Oil Semi-Fluid Compound

The compound shall be suitable for filling metal clad cable end boxes with level indicators.

The compound shall have a pouring temperature above 100°C.

The compound shall be non-hygroscopic and shall have a high dielectric strength and insulation resistance.

The compound shall have minimal contraction when cooling.

The compound shall be "HENLEY COMPOUND NO. 57018, INSULOL DG" or equivalent.

f) Quantity

An adequate quantity of compound shall be supplied to fill each cable end box. The supply of the compound is included in the contract. The compound level shall be checked after approximately six months and topped up.

A3.13.3) TERMINATIONS OF XLPE CABLES

Cross-linked polyethylene cables (XLPE) shall be terminated in accordance with the requirements for terminations and joints specified above unless a pre-fabricated system based on pre-moulded slip-on EPR stress cones is used.

The copper tapes of the earth screen on the cable shall be bonded to the main earth bar of the switchgear or transformer, but the bond shall be easily removable for testing purposes.

The cable shall be firmly secured on the switchgear by means of a clamp to prevent mechanical stress on the cable and terminations.

A3.13.4) TERMINATIONS OF PVC CABLES

Cable ends shall be terminated by means of adjustable glands in accordance with the standard specification for glands, clause 3.4.1 above.

The glands shall be fitted in accordance with the cable and gland manufacturer's instructions.

The correct size and type of gland shall be used for the particular cable and application.

A3.13.5) CONNECTION OF CABLE CONDUCTOR

Suitable lugs shall be used, preferably solidly sweated to the cable conductor ends. Lugs may be crimped, using mechanical or pneumatic tools designed for this purpose, on condition that evidence is submitted that the method used complies with the performance requirements of BS 4579, Part 1: "COMPRESSION JOINTS IN COPPER".

Contact surfaces shall be thoroughly cleaned and smoothed and fixing bolts shall match the hole size of the lug.

Cables that are connected to clamp type terminals where the clamping screws are not in direct contact with the conductor need not be lugged, but the correct terminal size shall be used.

Ferrules shall be used on cable conductor ends where the cable conductors are connected directly to equipment with screws against the conductor strands.

When cutting away insulation from cable conductors to fit into lugs, care shall be taken that no strands are left exposed. Under no circumstances may any of the conductor strands be cut away to fit into lugs.

A3.13.6) JOINTS

Verification or authorized in writing by the Engineer.

Jointing shall be carried out strictly in accordance with the manufacturer's instructions and by personnel competent in jointing the types of cables used.

During outdoor jointing operations, the joint bays shall be adequately covered by tents of waterproof material suitably supported. Where necessary a trench shall be excavated around the bay to prevent the ingress of moisture. The sides of the hole shall be draped with small tarpaulin or plastic sheeting to prevent loose earth from falling in during jointing operations.

The joint shall not impair the anti-electrolysis characteristics of the cable.

The Contractor shall notify the Engineer timeously of the day on which jointing is to be carried out in order that an inspection may be arranged if so required. Any cable joint not inspected by the Engineer because of

insufficient notice being given, shall be opened for inspection and redone at the discretion of the Engineer and at the cost of the Contractor.

MV cable joints on paper insulated cables shall be of the compound cast type and the compound used shall comply with the specification provided above.

MV cable joint on XLPE-insulated cables shall be of the heat-shrinkable type and shall comply with the specification above or shall be based on a prefabricated system utilising pre-moulded slip-on EPK stress cones.

LV cable joints shall be of the epoxy-resin type.

Joints shall be fully water and air tight and shall be free of voids and air-pockets.

The crossing of cores in joints will not be permitted under any circumstances.

A3.13.7) CABLE GLANDS

Mechanical cable glands required for the attachment of cables complying with the requirements of SABS 150 to enclosures for electrical apparatus, including enclosures for type "e" apparatus and enclosures that are dust-ignition-proof or hose-proof or both, shall comply with the requirements of SABS 1213 and shall bear the mark.

Each gland shall bear the following information in legible and permanent marking:

- The Manufacturer's Name, Trade Name or Trademark
- The Size Designation of the Gland
- In the case of glands for use on enclosures for type "e" apparatus, or on enclosures that are dust-ignition-proof or hose-proof or both, an indication to that effect shall be provided.

For outdoor applications and for environments where the cable gland will be exposed to water, suds or oils, gases and dust, the cable gland shall be fitted with a seal and a shroud in accordance with the requirements of Clauses 4.5 and 4.6 respectively of SABS 1213.

Glands required for use on enclosures for type "e" apparatus or enclosures that are dust-ignition-proof or hose-proof or both, shall comply with the requirements of Clause 4.7 of SABS 1213.

Glands for armoured cables required for use on non-metallic enclosures shall be provided with an attachment for the purpose of applying an earthing bond to the gland and shall comply with the requirements of Clause 3.4 of SABS 1213.

Glands for armoured cables required for use in highly corrosive atmospheres and/or for use on enclosures or motor specified for a degree of protection of IP65 or better, shall be tested in accordance with the requirements of IP65/IEE144, shall carry the SABS mark and shall be type CCG EIW by CCG Systems or equal and approved.

A3.13.8) CABLE JOINTING FERRULES & CABLE TERMINATING LUGS

Only ferrules and lugs which meet the requirements of the performance specification BS 4579 – Part 1 may be used, alternatively ferrules and lugs which meet the dimensional requirements of DIN 46235 may be used.

The cross-sectional area of the material of the ferrule or lug shall not, under any circumstances, be less than the cross-sectional area of the conductor to be jointed or terminated.

The size of ferrules and lugs must match exactly the size of the conductor to be jointed or terminated. The use of oversized lugs or the removal of strands of the conductor is not acceptable.

The use of cable lugs with oversized bolt holes or the connection to busbars with undersized bolts is not acceptable.

The crimping of ferrules and lugs shall be carried out by means of the circumferential single hexagonal or, preferably, double hexagonal crimp. Indentation crimping is not acceptable.

Copper cable ferrules and lugs shall be manufactured by a cold forming process, shall be completely free of seams or joints and shall be manufactured by Metmak, BICC-Burndy or equal and approved.

A3.13.9) IDENTIFICATION OF CABLES

Cables shall be identified at all terminations by means of punched metallic bands or marked with labels or tags.

The use of PVC tape with punched characters is not acceptable.

The identification numbers of cables shall be shown on "as built" drawings of the installation and shall correspond with the Cable Schedule.

A.3.14) EARTHING

Provide all required labour, materials and specialized Contractor services necessary for a completely safe installation of an Earthing System in full conformity with requirements of the Wiring Code and authorities having jurisdiction. Include in general the following:

- Main Earth Electrode System
- 230/400 Volt Service & Equipment Earthing
- Miscellaneous Earthing

All earthing shall also be carried out in accordance with BS CP 1013/1965, except where this varies from the Wiring Code.

All earth connections shall be lugged.

A3.14.1) SUPPLY EARTHING

An appropriately sized copper earth conductor in accordance with the requirements of SANS 10142 will accompany all power cables.

A3.14.2) SAFETY EARTHING

All cabinets (including doors) and equipment bodies shall be earthed and equipotentially bonded in accordance with SANS 10142.

A3.14.3) EARTH LEAKAGE UNITS

All circuits serving switched socket outlets shall be routed via an earth leakage unit. Any other circuit, as required by the Engineer will be routed via an earth leakage unit.

A3.14.4) MATERIALS

Earth conductors shall generally be stranded copper with green PVC insulation. The conductors shall conform to SABS 150 (current edition) quality specification for "PVC-INSULATED CABLES". All earth conductor sizes shall be determined in accordance with SABS 0142, paragraph 4.6 where the earth does not form an integral part of the cable.

Earth conductors for substations, cable trays and rising mains shall generally be copper bar or solid drawn copper rod (annealed). Conductor sizes, where not specified, shall be no less than the size determined in accordance with SANS 10142.

A3.14.5) SUB-DISTRIBUTION BOARDS & SUB-CIRCUITS

A separate earth connection shall be supplied between the earth busbar in each sub-distribution board and the earth busbar in the Main Switchboard.

The connections shall consist of bare or insulated stranded copper conductors installed along the same routes as the supply cables or in the same conduit as the supply conductors. Alternatively armoured cables with earth continuity conductors included in the armouring may be utilized where specified or approved.

The earth conductors of all sub-circuits shall be connected to the earth busbar in the supply board in accordance with SANS 10142.

A3.14.6) RING MAINS

Common earth conductors may be used where various circuits are installed in the same wiring channel in accordance with SANS 10142. In such instances the sizes of earth conductors shall be specifically sized and approved by the Engineer.

Earth conductors for individual circuits branching from the ring main shall be connected to the common earth conductor with T-ferrules or soldered. **The common earth shall not be broken.**

A3.14.7) CONNECTIONS

Under no circumstances shall any connection points, bolts, screws, etc., used for earthing be utilized for any other purpose.

It will be the responsibility of the Contractor to supply and fit earth terminals or clamps on equipment and materials that must be earthed where these are not provided. Unless earth conductors are connected to terminals, the ends shall be tinned and lugged.

A3.14.8) NON-METALLIC & FLEXIBLE CONDUITS

Stranded copper earth conductors shall be installed in all non-metallic conduits and fixed securely to all metal appliances and equipment, including switch boxes, socket-outlet boxes, draw-boxes, switchboards, luminaires, etc. The securing of earth conductors by means of self-threading screws will not be permitted.

An earth conductor shall be installed in all non-metallic flexible conduit. This earth conductor shall not be installed externally to the flexible conduit but within the conduit with the other conductors. The earth conductor shall be connected to the earth terminals at both ends of the circuit.

A3.14.9) WATER PIPES

Metal cold water mains shall be bonded by solid 12mm x 1,6mm copper strapping to the earth busbar in the Main Switchboard.

All other hot and cold water pipes shall be connected with 12mm x 1,0mm perforated or solid copper strapping (not conductors) to the nearest switchboard.

The strapping shall be fixed to the pipework with brass nuts and bolts and against walls with brass screws at 150mm centres.

In all cases where metal water pipes, down pipes, flues, etc., are positioned within 1,600mm of switchboards an earth connection consisting of copper strapping shall be installed between the pipework and the board.

In vertical building ducts accommodating both metal water pipes and electrical cables, all the pipes shall be earthed at each distribution board.

A3.14.10) ROOFS

Where service connections consist of overhead conductors, all metal parts of roofs, gutters and down pipes shall be earthed.

One bare 10mm² copper conductor shall be installed over the full length of the ceiling void, fixed to the top purlin and connected to the main earth conductor of each switchboard.

The roof and gutters shall be connected at 15m intervals to this conductor by means of 12mm x 1,0mm copper strapping (not conductors) and galvanized bolts and nuts. Self-tapping screws are not acceptable.

Where service connections consist of underground supplies, the above requirements are not applicable.

A3.14.11) PUSH BUTTON & ISOLATOR STATIONS

All isolator/push button stations shall be provided with an earth terminal. This shall be connected to the body of metal enclosures.

All fibreglass enclosures shall be similarly supplied with earth terminals. All exposed metal portions of equipment (push button shrouds, etc.) shall be connected to this terminal.

A3.14.12) TRUNKING & TRAYS

All metal trunking and cable trays are to be earthed.

A3.14.13) EARTHING & BONDING WIRE

The medium voltage switchboard, transformer earthing terminal and cable supports must be bonded to the main earth bar by means of 70mm² earth conductors.

The neutral busbar and earth bar in the main LV switchboard shall be bonded to the main earth bar with an earth conductor (or conductors in parallel) having a cross-sectional area of not less than half the size of the LV phase conductor (or conductors in parallel) between the transformer and the main LV switchboard.

In addition, a 70mm² copper earth conductor must be laid in the cable trenches along with all incoming and outgoing medium voltage cables for a distance of 40m (or as specified) and the conductors must be connected to the main earth bar.

A3.14.14) EARTH RESISTANCE MEASUREMENTS

Test the resistance to earth of each distribution board earth bar.

Carry out 'spot' tests on at least 5% of all sub-circuits to determine the impedance to earth of the sub-circuits' earth connection.

All test results are to be fully documented and forwarded to the Engineer in written form.

The Contractor must carry out earth resistance measurements on completion of the installation of the earthing electrode and the results must be submitted to the Engineer for approval.

Should the earth resistance be too high, the Contractor may be requested to install additional earth rods or trench earths, for which a variation order will be issued.

A3.14.15) LIGHTNING & SURGE PROTECTION – ELECTRONIC/COMMUNICATIONS SYSTEMS

The Contractor shall supply and install all the necessary lightning protectors, arrestors and other equipment to provide protection for both the equipment and people utilising this equipment. This equipment shall form part of the Works unless otherwise specified.

The guidelines laid out in the CSIR special report No. ELEK 165 - "A Lightning Protection Guide for Electronic Installations" shall be followed to protect all electronic and other equipment prone to suffer lightning surge damage.

All input and output circuits shall be equipped with surge protection so as to ensure that surges transmitted along the control cables do not affect the equipment.

All CCTV coaxial cables shall be provided with in-line surge suppressors.

All data communications cables which run between different buildings shall be protected at both ends by suitable lightning protection terminals.

The Contractor shall guarantee the entire installation against any damage that may be caused by lightning and static discharges and all necessary steps shall be taken to safeguard the equipment and the installation.

All mains lightning arrestors shall comply with the requirements of SABS 171 and shall bear the SABS mark.

The protection unit shall consist in essentials of a four terminal plus earth assembly containing coarse and fine protection. The fine protection shall consist of in-line impedances shunted by a silicon clamping device such as a transorb diode on the output terminals; coarse protection shall consist of two spark gaps in series across the incoming terminals with the centre point taken to earth (alternatively a 3 terminal spark gap is acceptable). In either case the signal lines shall remain decoupled from earth under normal conditions.

The unit shall be selected to have a voltage rating as close to, but above the normal line voltage and to safely carry the maximum expected line current. The internal impedances shall be rated to withstand a continuous short circuit on the output terminals without overheating or change in characteristics.

The nominal discharge surge current shall be not less than 10kA on an 8/20 impulse. The unit shall be capable of sustaining ten successive pulses of this value, at one minute intervals, without suffering a change of characteristic.

The protection level shall be such that the output voltage between terminals will not rise to more than 1,5 times the rated voltage within 1nS on the application of an input surge voltage of 10kV, 1,2/50 waveform or on a current surge of 5kA on a 8/20 wave, conductor to earth voltage shall not rise to more than 1,1kV under similar conditions.

The unit shall consist of a base which can be attached to a DIN rail and fitted with incoming, outgoing and earth terminals and into which the protection device is plugged. The plug-in assembly shall contain all the dynamic devices. It shall be possible to remove this part for remote testing without impairing the current loop in any way. The input terminals for the field cables shall be arranged to be at the bottom of the unit. The earth connection shall be as direct as possible and not less than 4mm² in cross section.

A.3.15) CABLE FASTENING

All cables shall be individually strapped onto trays with PVC cable ties or stainless steel cable ties where mounted externally. Cables shall be strapped at appropriate intervals to ensure that they are straight and sag free.

The correct spacing shall be maintained.

Kinking of cables is to be avoided.

A.3.16) GENERAL POSITION OF SWITCHES

Sockets with their controlling switches shall be mounted with the centre line 300mm above finished floor level, unless otherwise specified or if mounted in approved trunking.

Switches for lights are to be mounted with the centre line 1.4m above the floor, except where otherwise specified or indicated on a drawing.

Where walls are tiled halfway switches and sockets must be installed 40mm above the tiles.

Unless otherwise approved, the switches controlling lights and installed adjacent to doors are to be placed at the lock side of the door at a distance of 200mm from the door jam to the centre line of the box, in each case. If the lock side of a door is not shown on a drawing, it must be ascertained before the switch is positioned.

A3.16.1) LIGHT SWITCHES

Light switches generally shall be of the Crabtree type rated at not less than 16Amps and shall conform to SABS 163 of 1951 as amended. The switches shall have an Ivory type non-conductive cover plate in wet areas.

Where weatherproof light switches are called for, they shall be of the totally enclosed Rotary type. All light switches shall be mounted at a height of 16,5 brick layer's centre (1.4m).

A3.16.2) SWITCHED SOCKETS

Switched socket outlets generally shall be 16Amp 3-pin and of the Crabtree make. Surface outlets shall be installed into YORK fiberglass boxes with a sliding cover. Mounting heights for socket outlets shall be 300mm from floor level, unless specified or in power trunking.

A.3.17) CONNECTION OF LIGHTING FITTINGS & APPLIANCES

All high bay and fluorescent fittings will be supplied with a 3m flexible cord and 5Amp plug.

A3.17.1) LIGHT FITTINGS

Information as to type and position of light fittings will be given in finishing schedules or specified elsewhere in the RFQ.

Where it is necessary to supply lights from a ceiling mounted trunking, they will in general be supplied from a 5A unswitched socket outlet and a plug.

Unless otherwise specified, all outside lighting will be switched via a daylight switch-contactor combination.

A3.17.2) LAMPS

The sizes and types of lamps are specified in the SCHEDULE OF LUMINAIRES.

Where the Contractor is required to supply a luminaire, he will supply the appropriate lamp with it.

A3.17.3) ISOLATORS

Isolators in general shall be of the double pole type. Crabtree or similar and equal and approved will be accepted.

A3.17.4) LIGHTING LEVELS

The design of the lighting layout shall be such to conform to SANS 0114 with respect to the lux requirements.

A.3.18) CONNECTION OF DOMESTIC TYPE STOVES

The connection of each stove, except where otherwise specified, shall consist of 2x10mm² conductors and a 6mm² bare copper earth wire in 25mm conduit. A 60Amp double pole micro-gap isolator shall be flush mounted in a wall outlet box behind the stove in the run or the tubing, above or in the tile work, if any, but not less than 1.2mm above finished floor level. A 25mm conduit from the isolator shall terminate 300mm above the floor in such a position that it will be behind the stove. Wiring from the conduit to the stove shall be housed in a flexible conduit of the same diameter as the conduit used. The flexible conduit may be connected to the conduit by means of an extension ring and cover, a coupling or by means of a dome lid, with m.i. box.

A.3.19) CONNECTION OF GEYSERS

Each geyser shall be protected on the distribution board by means of a double pole circuit breaker. In addition, a recessed or surface-mounted 2 pole 30Amp isolator must be positioned adjacent to the geyser. Where the Wiring Code or regulations of the Local Supply Authority prohibit the installation of an isolator, the protection on the distribution board shall be a circuit breaker and neutral isolator combination.

The conduit connection is to terminate directly on the geyser in such a manner that it can be uncoupled from below. A flush round draw-box shall be provided close to the geyser. Flexible conduit may only be used where specifically approved.

The Electrical Contractor must ensure that all geysers are installed to allow for easy removal of elements and thermostats. The geyser outlet steelwork or mounting lug must be earthed, in addition to any earthing terminal in the geyser connection box. The use of copper tubing as an earth path is not acceptable.

A.3.20) INSTALLATION OF DISTRIBUTION BOARDS

All distribution boards shall be installed with the top edge 2m above finished floor level, unless otherwise specified. The Electrical Contractor is to supervise the actual building-in of trays to ensure a neat installation and shall, after placing in position of any tray, provide wooden struts inside the tray to prevent any deformation of tray sides during building operations. All boards shall be accurately level in all planes.

All distribution boards shall be cream coloured. Where there is a requirement for emergency and UPS supplies, the following will apply:

- The distribution board shall have compartments for mains, emergency and UPS sections and they shall be electrically and mechanically separate.
- The arrangement for the boards shall be from left to right, main section, emergency section and the UPS section. Each section shall be provided with its individual doors. All equipment, including the main switch shall be behind hinged doors. Each door shall be clearly labeled.

The final colour of the boards shall be as follows:

- Distribution Board Outside: Cream
- Main Section: White
- Emergency Section: Red
- UPS: Yellow

A legible label will be fixed on the distribution board door stating the distribution board name, where it is supplied from and the size of the supply cable.

All other warning labels shall be affixed in the appropriate fashion.

A.3.21) BUILDING DAMAGES

On completion of the contract, any damage to plastering, floors, ceilings, wood and paintwork, etc. during and because of the electrical installation shall be made good to original finishes by the Electrical Contractor.

A.3.22) UNINTERRUPTIBLE POWER SUPPLY (UPS)

All UPS equipment to be installed by the Contractor will in general be free issued to him.

Switched socket outlets serving UPS powered equipment shall consist of a 16Amp plug with a flat earth pin.

The 16Amp socket outlet units shall be supplied complete with a plug top. The plug top and the socket outlet shall be red in colour. Each circuit shall be protected as per specification.

A.3.23) TELEPHONE INSTALLATION

Conduits from the telephone DB to various telephone points shall be 25mm and shall be complete with draw wires. Every telephone point must have a separate conduit from the distribution board. Looping is not permitted.

Unless mounted in trunking, all telephone points shall terminate in a 100x50x50mm flush conduit box.

All telephone connection boards shall be 600x600x150mm. The telephone connection boards shall be complete with architrave and door with two flush fitting twist locks. A full size 20mm thick hardwood mounting board shall be provided in each board.

The boards shall be fitted with a label with 10mm white engraved letters on black background "TELEPHONE BOARD" with two screws.

The colour of the telephone connection board is to be white.

A.3.24) COMPUTER (DATA) INSTALLATION

Data cabling will be installed in dedicated conduits and trunking enclosures. All computer connection boards shall be 600x600x150mm. The computer connection boards shall be complete with architrave and door with two flush fitting twist locks. A full size 20mm thick hardwood mounting board shall be provided in each board.

The boards shall be fitted with a label with 10mm white engraved letters on black background "COMPUTER BOARD" with now screws.

The colour of the telephone connection board is to be grey unless otherwise specified in the project drawings.

A.3.25) SUPPORTING BRACKETING & FIXING

The drilling of holes in structural steelwork is not permitted except with prior written approval of the Engineer.

The drilling of holes in vessels or process pipe work is prohibited. Welding on any vessel of process pipe is prohibited, however clamping on process pipe work can be accepted if its design is approved by the Engineer.

A.3.26) EQUIPMENT ISOLATORS

All machinery, control panels and motor circuits are to have a lockable MAIN SWITCH, which shall be able to be switched off and locked out in the off position.

A.3.27) PREFERRED EQUIPMENT LIST

The trademarked equipment is to be used when tendering for installation work. Any deviation must be approved by the Engineer or his representative.

A3.27.1) ITEM MANUFACTURER

- Distribution Boards SABS Approved
- PVC-Insulated Conductors SABS Approved
- PVC-Insulated Cables SABS Approved
- Conduits & Accessories
- Light Switches
- Plug Sockets
- Moulded Case Circuit Breakers
- Earth Leakage Units
- Isolators
- Light Switches (Waterproof)
- Cable Ladder
- Wiring Channels
- Power Skirting
- Contactors
- Local Isolators
- Time Switches
- Transformers
- Ht Switchgear
- Welding Sockets
- Cable & Core Markers
- Push Button & Control Gear
- Motor Control Gear
- Proximity Switches
- Ups Units
- Power Supplies

- Enclosures
- Terminals
- Relays

A.4) INSPECTION & TESTING

A.4.1) GENERAL REQUIREMENTS

Complete functional and operational tests shall be carried out on all of the Contractor's work as may be described by the Engineer at that time. The Engineer or his representative reserves the right to be present at these tests. Such inspections shall not relieve the Contractor of his responsibility for meeting all requirements of the inspection and it shall not prevent subsequent rejection if such material or equipment is later found to be defective.

To ensure that wiring may be easily withdrawn from any circuit run, the Engineer may, at his own discretion, direct that wires be withdrawn by the Contractor. If these wires are withdrawn easily without showing damage, the costs of withdrawal and replacement will be borne by the employer, otherwise the Contractor will rectify this at own expense.

The Electrical Contractor shall furnish a test report detailing particulars of at least the following tests executed:

- a) High voltage test of 2,000V, 50Hz, AC for one minute between phase and earth in turn with the remaining phases earthed.
- b) A 1,000V megger test on all insulated sections, from phase-to-phase and phase-to-earth. Resistance readings shall exceed 1,000 megohms.
- c) Full operational tests of all equipment according to drawings on circuits.
- d) A trip test on all earth leakage units by creating an earth fault to appropriate magnitude.
- e) A current injection trip test on all main breakers to ensure that they trip at their set current.
- f) Earth loop resistance tests on all earthed equipment.
- g) Checking of all polarity on all switched outlets.
- h) Such other tests as may be laid down in the "Detailed Requirements" or "Schedules"

A Certificate of Compliance (COC) according to the Act shall be issued for the complete installation.

A.4.2) TESTING OF MEDIUM VOLTAGE CABLES AFTER INSTALLATION

A4.2.1) PROCEDURAL

Within fourteen days of the completion of a cable installation and jointing the Contractor shall arrange for a pressure test on all new and re-routed MV cables and shall provide all necessary test equipment and instruments. Pressure tests are to be carried out before and after connections to switchgear are made.

The Contractor shall establish the requirements of the Supply Authority as regards both testing and witnessing of tests before commencement of tests.

All tests are to be carried out in the presence of the Engineer and the Contractor shall record all results and confirm in writing.

All tests shall be reported on in an agreed format and individual megger readings are to be presented for each cable tested.

A4.2.2) TEST VOLTAGES – PILC CABLES

After installation of MV PILC cables, test each length of cable for continuity and insulation in accordance with the following table:

Cable Rating (kV)	TEST VOLTAGE (Applied for 15 minutes) (kV)			
	Paper-Insulated cables			
6,6 11	Between Conductors		Conductors to sheath	
	AC (r.m.s.)	DC	AC (r.m.s.)	DC
	12	18	12	18
	20	30	20	30

A4.2.3) TEST VOLTAGES – XLPE CABLES

The values, magnitudes and testing procedures for XLPE insulated cables differ significantly from those accepted for PILC cables. If the latter methods are used significant initial or latent damage will occur.

The leakage resistance of each core shall be accurately measured and recorded using a Megger type DC instrument generating a voltage of not less than 500 and not exceeding 5000 volts. The values shall be not less than $(2U + 2)$ MΩ/km e.g. for 1km cable operating at 11kV the minimum acceptable insulation resistance is 24MΩ.

The integrity of the sheath shall be verified by the application of 5kV DC for 1 minute between earth and the inner metallic sheath. A current of 1mA/km is acceptable.

An overvoltage test shall be applied to the cores prior to energisation, as switching a circuit breaker onto a fault could be hazardous to the operator as well as causing severe damage to the equipment.

The overvoltage shall be produced by either:

A sine wave voltage in the range 25-100Hz

A sine wave or square wave voltage at 0.1Hz approximately

and applied for 60 minutes at the magnitudes shown below in kV between the three conductors connected together and the screens and armouring tied together to earth.

	Cable operating voltage kV			
Applied Test Voltage kV	6.6	11	22	33
Power Frequency	8	13	25	38
Very Low Frequency	11	19	38	57

The cable shall be discharged through a resistance of 200k Ω and then earthed for 5 minutes.

In the event that the capacity of the mains frequency test set is adequate or a VLF set is unavailable a DC test is permissible under the following conditions:

The duration of the test shall not exceed 10 minutes.

The cable shall be discharged through a resistor of 200k Ω and then solidly earthed for 24 hours.

Discharging the cable by applying a short circuit can cause severe damage.

	Cable operating voltage kV			
Applied Test Voltage kV	6.6	11	22	33
DC Voltage kV	6	10	20	30

Prior to energisation the leakage resistance shall be measured as in 2.1. Any significant reduction shall be reported to the engineer.

The terminal load (e.g. transformer) must be connected and switched in prior to closing the source circuit breaker as the energisation of an unterminated line can cause voltage doubling to occur at that position.

A.5) SHIPPING

The assembly shall be suitably crated and packed for the transport system to be used. If the transport of the assembly to site is included in the contract it shall be the responsibility of the Contractor to ensure that the crating and packaging is suitable. If transport is excluded from the contract, the crating and packaging shall be done in accordance with the instructions of the transporter. The proposed crating and packaging system shall be approved by the Engineer, but this approval shall not relieve the Contractor of any of his responsibilities. The costs of preparation for shipping will be included in the vendor's price.

The vendor is responsible to ensure that no damage will be sustained while shipping and he will prepare the appropriate packaging to ensure this.

The datasheet shall indicate whether the vendor is to deliver the equipment to site and whether the vendor is to offload the equipment on site or if the delivery and offloading on site shall be carried out by a third party.

Where delivery and/or offloading by the vendor is specified on the datasheet, the costs thereof shall be included in the vendor's price.

A.6) INSTALLATION

The datasheet shall indicate whether the vendor is to install the equipment in its final position on site or if the installation shall be carried out by a third party.

Where installation by the vendor is specified on the datasheet, the costs thereof shall be included in the vendor's price.

The Contractor shall provide and carry out everything necessary to complete the whole installation and put it into service. Full details and drawings of the equipment are to be obtained by the Contractor. Where necessary in the opinion of the Engineer the Manufacturer or Suppliers of the equipment are to provide engineering assistance at the Contractor's expense to enable any difficulties experienced with the equipment during erection, connecting, testing, putting into service or operating, to be overcome to the satisfaction of the Engineer. The Contractor shall advise the suppliers the time and extent of the engineering assistance required.

Before erection commences, the equipment shall be inspected by the Contractor and properly cleaned to remove the protective coverings and coatings supplied before dispatch from the Manufacturer's works. Examine all components for visible signs of damage and report all damage in writing to the suppliers with a copy to the Engineer.

The Contractor shall carry out the erection, including cutting holes for holding-down bolts, positioning and grouting holding down bolts in accordance with jigs or drawings supplied observing all erection instructions and precautions for erection that may be issued by the Manufacturer or supplier of the equipment.

The Contractor is to make sure that complete switchboards have been properly aligned vertically and horizontally and that all bolts and connections between panels and/or busbar joints and other mating parts have been properly assembled. All bolts and other fastenings are to be tightened and the Contractor is to ensure that all cubicles will receive the switchgear units correctly and that there is no distortion which will result in poor appearances and difficulties in operating the equipment.

The paintwork is to be touched up with matching paints supplied by the Manufacturers.

All wedges and packings installed at Manufacturer's works to prevent damage to moving or delicate components during transport are to be removed.

Check from the Manufacturer's drawings that all instruments and components are correctly connected.

Busbar covers are to be removed and all connections and tap-offs are to be checked and all loose connections tightened. Check support insulation for defects or damage and replace faulty insulators. Remove any dirt, tools and loose materials from the busbar chamber before replacing covers.

A.7) COMMISSIONING

The datasheet shall indicate whether the vendor is to allow for a site technician to be present when the equipment is commissioned and energized. In such a case the vendor's site technician will:

- Conduct the site tests as described in Section 4 above.
- Conduct voltage tests on the equipment, after the equipment is energized and adjust the tap changer so that the equipment delivers the required output voltage.

A.8) DRAWINGS & DOCUMENTATION

Prior to work commencing, the tenderer shall receive a copy of drawings the Engineer deems relevant for tendering. The successful tenderer shall receive all relevant drawings before work commences and in the event of updates on drawings, the Contractor shall receive such copies for construction. In the case of design/drawings required from the Contractor, all working drawings will be submitted to the Engineer for his approval before commencement of work.

The Contractor shall in any case provide the Engineer with all "as built" change notes as gathered/identified during installation and commissioning on mechanical and electrical work (including wiring diagrams) as a pre-requisite to final payment. "As built" drawings shall be maintained on a current basis as work in progress.

The Contractor shall be responsible for providing all the necessary drawings for approval by the Engineer. Unless otherwise specified all drawings shall be done to the IEC drawing standards using IEC symbols.

The Engineer may provide reference drawings, as listed in the data sheet for information to the Contractor. These could include amongst others, single line diagrams, actual or typical schematic diagrams, control system drawings or schedules etc.

The Engineer may require a single schematic diagram for each functional unit type or require separate schematic diagrams for each functional unit and this preference shall be expressed in the data sheet.

General arrangement (GA) drawings shall indicate the physical size of the assembly, the space required around the assembly for operation, transport unit sizes, positions of the functional units and the foundation arrangement. It shall also detail the overall mass of the assembly as well as the mass per transport unit.

Typical schematic drawings are preliminary drawings generally done per functional unit type and issued for information, comment and or preliminary approval. They shall in all cases be developed into detailed drawings for construction.

The Contractor shall provide one set of the manuals for all components contained in the assembly (preferable in electronic format on a CD).

A.9) QUALITY ASSURANCE

A.9.1) CERTIFICATION

The vendor shall supply a comprehensive QA/QC Plan in accordance with ISO 9001:2008, as part of his bid or prior to manufacture, as indicated on the data sheet.

All equipment manufacturers shall have valid SANS 9000 certification.

A.9.2) QUALITY PLAN

The Contractor on receipt of a contract for the manufacture of switchgear and controlgear assemblies shall compile and submit a quality plan which shall be approved by the Engineer prior to commencement of manufacture.

The quality plan shall list all major operations, specifications, verifications, tests, methods of test and equipment to be used and acceptance/rejection criteria.

The quality plan shall list all major operations, specifications, verifications, tests, methods of test and equipment to be used and acceptance/rejection criteria.

A.9.3) ACCESS

The Engineer's representative shall have access at all reasonable times to those parts of the manufacturing facilities engaged in the manufacture of articles to this specification. The representative is authorised to witness any stage of the manufacture and testing and inspect documentation. The representative is authorised to reject any items not complying with the requirements of this specification. In the event of a dispute arising regarding interpretation of test results the decision of the Engineer shall be final.

A.10) GUARANTEE

All equipment and materials shall be guaranteed against defect for a period of twelve months, from the date of mutually agreed successful hot commissioning, fair wear and tear accepted.

Tenderers shall submit a written undertaking at the time of tender that a complete range of spares for the equipment offered will be held by the manufacturer for a minimum period of 10 years from the date of tender.