STANDARD SPECIFICATIONS AND REGULATIONS

All electrical equipment shall comply with this specification and the latest issues of the relevant standard specifications and codes of practice.

Where there is any conflict between the requirements of the Specification and the Specification of Equipment, then the Specification shall take precedence. Where there is any conflict between the requirements of this Specification and International Standards, then this Specification shall take precedence, unless otherwise agreed to, in writing, by the Engineer.

The works performed under this contract shall comply in every respect with the latest relevant rules and regulations including following:

- Occupational Safety and Health Act (OSH Act)
- The South African Bureau of Standards Code of Practice SANS 10142
- Normal requirements laid down by Eskom
- The latest requirements of the IEC and the British Standard Institute, where no SANS codes of practice exist
- All rules and regulations issued by local and other authorities having jurisdiction over the contract.

The Contractor shall note that he will be held fully responsible for the electrical works and for the correct and satisfactory testing and commissioning of the complete electrical installation. Tests shall be made on each item of major equipment at the manufacturer's works. The contractor shall give reasonable notice in writing to enable the Engineer to inspect and witness tests of materials and equipment. He shall provide the Engineer with facilities for witnessing these tests and for any additional tests that the Engineer may require. The Contractor shall, at his own cost, render all assistance and supply all labour appliances and any other materials, as the Engineer may require to check the setting out, measure up and inspect any portion of the works at any stage during manufacture, construction, erection of painting. During such operations the Contractor shall if required, suspend any or all the Works without having any claim for loss of damage as a result thereof. The repetition of any test shall be deducted from the contact price.

Commissioning shall not commence until all work on that part of the system has been completed. First, the electrical equipment and circuitry shall be checked and tested in each distribution board and shall be rendered "healthy" and fully operational before any other part of the installation is commissioned. The settings of all protective, instrument and timing devices are to be correct, based on the manufacturer's characteristic curves. The operation of all equipment and motors shall be tested in the "manual" sequence first, prior to attempting "automatic" sequence control. Commissioning shall follow the electrical testing procedures, prior to start-up of the plant. The start-up of each system or plant shall be done in the present of the authorised representatives of the pump contractor suppliers, the electrical suppliers of any MV boards, the Contractor and the Engineer.

The Contractor shall check and satisfy himself that all items of installation and equipment are correctly wired and connected before start-up. This work is to be carried out by skilled commissioning engineers who are completely familiar with the equipment and the operation of the installation involved. On completion of the commissioning the Contractor shall provide written confirmation to the Engineer that he has completed all commissioning work and is satisfied that the items of equipment and plant are operating satisfactorily.
On completion of the Contractor’s Initial Testing and Plant Commissioning as specified above, the plant shall be put into normal operation and the final adjustments of the plant shall be made. These tests shall extend for a period of at least four weeks.

On completion of all inspections, tests and commissioning of the Works the Contractor shall issue the Engineer with a certificate of compliance by an accredited person.

CABLES & TERMINATIONS

GENERAL

Cables shall be supplied and installed which conform to the requirements of SANS 1411, SANS 10198, SANS 1507, SANS 1574. The minimum size of conductors and shall be:
- Instrumentation and control – 1,5 mm²
- Lighting – 2,5 mm²
- 1 phase power – 2,5 mm²
- 3 phase power – 2,5 mm²

Cable ends shall be terminated with glands or in cable boxes with the associated accessories such as clamps, shrouds, etc., complying in all respects with the recommendations laid down by the manufacturers of the cables, glands and termination kits employed. No low voltage cable joints will be permitted during initial installation. Jointing of MV cables is similarly prohibited. Any cost implication resulting from this ruling must be allowed for in the tendered rates for cables.

Cable glands shall include a neoprene sealing arrangement over the outer sheath of the cable at the point of entry of the cable into the gland. Glands that utilise split compression cones for armouring shall not be permitted. Cable gland shrouds shall be provided in all cases except where cables are made off into gland plates at the base of equipment.

All MV cables shall be cross-linked polyethylene cables (XLPE). 3-core cables shall be steel wire armoured cables and 1-core cables shall be aluminium wire armoured cables of an approved manufacture and full technical information shall be submitted with the tender. Cables shall be in accordance with the following conditions:

- Specification SANS 1339
- Number of cores: 3 (Type A)
- Number of cores: 1 (Type A)
- Conductor material: Stranded annealed copper
- Conductor insulation: Cross-linked polyethylene (XLPE)
- Bedding: Extruded compound
- Armouring: Galvanised steel or aluminium wire
- Covering/outer sheath: Extruded black PVC
- Screened: Individually
- Duty: General use
- Earthed or unearthed: Earthed

XLPE cables shall be terminated and jointed with suitable terminating kits approved by the cable manufacturers. All joints shall be of the blocking type designed that prevents the ingress of moisture from one cable to the next through the through joints. Only Acrylic resin type joints of an approved, recognised and internationally accepted make will be accepted. Heat-shrink blocking type joints shall be of an approved make and the construction shall be of a well-proven design. Type test certificates shall be made available on request. These documents shall
emphasise, in particular, the moisture blocking ability of the joint. All joints offered shall be fully capable of working as transition joints for the types of cable concerned.

All MV cables shall be terminated by means of heat shrink terminations. Terminations shall be supplied in kit form and shall be clearly marked with the type of cable and voltage grade. The material used shall be resistant to ultra-violet radiation and shall comply with the requirements of VDE 0278.

All low voltage cables shall be halogen free; XLPE insulated with steel wire armouring and served overall with a final layer of EVA. Cables shall be round with the number of cores specified on the outer sheath and be suitable for general service, as prescribed in SANS 1520. The cores shall be made of stranded annealed copper. Cables shall be armoured with single layer steel wire armouring (SWA).

All cables shall be installed in unbroken lengths. No joints will be allowed.

Low voltage cables shall be:
- 600/1000 volt XLPE insulated type suitable for general use
- manufactured in accordance with to the latest revision of SANS 1520.

One-piece cable clamps, with rear pressure shoes, shall be used to clamp cables.

Low voltage cable ends shall be terminated by means of adjustable glands. 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. The armouring shall be clamped between substantial tapered sections, which form an integral part of the gland. When tightened, these sections shall be secured by lock nuts in order to give a proper earth connection. Each gland shall be fitted with a rubber shroud. The armouring of the cable shall be connected to an earth bar by means of a suitable tinned cable lug.

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 I: "COMPRESSION JOINTS IN COPPER". Contact surfaces shall be thoroughly cleaned and smoothed and fixing bolts shall match the whole 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 as far as possible where 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.

Glands shall be used for all cables to be terminated outdoors. Neoprene shrouds and suitable heat shrink covers shall be fitted. Where cables enter outdoor boxes, glands shall be provided with neoprene washers in order to seal off the holes.

The Contractor shall install cables in such a manner to avoid twisting and to ensure that they are not bent to a radius less than that specified in the regulations. Where cables are run in ceiling voids or vertically, they shall be adequately supported on stainless-steel cable trays, being fixed to the trays by means of plastic self-locking straps or drawn through saddle supported galvanised conduit. Suitable tinned lugs, terminals and other fittings shall be used to match the
different sizes of stranded copper core cables. The correct type of crimping tools shall be used to
crimp the lugs, terminals and other fittings onto the copper cores.

The contractor shall install cables in such a manner as to avoid twisting and to ensure they are
not bent to a radius less than that recommended in regulations. Cables shall be clamped to
racks with cable clamps for vertical runs and strapped to racks with plastic self-locking straps for
horizontal runs. The clamps shall be stainless steel and shall be suitable sized to accommodate
the different sizes of cables. Power cables shall be installed on the ladders at a spacing between
centres of not less than twice the overall diameter of the cable. Wherever cables pass through
holes in floors and walls or enter or leave pipes or ducts in the floor, the Contractor shall seal the
opening. The opening shall be filled for the full thickness of the floor or wall.

All cables shall be properly identified and labelled as "MV" or "LV", "Control" or
"Instrumentation".

This paragraph describes the procedures for excavating, preparing, marking and closing the
following types of trenches:

- Trenches for cables only
- Common trenches shared by pipes and cables

Trench widths shall be consistent with the working space required. They should not normally be
wider than 500 mm. Trench depths to which trenches are excavated shall be more than:
For MV cables: 800 mm PLUS 150 mm for sifted soil bedding
For LV cables: 500 mm PLUs 150 mm for sifted soil bedding

Trenches shall be as smooth as possible along the bottom. No sharp rocks shall project up into
the trench. MV and LV power cables may share a common trench but shall not be mixed
together MV and LV cables shall be grouped separating with MV cables being at the 800 mm
below ground level.

After the Contractor has excavated a sufficient length of trench, the Client will inspect the trench.
If it is acceptable to the Client, the Contractor shall provide a 150mm layer of bedding materials
in the trench. The Contractor shall then supply and install the cables. After the cables have been
installed, a layer of 300mm approved sifted sand shall be supplied and placed on top of the
cable by the Contractor. The Contractor shall ensure that no stones or rocks are backfilled
directly onto the cables. He shall at all times be present when trenches are backfilled. The cost
of repairing cables, which have been damaged by rocks backfilled onto cables, shall be claimed
from the Contractor.

The cable shall be installed parallel to the water pipe, where a single trench is shared by the
cable and the pipe. In general, cables shall be laid after water pipes have been laid. Cables shall
be removed from their drums in such a manner that no twisting, excessive tension or mechanical
damage is caused. The cable must be adequately supported between short centres during the
whole installation operation. Cable rollers shall be used in all cases.

Where cables have to be drawn through pipes or ducts, a suitable cable sock shall be used.
Particular care shall be exercised to avoid abrasion, elongation or distortion of any kind. Ends of
all pipes and ducts shall be sealed with a non-hardening watertight compound after the
installation of cables.
The Contractor shall ensure that the correct quantities of cable are available, when required. He shall also ensure that the cables are installed in the trenches within a reasonable period acceptable to the Client. Any re-excavations that become necessary because of any lack of performance by the Contractor shall be at his cost.

The Contractor will take all necessary precautions and provide the necessary warning sings and/or lights to ensure that the public and/or employees on site are not endangered while the trenches are open.

A cable sleeve shall also be provided whenever a cable crosses a water pipe. The cable shall always cross underneath such a water pipe. The Contractor shall leave galvanised draw wires in all unused pipes. The backfill under joints shall be firmly tamped to prevent subsequent setting.

After an underground cable has been installed, the length of the cable between the supply point and its termination shall be measured as accurately as possible. This length shall be stencilled or engraved at the cable begin and end terminations. The distance to the first cable marker from each cable begin termination shall also be indicated.

Approved cable markers of a standard departmental design, with an aluminium plate inset, shall be installed on the surface along all MV and LV distribution cable routes. Cable markers shall be placed:

- At intervals not exceeding 100 m
- At every change of direction and joint
- Where indicated by the Engineer
- The first marker shall be placed immediately above the point where the cable enters a substation or building. Cable markers are also required where cables are installed in underground pipes and ducts.

All underground cable shall be identified at all through-joins and at each cable marker by means of a 75 mm wide lead tape, which is clamped around the cable. The following type of information shall be punched onto each lead tape: Example Voltage – 6,6 kV and Cable size – 50 mm².

After the Contractor has placed the 300 mm compacted selected backfill on top of the cable, the Contractor shall supply and install plastic warning strips which shall be installed at a level 300 mm above the electrical cable. This warning strip shall have a minimum width of 300 mm and have a bright orange colour with the wording "Danger/Gevaar/Ingozi". The strips shall also bear the scull and crossbones danger sing. The Contractor shall lay this warning strip and adequately secure it in position with regularly spaced quantities of soil. The minimum thickness of the warning strip shall be 800 gauge.

An earth wire, consisting of an annealed bare stranded copper conductor which shall be run with any selected cable and be buried in the trench with it. The earth wire shall be fixed to the cable with nylon tape at regular intervals not exceeding 2000 mm.

After the cable has been installed in the trench and the initial 300 mm covering has been installed, the installation shall first be inspected and approved by the Engineer before the trenches may be refilled by the Contractor. Should the Contractor ignore this requirement, the trench may have to be re-opened, at the cost of the Contractor, to enable the Engineer to carry out an inspection. The Contractor shall ensure that the proper backfilling of the trench is carried out in a way that causes no damage to the cable after backfilling and compaction. The Engineer shall inspect the trench from time to time to ensure that the requirements are fulfilled. The
Contractor shall keep a logbook with three copies per page on the site. In this logbook, the Client shall record the inspection details of each part of the cable installation that has been checked after inspection and any subsequent approval.

Complete "as installed" drawings of the actual cable work, as it progresses, shall be kept by the Contractor in his site office. Paper drawings showing only the general layout of the area shall be furnished to the Contractor for this purpose. The Contractor shall indicate on these drawings all work completed as well as all the required dimensions. The following information with dimensions shall be indicated on the drawings:

- Actual positions and number of cable ducts installed
- Actual position and sizes of all cables. Where two or more cables are installed adjacent to each other, the correct sequence shall be indicated
- Actual position of all MV joints
- Actual position of all pump stations
- All dimensions taken from easily identifiable fixes points or lines.

The Engineer shall regularly inspect and certify the above "as installed, cable drawings. On completion of the installation, the Contractor shall furnish the Engineer with two complete sets of transparencies, indicating the actual installation. These drawings shall indicate the actual positions of the pump stations, cables, cable joints, cable casings, etc.

The Contractor shall ensure that all materials used are subjected to and shall satisfactorily withstand sufficient of the sample tests detailed in the relevant SANS and BS Specifications to prove the individual materials and the completed cable. The records of such tests shall be available to the Engineer for inspection. The Engineer also reserves the right to visit the factory at any stage and demand that any of all the sample tests detailed in the relevant SANS specification be carried out.

TESTS

All PVC cables shall be subjected to the spark test during manufacture. All cables shall be tested with the voltage applied between cores, and between conductor and earth. Cables with screened cores shall have the conductor to earth voltage applied between all the conductors connected together and all screens connected together. The conductor resistance of each drum length of completed cable shall be measured and shall not be greater than the guaranteed value. The insulation resistance of each core of every drum of completed cable shall be measured and shall not be less than the guaranteed value, corrected for temperature and length. Records of all type and routine test results shall be available for inspection by the Employer's representative at any time.

The Engineer reserves the right to appoint a representative to inspect the cables at any stage of manufacture or to be present at any of the tests specified. The Contractor shall ascertain whether inspection or witnessed tests are required, and the Contractor shall than give the Engineer not less than seven days notice of when items will be ready for inspection or witness tests.
LOW VOLTAGE EQUIPMENT

SWITCHGEAR

All MCCB’s shall comply with SANS 156. Mechanically coupled single pole MCCB’s shall not be used to build up 2-pole or 3-pole units. When selecting MCCB’s, the design current to be used shall not be less than 1.25 times the calculated actual current. The break capacity of each MCCB shall be suitable for the full load specified for the distribution board. When selecting MCCB’s the design system voltage to be used shall not be less than 1.10 times the actual or specified system voltage. Tenderers shall in their original tenders, submit catalogue evidence that the MCCB’s offered will have an estimated mechanical life of over 12 000 operations for the given duty.

Surge arrestors shall be installed in order to protect all 400V electrical equipment and all instruments, signal cables and power cables situated outside the building. For the 400V protection, the surge arrestor ratings shall be co-ordinated with the surge arrestors used by upstream panels and by Eskom. Surge arrestors shall be connected to the live side of the main income breakers in order to protect the 400 V equipment. The surge arrestors shall be of the three-stage cascade type connected in parallel to spark gaps. There shall be one surge arrestor per phase.

Distribution boards (DB’s) shall be of totally enclosed, fixed pattern and multitier design and allow for the logical grouping of equipment. They shall have front access to all equipment, busbars, wiring and terminations. All distribution boards (DB’s) shall be of watertight design and be made of corrosion resistant materials. All isolators and moulded case circuit breakers (MCCB) shall be flush mounted with only the toggle protruding through the front panel. Contactors shall be mounted behind the front panels. They shall be clearly marked in a way to indicate their functions. Miniature circuit breakers (MCB’s) may be installed on mounting panels designed for this purpose and fixed to the chassis or framework. All instruments shall be flush mounted. Where instruments are mounted on hinged panels, removable covers made of insulating materials shall cover the backs of these units. These covers shall protect the instrument terminals and prevent accidental contact. All incomers shall be suitable for fault-make and full load-break service.

EARTHING SYSTEMS

The system of earthing and the earthing of all equipment and apparatus shall be carried out strictly in accordance with the requirements of the supply authority and SANS 10142. The contractor shall provide a complete earthing mat and all the earthing connections. The earthing circuits shall consist of copper earthing bars or bare standard conductors connected to the above ground terminals of the buried earth mat. Joints shall not be permitted in any earth continuity conductor or the earthing lead between the points of terminations. The connections to earth continuity conductors shall utilise crimp or cadweld techniques. The installation of the earth continuity conductor or any earthing lead shall be undertaken in such a manner that it is adequately supported along its entire length. Each switch socket outlet and equipment isolator shall be earthed by means of a stranded bare copper earth wire (BCEW).

All earth conductors shall be EVA insulated. Bare copper earth conductors will be used as trench earths only. All earth conductors inside distribution boards must be terminated individually on the relevant earth bars. Earth conductors in conduit boxes, luminaires, trunking, etc. must be unbroken. Pin lugs or crimped ferrules shall be used where intermediate earth connections are required. Earth conductors shall be lugged and bolted to the earth bars (on DB side only) to form a removable connection for testing purposes. Earth connections to water pipes shall be clamped
with cadweld standard clamps onto 25 mm diameter water pipes or by bolted copper tape connections on 50 mm diameter water pipes. Bolted connections shall be sealed against the ingress of moisture by an inert self-fusing insulating vinyl mastic compound tape. All other connections in earth conductors shall be welded by the cadweld exothermic process. (i.e. earth wire to earth wire or earth wire to spike-electrode and trench earth). All stranded copper conductor joints shall be properly brazed. Where stranded copper conductors are to be connected to earth bars, the conductors shall be properly soldered into suitable tinned lugs. The lugs shall be bolted onto tinned copper bars.

The contractor shall carry out Earth Resistance tests with the main earth conductor DISCONNECTED from the earthing system of the supply network to prove the earth efficiency. The maximum resistance to earth that will be allowed is 1 ohm. The contractor shall provide the Engineer with a certificate in this regard. When the Earth Resistance test has been successfully completed, the contractor shall connect the main earth conductor to the earthing system of the supply network. Before the engineer accepts the earthing system, the resistance to earth shall be measured by means of a recognised bridge method. The contractor shall provide the necessary test equipment. The earth tests shall be done at all earth points i.e. at any apparatus or equipment where they are connected to the earthing system.

An earthing survey shall be carried out in the development area. Tests shall be carried out at the positions of the weir and at all earth electrode positions depicted on the site plan. The result of these tests shall be submitted to the Engineer in writing. These tests shall also include recommendations to obtain the earth resistance described above. A recognised specialist in this field shall carry out the earthing survey. Tenders shall include for the number of earthing tests as set out in the Bill of Quantities. After earth electrodes have been installed a recognised authority shall test the earth resistance and the values shall be documented on test certificates. Earthing shall generally be effected by means of earth spike electrodes, as well as trench earth conductors where specified.

Earthing mats shall be included in the civil design and subsequent erection in the case of foundations for pump stations and valve chambers. The whole of the completed installation shall be effectively and efficiently earthed in accordance with the latest edition of SANS 10142 and to the requirements of the local Supply Authority. The Tenderer shall allow in his tender price for the provision of earth mats, copper bonding straps, wiring and the proper bonding of the whole installation, including the bonding of the sheeting, down pipes, gutters, etc. No part of an earthing mat or connection to it shall be enclosed by a metal pipe or similar structure. The conductors of the mat proper shall be made of copper and have a minimum section of 25 mm x 3 mm. Connections to and joints within earthing mats shall have joints within the mats which overlap by at least 100 mm, shall have connections to the mats which overlap a mat member by at least 100 mm and shall have joints which are brazed. Where a conductor passes through concrete, it shall be made of solid copper bar or rod with a minimum section of 70 mm^2. Earthing mats shall be located at a level more than 500 mm below ground level.

Single-phase socket outlets shall be flush mounted and be rated for 16 amperes at 230V, incorporate three contact tubes and be mounted in 100 mm x 100 mm conduit boxes.

Industrial surface mounted socket outlets shall be manufactured of steel box and cover plate parts in a manner to make a dust proof assembly to IP 44, have switch toggles or rockers which are shrouded where it protrudes through the cover plates and where required for dust proofing reasons, have hinged and sprung dust proof flaps over the switches and contact tubes.
Three-phase socket outlets shall be of the GEE 17, 380V, 6h pattern, have 5 contact tubes for 3 phase, neutral and earth, incorporate switches which can only be operated when the plug is inserted and be rated at 40 ampere, unless otherwise specified.