

23 March 2023

Ezemvelo Wildlife: Midmar

Project Description: Refurbish and replacement of existing electrical infrastructure.



1. INTRODUCTION

This report outlines the details, on which the scope for the proposed refurbishment and replacement to the existing electrical infrastructure to the various buildings and external distribution network located at Midmar with the result being the issuing of certificate of compliances for all the distribution boards and external kiosks, in a phased approach and in accordance with the latest revision of the SANS 10142-1 wiring codes. The list of buildings are as follows:

- Main Office
- Law Enforcement Office
- Staff Accommodation
- All Chalet's
- Midmar Training centre kitchen
- Laundry
- Pump house
- Electricity Room
- All staff accommodation
- Orient Park Staff Accommodation
- Classrooms

- Storerooms
- Ablutions
- Strong room

2. PHASE 1 – Testing

2.1 SCOPE

The contractor to test the following items but not limited too with the intent to provide a detailed report of findings once testing has been concluded per distribution board and external kiosk.

- All electrical circuits
- Earthing and bonding
- All plug points.
- All lighting points.
- The Distribution Board is labelled correctly.
- The correct sized conductor has been used.
- The correct breaker size has been used in the Distribution Board for all circuits.
- Sufficient breaker protection has been used.
- All breakers have their ratings visible.
- The earth leakage is in working order.
- The stove is cabled up correctly.
- The stove has an accessible isolator.
- All socket outlets, switches and light fittings are secured.
- All socket outlets, switches and light fittings are earthed.
- All socket outlets are in working order.
- The satellite and TV antenna is earthed and bonded.
- The geyser water pipes are earthed and bonded.
- The geyser cover is secure and has a gland.
- The following portable appliances must be fitted with an isolator within 1.5m of the appliance: Geyser, gate motor, garage door motor, extractor fans, ceiling fans, air-con units, water feature, and any pump if applicable.
- The correct cable size and colour has been used for the various applications.
- Light fittings being used are rated for the specific areas.
- That there is no exposed house wiring.
- No open joints or broken conduit.
- All conductive parts of the installation shall be earthed and bonded and be the same electrical potential as the supply authority earthing.
- Certificate valid for 2 years from date of issue (If the installation has not been amended).

Once the testing phase has been completed the electrical contractor to provide an electrical certificate report to Reveal if any of the electrical circuits or equipment are overloaded, find any potential electric shock risks and fire hazards, identify any defective electrical work, and highlight any lack of earthing or bonding in a logically format.

3. PHASE 2 – Work to be undertaken to enable the issuing of a certificate of compliance per distribution board and External kiosk

3.1 SCOPE

- Following phase 1, the engineer and contractor will discuss the report provided by the contractor and identify items that are of necessity to ensure a certificate of compliance can be issued per distribution board and external kiosk.
- All lights fittings to be replaced with new energy efficient lighting.
- All plug points to be replaced with new regulation type plug points.

SPECIFICATION
FOR THE
ELECTRICAL INSTALLATION

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SPECIFICATION FOR ELECTRICAL WORK

PART 1 - GENERAL

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PART 1 - GENERAL

1. INTRODUCTION

- (a) These Standard Specifications cover the general technical requirements for the equipment, materials, installation, testing, commissioning and maintenance of electrical installations for the Department. This specification shall be read in conjunction with the relevant , Bills of Quantities and General/Standard specification for this installation.
- (b) "Document" shall mean the complete set of contract documents, including the Department's Tender Conditions, Tender Qualifications, the Standard Specification and the Detail Technical Specification including variation orders issued in terms of the contract.
- (c) "Contractor" shall mean the person, partnership, company or firm appointed for the supply, installation, testing, commissioning and maintenance of the Electrical Installation. In the case of the Electrical Installation being a sub-contract, nominated in terms of the Main Contract or otherwise, the word "Contractor" shall also mean "Sub-Contractor" in terms of the Sub-Contract Conditions for the specific installation. Where applicable the Builder or Principal Contractor shall be referred to as "Main Contractor".

2. INSTALLATION WORK

- (a) The complete installation shall comply with the requirements of this Specification. Should any discrepancies or contradictions exist between this specification and the Detail Technical Specification for the specific installation, then the latter shall take precedence.

In the event of discrepancies between, specifications and bill of quantities the Client shall decide whether the work as executed shall be re-measured on site or whether re-measurement shall be effected.

The main contractor shall appoint an electrical contractor timeously, no unnecessary chasing will be allowed.

- (b) The Department's authorised representative will inspect the installation from time to time during the progress of the work. Discrepancies will be pointed out to the Contractor and these shall be remedied at the Contractor's expense. Under no circumstances shall these inspections relieve the Contractor of his obligations in terms of the Documents.
- (c) The Contractor shall notify the Client timeously when the installation reaches important stages of completion (e.g. before closing cable trenches, before casting concrete, etc.) so that the Department's authorised representative may schedule his inspections in the best interest of all parties concerned.

3. SITE CONDITIONS

Tenderers are advised to visit the site and acquaint themselves with all local conditions pertaining to the execution of the installation before tender closing date. No claims from the Contractor which may arise from insufficient knowledge of site access, type of site, labour conditions, establishment space, transport and loading/unloading facilities, power and water supply, etc. will be considered after submission of tenders

4. WORKMANSHIP AND STAFF

The electrical installation shall be carried out by an electrical contractor whom is registered with the Department of Labour and be in possession of a valid wireman's licence in order to issue valid electrical certificate of compliance certificates for both single and three phase electrical installations.

The workmanship shall be of the highest grade and to the satisfaction of the Employer.

All inferior work shall, on indication by the Employer's inspecting officers, immediately be removed and rectified by and at the expense of the Contractor.

5. MAINTENANCE OF INSTALLATIONS

With effect from the date of the Practical completion Certificate the Contractor shall at his own expense undertake the regular servicing of the installation during the maintenance period and shall make all adjustments necessary for the correct operation thereof.

If during the said period the installations is not in working order for any reason for which the Contractor is responsible, or if the installations develops defects, he shall immediately upon being notified thereof take steps to remedy the defects and make any necessary adjustments.

Should such stoppages however be so frequent as to become troublesome, or should the installations otherwise prove unsatisfactory during the said period the Contractor shall, if called upon by the Principle Agent/Electrical Engineer or the Employer, at his own expense replace the whole of the installations or such parts thereof as the Principal Agent/Electrical Engineer or the Employer may deem necessary with apparatus specified by the Principal Agent/Electrical Engineer or the Employer.

6. REGULATIONS (TO BE OF THE LATEST REVISION)

The installation shall be erected and tested in accordance with the Acts and Regulations as indicated in the scope of works. The installation shall be erected and tested in accordance with the following (but not limited to) National Standards:

- a) SANS 10142 Code of Practice for the Wiring of Premises
- b) SANS 10313 Code of Practice for the Protection of Structures against Lightning
- c) SANS 156 Moulded Case Circuit Breakers
- d) SANS 164-1 Plugs and Socket Outlets for Household and similar purposes
- e) SANS 767 Earth Leakage Protection units
- f) SANS 1091 National Colour Standards
- g) SANS 1065 Metal Conduits and fittings
- h) SANS 1213 Mechanical Cable Glands
- i) SANS 60439 Low Voltage Switchgear and Control Assemblies
- j) SANS 60669 Switches for household and similar fixed electrical appliances
- k) SANS 60947 Low Voltage Switchgear and Control gear
- l) SANS 61058 Switches for Appliances
- m) SANS 61386 Conduit System for Cable Management
- n) The Occupational Health and Safety Act, 1993 (Act 85 of 1993) as amended,
- o) The Local Government Act 1998 (Act 10 of 1998 (Gauteng)) as amended and the municipal by-laws and any special requirements of the local supply authority.
- p) The Fire Brigade services Act 1993 Act 2000 (Act 14 of 2000) as amended,
- q) The National Building Regulations and Building Standards Act 1996 (Act 29 of 1996) as amended,
- r) The Post Office Act 1998 (Act 124 of 1998) as amended,
- s) The Electricity Act 1996 (Act 88 of 1996) as amended and
- t) The Regulations of the Local Gas Board where applicable.

Where reference is made to any Code of Practice or Standard Specification in this document the latest edition or amendment shall be applicable, except where specified to the contrary.

7. NOTICES AND FEES

The Contractor shall give all notices required by and pay all necessary fees, including any connection fees or inspection fees, which may be due to the local Supply Authority.

On production of the official account, only the net amount of the fee charged by the Supply Authority for connection of the installation to the supply mains, will be refunded to the Contractor by the Employer.

The Contractor shall issue all notices and pay all the required fees in respect of the installation to the authorities, and shall exempt the Client from all losses, claims, costs or expenditures which may arise as a result of the Contractor's negligence in complying with the requirements of the regulations.

8. SCHEDULE OF FITTINGS

N/A

9. QUALITY OF MATERIALS

Only materials of first-class quality shall be used and all materials shall be subject to the approval of the Employer. Departmental specifications for various materials to be used on this Contract are attached to and form part of this specification. All materials shall be suitable for the conditions under which the materials are installed and used.

Materials manufactured in South Africa shall as far as possible be used and where applicable shall bear the SABS mark. Imported materials shall comply with the requirements of the appropriate B.S. or I.E.C. specification.

10. CONDUIT AND ACCESSORIES

The type of conduit and accessories required for the service, i.e. whether the conduit and accessories shall be of the screwed type, plain-end type or of the non-metallic type and whether metallic conduit shall be black enamelled or galvanised, is specified in Part 2 of this specification.

Unless other methods of installation are specified for certain circuits, the installation shall be in conduit throughout. No open wiring in roof spaces or elsewhere will be permitted.

The conduit and conduit accessories shall comply fully with the applicable SANS specifications as set out below and the conduit shall bear the mark of approval of the South African Bureau of Standards.

- a) Screwed metallic conduit and accessories: SANS 61386-1 and 21.
- b) Plain-end metallic conduit and accessories: SANS 61386-1 and 21.
- c) Non-metallic conduit and accessories: SANS 61386-1 and 21.

All conduit fittings except couplings, shall be of the inspection type. Where cast metal conduit accessories are used, these shall be of malleable iron. Zinc base fittings will not be allowed.

Bushes used for metallic conduit shall be brass and shall be provided in addition to locknuts at all points where the conduit terminates at switchboards, switch-boxes, draw-boxes, etc.

Draw-boxes are to be provided in accordance with the "Wiring Code" and wherever necessary to facilitate easy wiring.

For light and socket outlet circuits, the conduit used shall have an external diameter of 20mm. In all other instances the sizes of conduit shall be in accordance with the "Wiring Code" for the specified number and size of conductors, unless otherwise directed in part 2 of this specification.

Only one manufactured type of conduit and conduit accessories will be permitted throughout the installation.

Running joints in screwed conduit are to be avoided as far as possible and all conduit systems shall be set

or bent to the required angles. The use of normal bends must be kept to a minimum with exception of larger diameter conduits where the use of such bends is essential.

All metallic conduit shall be manufactured of mild steel with a minimum thickness of 1,2mm for plain-end conduit and 1,6mm in respect of screwed conduit.

Under no circumstances will conduit having a wall thickness of less than 1,6mm be allowed in screed laid on top of concrete slabs.

Bending and setting of conduit must be done with special bending apparatus manufactured for the purpose and which are obtainable from the manufacturers of the conduit systems. Damage to conduit resulting from the use of incorrect bending apparatus or methods applied must on indication by the Department's inspectorate staff, be completely removed and rectified and any wiring already drawn into such damaged conduits must be completely renewed at the Contractor's expense.

Conduit and conduit accessories used for flame-proof or explosion proof installations and for the suspension of luminaires as well as all load bearing conduit shall in all instances be of the metallic screwed type.

All conduit and accessories used in areas within 50 km of the coast shall be galvanised to SANS 32 and SANS 121.

Tenderers must ensure that general approval of the proposed conduit system to be used is obtained from the local electricity supply authority prior to the submission of their tender. Under no circumstances will consideration be given by the Client to any claim submitted by the Contractor, which may result from a lack of knowledge in regard to the supply authority's requirements.

11. CONDUIT IN ROOF SPACES

Conduit in roof spaces shall be installed parallel or at right angles to the roof members and shall be secured at intervals not exceeding 1,5m by means of saddles screwed to the roof timbers.

Nail or crampets will not be allowed.

Where non-metallic conduit has been specified for a particular service, the conduit shall be supported and fixed with saddles with a maximum spacing of 450 mm. The Contractor shall supply and install all additional supporting timbers in the roof space as required.

Under flat roofs, in false ceilings or where there is less than 0,9m of clearance, or should the ceilings be insulated with glass wool or other insulating material, the conduit shall be installed in such a manner as to allow for all wiring to be executed from below the ceilings.

Conduit runs from distribution boards shall, where possible terminate in fabricated sheet steel draw-boxes installed directly above or near the boards.

12. SURFACE MOUNTED CONDUIT

Wherever possible, the conduit installation is to be concealed in the building work; however, where unavoidable or otherwise specified under Part 2 of the specification, conduit installed on the surface must be plumbed or levelled and only straight lengths shall be used.

The use of inspection bends is to be avoided and instead the conduit shall be set uniformly and inspection coupling used where necessary.

No threads will be permitted to show when the conduit installation is complete, except where running couplings have been employed.

Running couplings are only to be used where unavoidable, and shall be fitted with a sliced couplings as a lock nut.

Conduit is to be run on approved spaced saddles rigidly secured to the walls.

Alternatively, fittings, tees, boxes, couplings etc., are to be cut into the surface to allow the conduit to fit flush against the surface. Conduit is to be bedded into any wall irregularities to avoid gaps between the surface and the conduit.

Crossing of conduits is to be avoided, however, should it be necessary purpose-made metal boxes are to be provided at the junction. The finish of the boxes and positioning shall be in keeping with the general layout.

Where several conduits are installed side by side, they shall be evenly spaced and grouped under one purpose-made saddle.

Distribution boards, draw-boxes, industrial switches and socket outlets etc., shall be neatly recessed into the surface to avoid double sets.

In situations where there are no ceilings the conduits are to be run along the wall plates and the beams.

Painting of surface conduit shall match the colour of the adjacent wall finishes.

Only approved plugging materials such as aluminium inserts, fibre plugs, plastic plugs, etc., and round-head screws shall be used for fixing saddles, switches, socket outlets, etc., to walls, wood plugs and the plugging in joints in brick walls are not acceptable.

13. CONDUIT IN CONCRETE SLABS

N/A

14. WIRING

Except where otherwise specified in Part 2 of this specification, wiring shall be carried out in conduit throughout. Only one circuit per conduit will be permitted.

No wiring shall be drawn into conduit until the conduit installation has been completed and all conduit ends provided with bushes. All conduits to be clear of moisture and debris before wiring is commenced.

Unless otherwise specified in Part 2 of this specification, the wiring of the installation shall be carried out in accordance with the "Wiring Code". Further to the requirements concerning the installation of earth conductors to certain light points as set out in the "Wiring Code", it is a specific requirement of this document that where plain-end metallic conduit or non-metallic conduit has been used, earth conductors must be provided and drawn into the conduit with the main conductors to all points, including all luminaires and switches throughout the installation.

Wiring for lighting circuits is to be carried out with 2,5mm² conductors and a 2,5mm²-earth conductor. For socket outlet circuits the wiring shall comprise 4mm² conductors and a 2,5mm²-earth conductor. In certain instances, as will be directed in Part 2 of this specification, the sizes of the conductors may be increased for specified circuits. Sizes of conductors to be drawn into conduit in all other instances, such as feeders to distribution boards, power points etc., shall be as specified elsewhere in this specification. Sizes of conductors not specified must be determined in accordance with the "Wiring Code".

The loop-in system shall be followed throughout, and no joints of any description will be permitted.

The wiring shall be done in PVC insulated 600/1000 V grade cable to SANS 1507.

Where cable ends connect onto switches, luminaires etc., the end strands must be neatly and tightly twisted together and firmly secured. Cutting away of wire strands of any cable will not be allowed.

Wiring shall only be carried out after the conduit or trunking installation and plaster work is completed, but before painting has commenced. No conductors shall be installed before the conduits have been cleaned of all debris and moisture.

Conductors that are connected to different switchboards, shall not be installed in the same conduit or trunking.

The wiring of one circuit only will be allowed in 20mm diam. conduit except for the wiring between switchboards and fabricated sheet metal boxes close to switchboards in which case more than one circuit will be allowed.

All wiring shall be carried out according to the loop-in system. If a conductor joint is found necessary in an isolated case, jointing will only be accepted in trunking and not in conduits. Conductor jointing shall be executed by approved ferruling, properly covered with heat shrink sleeving.

The number of conductors that may be drawn through a conduit, shall comply with the requirements of the SANS 10142. The total cross-sectional area of the conductors (including insulation) in trunking or power skirting shall not exceed 40% of the cross-sectional area thereof.

In cases where the conductors of more than one circuit are installed in trunking or power skirting, the conductors of each separate circuit (earth conductor inclusive) shall be taped at intervals of one metre with PVC insulation tape. The conductors of different circuits shall however remain separate in order that any given circuit can be withdrawn. Conductors entering switchboards or control boards shall be grouped and bound by means of plastic binding.

When conductors are drawn through conduit, care shall be taken that they are not kinked or twisted. Care shall also be taken that the conductors do not come into contact with materials or surfaces that may damage or otherwise adversely affect the durability of the conductor.

With the exception of three phase outlets, circuits of different phases shall not be present in lighting, switch or socket outlet boxes.

Conductors installed in vertical conduit or trunking shall be secured at intervals not exceeding 15m to support the mass of the conductors. Clamps shall be provided in suitable draw boxes for this purpose.

The insulation of conductors shall only be removed over the portion of the conductors which enter the terminals of switches, plugs or other equipment. When more than one conductor enters a terminal, the strands shall be securely twisted together.

When earth continuity conductors are looped between terminals or equipment, the looped conductor ends shall be twisted together and then soldered or ferruled to ensure that earth continuity is maintained when the conductors are removed from a terminal.

Cutting away of conductor strands will not be allowed.

The colours of conductor insulation for wiring purposes shall comply with the wiring regulations. The colours of conductors for sub-circuits shall as far as possible correspond with the colour of the supply phase. The colours of conductors for wiring to two-way and intermediate switches shall differ from phase conductors.

Single pole switches shall be connected to the phase conductor and not to the neutral conductor.

The connection to stoves or similar appliance unless specified to the contrary, shall consist of 10mm² insulated conductors and a 10mm² bare copper earth wire in a 25mm conduit.

A 60A double pole microgap isolator shall be flush mounted in a wall outlet box behind or adjacent to the stove or appliance in the run of the conduit at least 1350mm but not more than 1700mm above the finished floor level. The cover plate shall either fall entirely within the tiles surface or entirely within the plastered surface.

The conduits shall terminate 450mm above the floor behind the stove or appliance with the end set out of the wall pointing downwards.

The connection from the conduit end shall be by means of flexible conduit of sufficient length to enable the stove or appliance to be moved 600mm from its normal position for cleaning or maintenance purposes.

Crimped lugs shall be provided on all conductors or cable cores for connections to stoves or appliances. Soldered lugs may not be used.

Each stove or similar appliance shall be connected to a separate circuit and each shall have a separate earth conductor.

When earth continuity conductors are looped between terminals of equipment, the looped conductor ends shall be twisted together and then soldered or ferruled to ensure that earth continuity is maintained when the conductors are removed from a terminal. The installation shall be earthed to comply with SANS 10142.

15. SWITCHES AND SOCKET OUTLETS

All switches and switch-socket outlet combination units shall conform to the Client Quality Specifications, which form part of this specification.

No other than 16 A 3 pin sockets are to be used,

Switches SABS IEC 60669 as applicable and socket outlets SABS IEC 60884 as applicable shall be of the most modern manufacture and bear the SABS mark.

Switches shall comply with SABS 163. The sockets shall comply with SABS 164.

Flush switch and plug cover plates shall, unless otherwise specified, be of anodized aluminium of thickness not less than 0,9 mm, satin or other approved finish as directed and otherwise to be fully in accordance with SABS IEC 1084 for cover plates and SABS 1085 for wall boxes.

Except where otherwise specified, lighting switches are to be installed 1, 4 m above finished floor level.

Except where otherwise specified, socket outlets are to be installed 0, 450 m above finished floor level.

All mounting heights specified are to be measured from finished floor level to the bottom of the outlet box.

Where the lower portion of the wall consists of face brickwork and the upper portion of plastered finish, switches and socket outlets are to be mounted in the plastered surface, provided that the lower edge of the plasterwork does not exceed a height of 1, 5 m above finished floor level in which case the switches or socket outlets are to be installed in the face brick dado.

Where socket outlet and switch boxes have been installed with fixing lugs below finished wall surface, only approved distance pieces required to compensate for the recess shall be used. The lengths of distance pieces are not to exceed 15 mm.

Unless otherwise approved, light switches adjacent to doors are to be installed at the lock side of the door. Where the lock position is not indicated, its position shall be ascertained before the switch box is installed. Switches are to be installed 150 mm from the reveal, or centrally if there is a fitting near the door.

All switch and socket outlet boxes shall be installed plumb and built into the wall with a 1:1 mixture of cement and sand.

Industrial type switches and socket outlets shall be neatly recessed into the surface of plastered walls to avoid sets or alternatively spacer bar saddles may be used.

Deep type boxes may be used where switches or socket outlets are back-to-back, but where one side only is to be utilized at the time and the other is for future use, the side for future use shall be suitably covered with a metal cover plate.

All accessible current carrying parts, busbars, connecting strips, collector bars, etc., are to be adequately insulated in phase colours and suitably braced to withstand projected fault currents.

Connecting strips and collector bars must be of sufficient cross-sectional area to carry full rated current of the switches served, irrespective of the fuse or trip rating.

The complete distribution board including busbars must be suitably constructed to withstand fault currents

specified.

Connections to busbars are to be made by means of lugs suitably bolted and locked with high tensile bolts and connections to lugs must be effected by means of a crimping tools.

Incoming and outgoing bus-bar studs, where required, must be suitably insulated where they pass through panels of the board, and firmly supported within the board.

Where applicable, incoming and outgoing collector bars for cables in parallel must so arrange that the multiple cable ends can be connected to the bars with reasonably short tails which do not have to cross. Cable supports must be placed at suitable heights having regard to the bending radius of the cables concerned and convenience in making off.

Wall-mounting and floor-standing back to wall type boards must be provided with full easy access to all equipment and wiring without any necessity of disconnecting or removing of any of the equipment mounted in the board.

Clear visible indication of all switch positions must be provided, and the switches must be clearly labelled.

16. SWITCHGEAR

Switchgear, which includes circuit breakers, iron-clad switches, interlocked switch-socket outlet units, contactors, time switches, etc., is to be in accordance with the Departmental Quality Specifications which form part of this specification and shall be equal and similar in quality to such brands as may be specified.

For uniform appearance of switchboards, only one approved make of each of the different classes of switchgear mentioned in the Quality Specifications shall be used throughout the installations.

Circuit breakers shall be of the size and type as directed and specified for the service. They shall comply with SABS Specification 156 and SABS IEC 60947-2.

All distribution boards & switchgear shall comply with the quality specification in Part 3 of this specification, and be approved by the Employer's Electrical Engineer.

17. SWITCHBOARDS

All boards shall be in accordance with the types as specified, be constructed according to the detail or type and must be approved by the Employer before installation.

In all instances where provision is to be made on boards for the supply authority's main switch and/or metering equipment the contractor must ensure that all requirements of the authorities concerned in this respect are met.

Any construction or standard type aboard proposed, as an alternative to that specified must have the prior approval of the Employer.

All busbars, wiring, terminals, etc., are to be adequately insulated and all wiring is to enter the switchgear from the back of the board. The switchgear shall be mounted within the boards to give a flush front panel. Cable and boxes and other ancillary equipment must be provided where required.

Clearly engraved labels are to be mounted on or below every switch. The working of the labels in English, or as directed by the Electrical Engineer and must be confirmed on site.

All distribution boards & switchgear shall comply with the quality specification in Part 3 of this specification and be approved by the Employer's Electrical Engineer.

18. TESTS

After completion of the works and before practical completion is achieved, a full test will be carried out on the installation for a period of sufficient duration to determine the satisfactory working thereof. During this

period the installations will be inspected and the Contractor shall make good, to the satisfaction of the Principle Agent/Electrical Engineer or the employer, any defects which may arise.

The Contractor shall provide all instruments and equipment required for testing and any water, power and fuel required for the commissioning and testing of the installations at completion.

19. VERIFICATION AND CERTIFICATION OF ELECTRICAL INSTALLATION (CERTIFICATE OF COMPLIANCE AND TEST REPORT)

On completion of the service, a certificate of compliance must be issued to the Principal Agent/Electrical Engineer or Employer in terms of the Occupational Health and Safety Act, 1993 (Act 85 of 1993) in the format as set out in SANS 10142-1 & 2 as revised.

20. EARTHING OF INSTALLATION

This section covers the earthing of electrical installations in buildings or other structures. The total earthing system of any electrical installation shall be in complete accordance with SANS 10142.

1. GENERAL RECOMMENDATIONS ON THE PRACTICAL INSTALLATION OF EARTH ELECTRODES

1.1 REQUIREMENTS OF AN EFFECTIVE EARTH

1.1.1 An effective earth must prevent dangerous over voltages arising between metallic structures, frames, supports or enclosures of electrical equipment and the ground during fault conditions.

1.1.2 An effective earth must be able to permit fault currents of sufficient magnitude to flow so as to operate protective devices to isolate the fault before damage can occur.

1.1.3 The ohmic resistance of an effective earth must be low enough to ensure that the step potential on the ground in the vicinity of the earthing point is within safe limits under fault conditions i.e. a voltage gradient not exceeding 40 V/m for fault durations exceeding 1s.

1.2 TYPES OF EARTH ELECTRODES

Three types of earth electrodes are suitable:

1.2.1 Trench Earths

Trench earths comprise a bare copper or galvanised iron conductor laid at a minimum of 800mm below ground level, usually when underground cables are installed. This type of earth electrode provides a relatively large contact area between electrode and surrounding ground, makes contact with a variety of types of soil and soils of varying moisture content and route and is economical to install.

1.2.2 Spike Earths

Spike earths comprise rods of bare copper, copper-coated steel, stainless steel or galvanised steel designed for the purpose of penetrating ground to depths of up to several metres. A low resistance earth may sometimes be obtained by driving multiple spikes at some distance from each other in order to provide parallel paths.

In hard or rocky ground, it is usually necessary to drill holes into which earth spikes are inserted and then packed with soft soil.

1.2.3 Foundation Earths

Foundation earths comprise bare copper or galvanised iron conductors laid under the foundations of buildings, miniature substations, distribution pillars, bases of wooden, concrete or steel poles and structures.

Because soil under foundations usually retains moisture, foundation earths are located to take advantage of this favourable condition. Furthermore, they are economical to install.

1.3 MATERIALS FOR EARTH ELECTRODES

1.3.1 Bare copper, either in stranded, strip or rod form, is considered the most suitable general purpose material for earth electrodes. Its main disadvantage is its cost and susceptibility to theft.

1.3.2 Bare galvanised iron and steel, either in stranded, strip or rod form, has a satisfactory record of survival in non-aggressive soils and is more economical than copper.

1.3.3 Bare aluminium is unsuitable as electrode material.

1.4 CORROSION

Because galvanised ferrous metals corrode sacrificially to copper, galvanised iron and steel electrodes should not be buried in close proximity to bare copper.

2. TECHNICAL REQUIREMENTS OF NEUTRAL EARTHING

The following relevant aspects have been extracted from the "AMEU CODE OF PRACTICE FOR THE APPLICATION OF NEUTRAL EARTHING ON LOW VOLTAGE DISTRIBUTION SYSTEMS."

2.1 DISTRIBUTION SYSTEMS

Multiple Earthed Neutral (MEN) and Protective Multiple Earthing (PME) systems.

Distribution equipment associated with transformer substations that are either ground mounted or pole mounted and fed by underground cable or overhead line, with or without an earth continuity conductor, (ECC), should be installed, connected and earthed in accordance with the following requirements:

- (a) Where the resistance to earth of the HV equipment earth is 1 ohm or less, it is permissible to earth the LV neutral to the HV earth electrode.
- (b) Where the HV equipment earth exceeds 1 ohm the LV neutral shall be earthed at a minimum distance of 6m from the HV equipment earth (i.e. 6m from the HV electrode/s and also from any earthed metalwork connected thereto).
- (c) Notwithstanding the requirements of (a) above, where transformers are associated with HV overhead lines, it is considered good practice to separate the HV and LV earth electrodes. The minimum earth separation should be 6m or one LV span.
- (d) The overall resistance to earth of the neutral of an LV distributor or distribution system must not exceed 1 ohm.
- (e) The LV neutral may be connected to other supply neutrals, earth electrodes, cable sheaths and armouring and these connections used to obtain the required earthing value of 1 ohm or less specified in par. (d). above.
- (f) The neutral of underground and overhead LV distributors must be earthed at the remote ends of each distributor.
- (g) Where the overall resistance to earth of the neutral of the distribution system exceeds 1 OHM, the neutral shall be earthed at intermediate positions on the distributor/s to reduce its resistance to earth to below this limit.
- (h) The cross-sectional area of the neutral of all LV distributors must not be less than that of a phase conductor.

- (i) No circuit-breakers, isolators, fuses, switches or removable links shall be installed in the neutral between the transformer star point and the remote end of any LV distributor or service connection.
- (j) All metallic sheathing and armouring of cables and all metalwork associated with meter cabinets, fuse pillars, etc., supporting or enclosing LV cables shall be bonded to the distributor neutral conductor.
- (k) Where a Separate Neutral Earth (SNE) cable is part of an MEN or PME system, the armouring and/or metallic sheath and any ECC shall be bonded to the neutral at the supply end of the cable.
- (l) To ensure the integrity of the neutral, it is recommended that all connections and joints on or to overhead line conductors be made by compression fittings or, alternatively double bolted connectors.
- (m) MEN or PME may be applied to any single LV distributor without alterations to other LV distributors supplied from the same transformer.

2.2 PROTECTIVE NEUTRAL BONDING (PNB) SYSTEM

Since the neutral is earthed at one point only, the question of multiple earthing does not arise and there is therefore no necessity to meet the MEN/PME technical requirements.

2.3 SERVICE CONNECTIONS

2.3.1 MEN System

The following conditions apply to consumers' service connections as well as service connections to traffic signals, road signs, street lighting and other power-consuming equipment installed in public places:

- (a) All service connections must be by means of cable with an insulated phase, an insulated neutral conductor and an ECC.
- (b) A single phase service connection comprises a live, a neutral and an ECC.
- (c) A polyphase service connection comprises two or three phase conductors, a neutral and an ECC.
- (d) The service neutral and ECC must be solidly and separately connected to the distributor neutral at the tee-off point.
- (e) The consumer's earthing lead is connected to the Supply Authority's earth terminal which is in turn connected to the ECC in the service cable at the consumer's supply point.
- (f) The neutral must not be connected to earth at the consumer's supply point.
- (g) If required by the Supply Authority, an earth electrode must be installed at the consumer's supply point.
- (h) In a service connection to street light and other power-consuming equipment installed in public places, such equipment is earthed to the ECC of the service connection.

2.3.2 PME System

- (a) All service connections must be by means of a cable with an insulated phase and an insulated neutral conductor.
- (b) A single phase service comprises a live conductor and a neutral.
- (c) A polyphase service connection comprises two or three phase conductors and a neutral.
- (d) The consumer's earthing lead is connected to the supplier's neutral and to a mandatory earth electrode at the consumer's supply point.

- (e) A label must be attached at the consumers supply point on his premises indicating that the installation is part of a PME system.

Note: It is not recommended that the PME system be applied to supply traffic signals, street signs or other power-consuming equipment installed in public places, because the PME system is inherently unsafe under "broken-neutral" conditions.

3. SUBSTATION EARTHING

In order to comply with the requirements of par. 1 and 2 above, an earth resistivity measurement shall be undertaken at the site of a new substation or miniature substation, preferably by a specialist firm. The contractor shall then submit to the Client details of a proposed substation earth indicating whether a trench earth, spike earth or foundation earth is intended and the proposed interconnections with the installation.

4. FENCES OF OUTDOOR SUBSTATIONS

In cases where substations contain transformers or switchgear installed outdoors, the compulsory fence shall be earthed as follows, if no other method is specified:

- (a) A 70mm² earth wire shall be installed 400mm below ground level and 500mm from the fence on the outside of the sub-station along the entire length of the fence. This earth wire shall be earthed at each corner by means of a 1.8m earth rod and the rod and earth wire bonded to the fence. The earth wire shall also be bonded, at least at two points, to the main earthing system.
- (b) A 70mm² earth wire shall also be buried at a depth of 400mm around each transformer and switch and bonded to the main earthing system.

5. EARTHING OF A GENERAL ELECTRICAL INSTALLATION

The installation shall be effectively earthed in accordance with the relevant sections of the SANS Code of Practice 10142 and the requirements of the Supply Authority.

The type of main earthing must be as required by the supply authority if other than the Employer, and in any event as directed by the Principal Agent/Electrical Engineer, who may require additional earthing to meet test standards.

Where required an earth mat shall be provided, the minimum size, unless otherwise specified, being 1,0m x 1,0m and consisting of 4mm diameter hard-drawn bare copper wires at 250mm centres, brazed at all intersections.

Alternatively or additionally earth rods or trench earths may be required as specified or directed by the Electrical Engineer.

Installations shall be effectively earthed in accordance with the "Wiring Code" and to the requirements of the supply authority. All earth conductors shall be stranded copper with or without green PVC installation.

Connection from the main earth bar on the main board must be made to the cold water main, the incoming service earth conductor, if any and the earth mat or other local electrode by means of 12mm x 1, 60 mm solid copper strapping or 25 mm² stranded (not solid) bare copper wire or such conductor as the Department's representative may direct. Main earth copper strapping where installed below 3m from ground level, must be run in 20 mm diameter conduit securely fixed to the walls.

All other hot and cold water pipes shall be connected with 12mm x 1.5mm 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 150-mm centres. In all cases where metal water pipes, down pipes, flues, etc., are positioned within 1,6m 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.

Roofs, gutters and down pipes

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 and each switchboard. The roof and gutters shall be connected at 15m intervals to this conductor by means of 12mm X 1.5 mm copper strapping (not conductors) and galvanised bolts and nuts. Self-tapping screws are not acceptable. Where service connections consist of underground supplies, the above requirements are not applicable.

Sub-distribution boards

A separate earth connection shall be supplied between the earth busbar in each sub-distribution board and the earth busbar in the Main Switchboard. These connections shall consist of a 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 utilised where specified or approved.

Sub-circuits

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

Ring Mains

Common earth conductors may be used where various circuits are installed in the same wire way in accordance with SANS 10142. In such instances the sizes of earth conductors shall be equivalent to that of the largest current carrying conductor installed in the wire way, alternatively the size of the conductor shall be as directed 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.

Non-metallic Conduit

Where non-metallic conduit is specified or allowed, the installation shall comply with the Department's standard quality specification for "conduit and conduit accessories".

Standard copper earth conductors shall be installed in the conduits and fixed securely to all metal appliances and equipment, including metal 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.

Flexible Conduit

An earth conductor shall be installed in all non-metal 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.

Connection

Under no circumstances shall any connection points, bolts, screws, etc., used for earthing be utilised 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 proper terminals, the end shall be tinned and lugged.

21. MOUNTING AND POSITIONING OF LUMINAIRES

The Contractor is to note that in the case of board and acoustic tile ceilings, i.e. as opposed to concrete slabs, close co-operation with the building contractor is necessary to ensure that as far as possible the luminaires are symmetrically positioned with regard to the ceiling pattern.

The layout of the luminaires must be adhered to as far as possible and must be confirmed with the Department's representative.

Luminaires installed against concrete ceilings shall be screwed to the outlet boxes and in addition 2 x 6mm expansion or other approved type fixing bolts are to be provided. The bolts are to be $\frac{3}{4}$ of the length of the luminaires apart.

Luminaires to be mounted on board ceilings shall be secured by means of two 40mm x No. 10 round head screws and washers. The luminaires shall also be bonded to the circuit conduit by means of locknuts and brass bushes. The fixing screws are to be placed $\frac{3}{4}$ of the length of the fitting apart.

Earth conductors must be drawn in with the circuit wiring and connected to the earthing terminal of all fluorescent luminaires as well as other luminaires exposed to the weather in accordance with the "Wiring Code".

Incandescent luminaires are to be screwed directly to outlet boxes in concrete slabs. Against board ceilings the luminaires shall be secured to the bracing or joists by means of two 40mm x No. 8 round head screws.

PART 2: DETAILSPECIFICATION & INSTALLATION DETAILS

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PART 2: DETAIL SPECIFICATION & INSTALLATION DETAILS

1. CABLE SLEEVE PIPES

Where cables cross under roadways, other services and where cables enter buildings, the cables shall be installed in earthenware or high-density polyethylene pipes.

The ends of all sleeves shall be sealed with a non-hardening watertight compound after the installation of cables. All sleeves intended for future use shall likewise be sealed.

2. NOTICES

N/A

3. ELECTRICAL EQUIPMENT

All equipment and fittings supplied must be in accordance with the attached quality specification (Part 3 of this document), suitable for the relevant supply voltage, and frequency and must be approved by the Employers Electrical Engineer. The electrical contractor is to provide samples of all electrical equipment for approval by the consulting engineer and the department's engineer. All samples are to be approved prior to any bulk purchase.

4. DRAWINGS

N/A

5. BALANCING OF LOAD

The Contractor is required to balance the load as equally as possible over the multiphase supply.

6. SERVICE CONDITIONS

All plant shall be designed for the climatic conditions appertaining to the service.

7. SWITCHES AND SOCKET OUTLETS

The installation of switches and socket outlets must conform to relevant clause of Part 1 of this specification.

Isolators shall be 2-pole or 3-pole of the no-load type as required, and be suitably rated for the load to be connected. Externally mounted isolators shall be enclosed in suitable weatherproof glass-reinforced polyester (GRP) enclosures with sliding lids. All connections from isolators have been measured in the Bills of Quantities.

Indoor light switches and socket outlets shall be installed in flush wall mounted boxes. The switch cover plates shall be white PVC with chrome-plated fixing screws as applicable.

Outdoor socket outlets shall be installed in suitable GRP boxes with sliding lid, which are either flush or surface mounted.

Outdoor light switches shall be of the water tight surface mounted type with metal body and rotary switch rated at 16 A, as per 'WACO' type NS3500 or similar and approved.

Labels shall be provided on the inside of all switches and power outlet cover plates.

Light sensitive (daylight) switches shall be equal and approved to "NATIONAL" or "ROYCE Thompson" and shall be installed in an approved bulkhead fitting for the control of outside lights. The daylight switch shall be of the fail-safe type and shall comprise a photo-electric cell, thermal actuator and a change-over switch rated at 15A, 230v. The Contractor shall ensure that the operation of the daylight switch is not affected by nearby light fittings.

8. LIGHT FITTINGS AND LAMPS

The installation and mounting of luminaires must conform to relevant clause of Part 1 of this specification.

All fittings to be supplied by the Contractor shall have the approval of the Employer.

The light fittings must be of the type specified in the Schedule of Light Fittings.

All equipment and fittings supplied must be in accordance with the attached quality specification (Part 3 of this document), suitable for the relevant supply voltage, and frequency and must be approved by the Employers Electrical Engineer.

Lamps and electrical components used in fittings shall comply with the relevant SANS standard and wherever possible shall bear the SABS mark or alternatively shall indicate compliance with the equivalent IEC standard. No-name brands are not acceptable.

All emergency lighting luminaires shall comply with SANS 10114-2. Unless otherwise specified, emergency lighting battery units installed within or adjacent to the luminaires shall be of the maintained mode type and are capable of operating one lamp at 20% light output for 60 minutes. The unit shall have a self-testing facility that constantly monitors the status of the unit and discharges the nickel-cadmium batteries on a regular basis. An LED status indication lamp shall be provided in a clearly visible position in/on the fitting.

Low voltage (12V) halogen "Dichroic" lamps shall be of the type rated at 4000 hrs and shall be as per "OSRAM TITAN" or other approved.

All lamps supplied with the light fittings shall be from a reputable manufacturer, such as the following: 'GE', 'OSRAM', 'PHILIPS' or 'SYLVANIA'.

The Contractor shall where necessary make allowance for additional fixing members, such as timber battens in suspended ceilings, in order to provide for the number of light points called for in this specification

As a minimum, all light fittings surface mounted against standard round conduit boxes shall be fixed with at least two (2) non-rust screws such as brass or stainless steel.

All light fittings recessed in suspended ceilings with removable tiles shall be connected by means of flexible cable, plug and socket arrangement. The flexible cable shall be a minimum of 1.5mm² PVC insulated and shall not exceed 3m in length.

Sockets installed within ceiling voids beneath reinforced concrete slabs shall be securely fixed against ceiling slab or suspended trunking and shall be accessible from below the ceiling. In situations like in roof structures or in ceilings where the voids are excessive, the socket outlets shall be fixed to rigid roof structure members or to a rigid wireway system to the approval of the Engineer.

The Contractor shall maintain close liaison with the ceiling specialist when installing recessed fittings.

Fittings mounted against suspended board ceilings shall, in addition to being fixed to the conduit outlet box, be fixed at two points using 50mm No.10 round head brass screws and oversize washers. Fittings mounted against concrete or brick surfaces shall be fixed with at least two No 8 plastic anchors and 50mm No10 round head screws and oversize washers. Fender washers shall be used when fixing fluorescent fittings. Fittings may only be fixed direct onto conduit boxes if additional fixings are provided.

Fittings mounted against steel trunking shall be fixed with "P2540" hollow brass adapters. Fittings mounted against steelworks shall be fixed with approved galvanised steel brackets. Drilling of steelworks for fixing purposes may only be done with the approval of the Structural Engineer.

High-bay fittings suspended from roof trusses shall be fixed by means of galvanised steel chain having links of not less than 5mm diameter. Each fitting shall be suspended with two (2) separate steel chains utilising "CADDY" clips or other approved fixing devices.

Outdoor mounted fittings exposed to the weather shall suitably be sealed to prevent ingress of moisture into the fittings or conduit boxes.

The connection to outdoor floodlights or equipment using a similar flexible connection shall be carried out

with uv-resistant neoprene cable of suitable cross-section.

Supply of light fittings

The sub-contractor shall allow in the tender for the cost of administration, offloading on site, storage, handling, installation, cleaning and commissioning of all indoor and outdoor light fittings,. The contractor shall be held liable for any damage to luminaires from the date of receipt until the date of handover to the Employer.

Installation of light fittings

In all cases where luminaires are fixed to ceilings, the Contractor shall ensure that the ceiling is capable of carrying the weight of the luminaires before commencing installation. Should any doubt exist in this regard, the matter shall be referred to the CLIENT. All additional required supports to be included within the installation rate of the specific light fitting.

(a) Positions

The mounting positions of light fittings shall be verified on site. All fittings shall be placed symmetrically with respect to ceiling panels, batons, beams, columns or other architectural features of the space. Should the Domestic Sub-Contractor neglect to refer any discrepancies to the Engineer, cost incurred as a result of subsequent alterations to suit the architectural features will be to the Domestic Sub-Contractor's account.

(b) Hangers and supports

Where provision has not been made for the support of fittings, the Domestic Sub-Contractor shall supply the necessary supports, hangers, conduit extensions, angle brackets or any fixing method approved by the Engineer.

(c) Ceilings

In all cases where light fittings are installed in ceilings, the ceiling shall be capable of carrying the weight of the fittings. Ceilings shall either be of the concealed 'T' acoustic tile or plaster board type. When installing fluorescent fittings in ceilings, a gap shall not be visible between the fitting and the ceiling. Fittings shall be constructed for installation from below.

(d) Continuous rows of light fittings

In cases where fluorescent fittings are installed in tandem, only one connection point need to be supplied per circuit. All fittings shall be coupled to one another by means of nipples or bushes and lock nuts to ensure that the wiring is not exposed and that earth continuity is maintained. Fittings on the same circuit may be wired through the channel formed by the fitting canopies. In this case silicon-rubber insulated conductors shall be used and internal connections shall be made at terminal blocks, Screw connectors are not acceptable. The wiring for any other circuits or outlets, even though these may be in the same row may not be installed through the fitting canopies. The Domestic Sub-Contractor shall ensure that continuous rows are straight and parallel to the relevant building lines.

(e) Recessed light fittings

Where recessed light fittings are indicated the Domestic Sub-Contractor shall maintain close liaison with the Ceiling Contractor. In the case of tiled ceilings, the fittings shall be installed while the metal supports are being installed and before the tiles are place in position. The Contractor shall ensure that the ceiling is capable of carrying the weight of the luminaires before commencing installation.

The Domestic Sub-Contractor shall be responsible for the co-ordination of the cutting of ceiling tiles or plasterboard with the Ceiling Contractor. All mounting rings and other accessories shall fit closely into cut-outs to ensure a proper finish.

(f) Waterproof light fittings

Waterproof and flameproof fittings shall be screwed directly to the conduit end. Draw boxes that may be required must be approved by the Engineer beforehand.

(g) Bulkhead fittings

Surface mounted bulkhead fittings shall not be screwed directly to conduit ends. The conduit shall terminate in a round draw box at the back of the fitting. The PVC insulated conductors shall terminate in a porcelain terminal block in the draw box. Asbestos or silicon-rubber insulated conductors shall be used from the terminal block to the fitting lamp holder. Screw connectors will not be allowed.

(h) Luminaires fixed to Ceilings

In all cases where luminaires are fixed to false ceilings, the Contractor shall ensure that the ceiling is capable of carrying the weight of the luminaires before commencing installation. Should any doubt exist in this regard, the matter shall be referred to the Department.

In cases where the weight of the luminaire is not carried by the ceiling but by a support or other suspension method, provision shall be made to prevent relative movement between the ceiling and luminaire, ceiling rose or connection point.

Surface mounted fluorescent luminaires shall fit firmly against the ceiling brandering without leaving gaps between luminaire and ceiling. The luminaire shall be fixed directly to the ceiling by means of brass plated round-head wood screws and washers or butterfly screws.

In case of tiled ceilings with exposed or concealed T-section supports, surface mounted luminaires shall be fixed only to the tiles by means of butterfly screws. The tiles shall be suitably reinforced. Luminaires may alternatively be fixed to metal cross-pieces resting in the ceiling tees.

Drilling of holes in ceiling tees to support luminaires will not be allowed. Luminaires shall be fixed in neat relation to the ceiling lay-out.

(i) Type of Conductor

PVC insulated conductors, unless protected by an approved heat-resistant sheathing, shall not be used where the temperature of the insulation is likely to exceed 70°C. In unventilated luminaires or luminaires capable of housing incandescent lamps over 60W, the interconnecting wiring from the lamp holder to the circuit wiring shall consist of silicon-rubber insulated conductors. Silicon-rubber insulated conductors shall be used exclusively in the case of high bay fittings.

9. EARTHING AND BONDING

The Contractor will be responsible for all earthing and bonding of the building and installation. The earthing and bonding is to be carried out strictly as described in clause 20 of Part 1 of this specification and to the satisfaction of the Employer/s Electrical Engineer.

The resistance of the main electrical earth shall be not less than 1 ohm.

10. MAINTENANCE OF ELECTRICAL SUPPLY

All interruptions of the electrical supply that may be necessary for the execution of the work, will be subject to prior arrangement between the Contractor and the Client and the Employer's Electrical Engineer.

11. WIREWAYS

All conduits, regardless of the system employed, shall be installed strictly as described in the applicable paragraphs of Part 1 of the specification. Wiring of the installation shall be carried out as directed in part 1 of this specification.

Where plain end conduit is offered all switches and light fittings must be supplied with a permanent earth terminal for the connection of the earth wire.

Lugs held by switch fixing screws or self-tapping screws will not be acceptable.

PVC conduit is to be utilized in when recessed in brick work or cast in concrete. Hot Dip Galvanized metal conduit to be utilized where conduit is to be installed outdoors & within all roof spaces. All conduits to be SABS approved.

The Contractor shall ensure that all wireways are completed timeously, so as not to delay building operations, and shall advise the Department's Representative, in good time, of such intended completion, so that it may be inspected prior to being covered up. The Contractor shall be in attendance when the Department's Representative carries out all such inspections.

The cut ends of all galvanised steel wireways shall be painted with zinc-rich cold galvanizing paint.

The various wireways used shall be as follows:

a) CONDUIT

Unless otherwise specified, all conduit concealed in floor slabs, walls & building structure shall be PVC. No surface mounted PVC conduit shall be permitted.

The tubing shall enable the loop-in wiring system to be followed throughout the installation. The Contractor shall allow 25% spare conduit between all flush mounted distribution boards and ceiling spaces.

Where conduit outlet boxes or draw boxes are mounted on finished surfaces, the Contractor shall ensure that such outlets are mounted symmetrically.

Drawboxes with blank covers shall be allowed for, in the conduit runs as necessary. Drawboxes with sliding conduit shall be installed where conduit crosses expansion joints. Galvanised draw-wire of 1,6mm diameter shall be drawn in all conduit provided for other services.

Conduit in roof spaces must be installed neatly and must wherever possible run along and/or at right angles to roof trusses and must not cross-over.

At building expansion joints, all the conduits must be provided with conduit expansion joints with a positive earth wire connection.

'Kopex' or other approved flexible conduit shall be used to connect movable appliances using approved connectors, etc. Earth conductors shall be installed together with PVC conductors in flexible conduit to ensure earth continuity.

Where plain-end hot dipped galvanized conduit is specified all switches and light fittings must be supplied with a permanent earth terminal for the connections of the earth wire.

b) CONDUIT OUTLET BOXES

Round conduit boxes shall be not less than 50mm deep PVC with brass screw inserts. Outlet boxes for switches and power points shall be 100 x 50 mm and 100 x 100mm galvanised steel. PVC outlet boxes will be permitted in open semi-exposed areas as directed by the Department's Representative.

c) TRUNKING

The Contractor shall be responsible for the supply and installation of all power trunking complete with corner pieces, end pieces, junction pieces, supply conduits, cover plates and power outlets as specified

The power trunking must comply with SANS 61084. The Contractor must ensure that the power trunking is installed to satisfaction of the Employer's Electrical Engineer before commencing with the wiring of the power trunking.

All trunking and trunking accessories shall be similar or equal to O-Line Support Systems and both shall be hot dip galvanized to SANS 32. Trunking shall be installed complete with clip-on galvanized metal covers. Adjoining lengths shall be correctly aligned and securely joined by means of connection pieces that are pop-riveted to both abutting sections. All adjoining sections shall be of identical rectangular section and shall butt tightly. Covers shall fit tightly across the joint.

Trunking shall be installed open end up wherever possible, but where it is installed on its side or in vertical runs all conductors shall be retained by means of metal clips or metal spacer bars at not less than 1m centres. All trunking shall be vermin proof after installation. All holes shall be covered by metal plugs or by means of metal strips that are pop-riveted to the channel.

Electrical and mechanical continuity shall be maintained throughout the trunking installation. A tinned copper bonding strip shall be installed across each joint and secured to both adjoining lengths by means of brass bolts, nuts and washers. The trunking shall be bonded to the earth bar of the associated switchboard.

All bends shall be of easy sweep design with 45° cornices. Burrs and sharp edges shall be removed and the inside edges of all joints shall be lined with silicon or other suitable rubberised compound to prevent conductor insulation laceration.

Trunking shall be large enough to ensure that the combined total cross-sectional area (including insulation) of all conductors does not exceed 40% of the cross-sectional area of the trunking.

The Contractor shall supply and install all hangers, supports or fixings required for the trunking. Trunking up to 127mm x 75mm shall be supported at maximum intervals of 1500mm and where trunking is suspended from roof structures this shall be done using CS3300 and threaded galvanized rods. Trunking runs shall be carefully planned to avoid clashes with other services and to ensure that all covers can be removed after completion of the entire installation.

All conduit connections shall be terminated by means of a female bush. All holes which conductors pass through shall be equipped with grommets.

d) POWERSKIRTING

The powerskirting shall come complete with purpose made accessories. Conduit access to the powerskirting shall be via flush mounted 100 x 50 steel boxes set behind the trunking. Slots cut/punched into the trunking for wiring purposes shall be free of sharp edges.

Where powerskirting is interrupted by doorways etc., conduit of not less than 32mm diameter shall be provided to bridge the break in each compartment. Where continuous powerskirting runs through walls a small section of powerskirting with cover shall be built-in the wall.

Power skirting is to be of the powder coated galvanized metal type. All plug points installed to be screwed on. Colour to be confirmed by Architect.

Power skirting in all areas to be earthed as per SANS 10142.

The powerskirting compartments shall be utilised as follows:

Upper compartment	-	Power
Centre compartment	-	Data
Lower compartment	-	Telephone

e) FLOOR BOXES

N/A

f) CABLE TRAY / LADDER

The Contractor shall supply and install all cable trays or ladders required for electrical cables as well as all wire mesh trays required for electronics services cables and the necessary supports, clamps, hangers, fixing materials, bends, angles, junctions, reducers, T-pieces, etc.

Tray type

Unless otherwise specified, all cable trays shall be medium duty type perforated hot dip galvanized (to SANS 32) cable trays. All supports, hangars and accessories to be hot dip galvanized (to SANS 32).

Wire mesh trays

Wire mesh trays shall be medium duty hot-dipped galvanized type.

Supports

Cable tray supports shall consist of two steel hangar rods, at least 10mm in diameter, on both sides of the tray with a substantial steel cross-member on the underside of the tray and bolted to the rods. Alternatively, cable trays may be cantilevered from walls on suitable brackets.

Trays and ladders shall be supported at maximum intervals of 900mm. In addition trays and ladders shall be supported at each bend, off-set and T-junction.

Joints

Joints shall be smooth without projections or rough edges that may damage the cables. The Domestic Sub-Contractor will be required to cover joints with silicon or other hardening rubberised or plastic compounds if in the opinion of the Engineer joints may damage cables. Joints shall as far as possible be arranged to fall on supports. Where joints do not co-coincide with supports, joints shall be made by means of wrap- around splices of the same thickness as the tray and at least 450mm long.

The two cable tray ends shall butt tightly at the centre of the splice and the splice shall be bolted to each cable tray by means of at least 8 round head bolts, nuts and washers. Splices shall have the same finish as the rest of the tray.

Fixing to the supports

Trays shall be bolted to supports by at least two round head bolts per support. Bolts shall be securely tightened against the tray surface to avoid projections which might damage cables during installation.

Fixing of the structure

The supports for cable trays and ladders shall in all cases be securely fixed to the structure by means of heavy duty, expansion type anchor bolts. It is the responsibility of the Contractor to ensure that adequate fixing is provided since cable trays and ladders that work loose shall be rectified at his expense.

Accessories

Purpose-made horizontal and vertical bends, T-junctions and cross connections shall be supplied by the Domestic Sub-Contractor. The dimensions of these connections shall correspond to the dimensions of the linear sections to which they are connected. The inside dimensions of bends shall be large enough to ensure that the allowable bending radius of the cables is not exceeded. Sharp angles shall have a 45° cornice. All accessories shall be galvanized.

Installation of cables

Electrical cables shall be installed by the Domestic Sub-Contractor adjacent and parallel to each other on the trays. Horizontal trays and ladders shall in general be installed 450mm below slabs, ceilings, etc. to facilitate access during installation.

Data/telephone cables shall be supplied and installed by others.

Earthing

Metal trays and ladders shall be bonded to the "Building" Earth bar of the switchboard to which the cables are connected. Additional bare copper stranded conductors or copper tape shall be bolted to the tray or ladder where the electrical continuity cannot be guaranteed.

Painting

No painting of trays or ladders shall be required.

12. WIRING

Wiring of the installation shall comply with General Specification Part 1 for Electrical Installations.

No open wiring nor the drawing of mixed circuits nor the drawing of more than two circuits of the same type of load per conduit will be permitted

All wiring of individual circuits installed in trunking or power skirting shall be harnessed together to facilitate the ease of identification of such circuits.

The wiring in roof spaces above ceilings with removable suspended tiles shall be wired via a wireway system of galvanised steel trunking and PVC conduit that provides maximum flexibility. The wireway system shall be to the approval of the Department's Representative. The final connection to recessed light fittings shall be via 6 A socket outlets which are within arm's reach of the fitting.

All wiring installed in conduit concealed within hard board ceilings shall be accessible from below the ceiling for re-wiring purposes. The final connection to recessed light fittings in hard board ceilings shall be via 6 A socket outlets in round conduit boxes that are connected to flexible PVC conduit. The flexible conduit shall be of sufficient length to enable the light fitting supply lead to be plugged into the socket outlet from below the ceiling. The wireway system employed in hardboard ceilings shall be to the approval of the Department's Representative.

13. POWER POINTS

Allow for the installation of power points and equipment as listed in the schedule.

Details of the power outlets for the various type of equipment to be connected shall be as follows:

1. Air Conditioning Units

Isolators for indoor air conditioning units, wall mounted at low level, shall be rated at not less than 20 A with cord grip outlet and flush mounted in power skirting adjacent to the connection point of the unit. The final connection to the unit shall be with suitably rated white PVC flexible cable.

Isolators for indoor air conditioning units, wall mounted at high level, shall be rated at not less than 20 A with cord grip outlet installed in suitable flush mounted box adjacent to the connection point of the unit. The final connection to the unit shall be with suitably rated white PVC flexible cable.

Isolators for air conditioning units mounted externally or in ceiling voids, shall be rated at not less than 20 A and installed in suitable GRP box with sliding lid mounted adjacent to the connection

point of the unit. The final connection to all external units shall be with suitably rated black uv-resistant neoprene flexible cable.

2. Hot Water Heaters

Isolators for instant hot water heaters shall be 50 A, 2-pole with neon indication light flush wall-mounted adjacent to the heater. A flush round conduit box shall be provided behind the heater for the electrical connection and shall be linked to the isolator with 25mm conduit.

NOTE: The hot water installation must be approved by the Employers Electrical Engineer. Detail with regard to the size and type of water heaters that must be provided must be obtained from the Architect.

14. EXCAVATION AND CABLE SLEEVES

The Contractor shall acquaint himself with the position of existing services such as storm water pipes, water mains, power cables, telephone cables, etc. and take the necessary precautions before commencing excavations to prevent disruption of these services. Any damage caused by the Contractor to these services shall be repaired at his cost.

The Contractor shall take the necessary precautions and provide the necessary warning signs and/or lights to ensure that the public and/or employees on site are not endangered. The Contractor shall take the necessary precautions to safeguard existing structures, sewerage works, water reticulation works, roads or other property on the site from any damage or risk of subsidence. Cable trenches for underground LV cables installed in general areas shall be excavated to a depth of not less than 750mm below ground level and the width shall not be more than 400mm for one or two cables. The minimum cover from the top of the cables to finished ground level shall not be less than 600mm for LV cables and 1000mm for MV cables.

Cable trenches for underground LV cables installed under roads and load bearing areas shall be excavated to a depth of not less than 950mm below ground level and the width shall not be more than 450mm for one or two cables. The minimum cover from the top of the cables to finished ground level shall not be less than 800mm.

The width shall be increased where more than two cables are laid together so that the cables may be spaced at least 150mm apart throughout the run. The bottom of the trench shall be level and clear and the bottom sides free from rocks or stones liable to cause damage to the cables.

Cable trenches may not be backfilled before the cables laid on the bedding have been inspected and the cables have been tested. Cable trench shall be backfilled and properly compacted in layers with suitable hand tampers or mechanical stampers to ensure that there is no subsidence. During compaction the soil may have to be moistened to an optimum moisture content to attain an adequate compaction density. If suitable backfill material is not available at the trenches, the Contractor shall obtain it elsewhere at no additional cost.

All surplus ground and rocks shall be removed from the site of works and this cost be included in the Contractor's tender price.

Tenderers must base their cost of trenching in soft or hard material on the total quantities as indicated in the Bill of Quantities. The actual quantities, based on the applicable number of cables to be laid, will be measured on site during the course of the service and adjustments made according to the price per cubic metre as inserted in the Bill of Quantities by the Tenderer. Payment for the trenching having a greater volume than that specified for the purpose will not be considered except where extra excavations are necessary to by-pass obstacles such as water pipes, drains, large boulder etc. In all such instances the amount of the extra excavations must be agreed upon on site between the Engineer and the Contractor.

The tendered rate shall include full compensation for clearing and grubbing the trench areas and the temporary removal of improvements from the line of the trench, for excavating the trench, preparing the

bottom of the trench, separating material unsuitable for backfill, keeping the excavations safe, dealing with any surface or subsurface water, measuring, classification and keeping of all records and for separating topsoil and selected backfill material where necessary.

The rate shall furthermore cover the costs of installing the sand bed and sand cover, backfilling, compacting and disposing of the surplus material.

The materials excavated shall be classified as follows for payment purposes:

Hard material:

Material which cannot be excavated efficiently except with the use of pneumatic tools, blasting or wedging and splitting, and shall include boulders exceeding 0, 15 m³ in volume.

Soft material:

All material not classified as hard material. Notwithstanding the above classification, all material previously constructed fills, embankments, pavement layers and from above existing services shall be classified as soft material.

The decision of the Department's Representative as to the classification of the material shall be final and binding and any objection as to the classification shall be made before the excavation has been backfilled.

The measured items shall include any or all of the following classes of material, which shall be as specified in the Preambles to all Trades:

- (1) Excavate in soft material for trenches, backfill, compact and dispose surplus material.
- (2) Extra over on item (1) for excavating in intermediate material, compact and dispose surplus Material
- (3) Extra over on item (1) for excavating in hard rock, and dispose surplus material.
- (4) Extra over on item (1) for using backfill material obtained from sources provided by the Contractor.

All underground sleeves shall, unless where otherwise specified, comprise uPVC pipes.

Where cables cross under roadways, other services and where cables enter buildings, the cables shall be installed in asbestos-cement pipes, earthenware or high density polyethylene pipes.

Suitable large radius or easy bends shall be allowed where sleeves are to terminate in distribution boards or draw boxes. Sleeves terminating in manholes are to be positioned to provide maximum cable bending radius.

The top of all underground sleeves, which are installed in general areas other than roadways and load bearing areas, shall be not less than 600mm below finished ground level. PVC warning tape shall be installed 300 below finished ground level directly above the sleeves.

Where cables cross under roadways or other load bearing areas the cables shall be installed in asbestos-cement pipes, earthenware or high density polyethylene sleeves. In all such cases the top of the sleeves shall be not less than 800 mm below the finished level of the road surface for LV cables and 1000mm for MV cables.

Before backfilling, the ends of all used and unused sleeves shall be sealed with paper and weak cement mix or a suitable non-hardening watertight compound. Suitable nylon draw cords shall be installed in all unused sleeves.

15. CABLES

1000 volt PVC SWA/ECC and 110 Volt ECC cable and accessories shall be in accordance with the relevant SABS specifications to SABS 1507. Copper cables are to be utilized unless otherwise stipulated.

The Contractor shall supply and completely install all distribution cables as indicated on the drawings, and

listed in the Schedule of Cables.

The storage, transportation, handling and laying of the cables shall be according to first class practice, and the contractor shall have adequate and suitable equipment and labour to ensure that no damage is done to cables during such operations.

The cable-trenches shall be excavated to a depth of 0,6m deep below ground level and shall be 450mm wide for one to three cables, and the width shall be increased where more than three cables are laid together so that the cables may be placed at least two cable diameters apart throughout the run. The bottom of the trench shall be level and clean and the bottom and sides free from rocks or stones liable to cause damage to the cable.

The Contractor must take all necessary precautions to prevent the trenching work being in any way a hazard to the personnel and public and to safeguard all structures, roads, sewage works or other property on the site from any risk of subsidence and damage.

In the trenches the cables shall be laid on a 75mm thick bed of earth and be covered with a 150-mm layer of earth before the trench is filled in.

All joints in underground cables and terminations shall be made either by means of compound filled boxes according to the best established practice by competent cable jointers using first class materials or by means of approved epoxy-resin pressure type jointing kits. Epoxy-resin joints must be made entirely in accordance with the manufacturer's instructions and with materials stipulated in such instructions. Low tension PVCA cables are to be made off with sealing glands and materials designed for this purpose which must be of an approved make. Where cables are cut and not immediately made off, the ends are to be sealed without delay.

The laying of cables shall not be commenced until the trenches have been inspected and approved. The cable shall be removed from the drum in such a way that no twisting, tension or mechanical damage is caused and must be adequately supported at intervals during the whole operation. Particular care must be exercised where it is necessary to draw cables through pipes and ducts to avoid abrasion, elongation or distortion of any kind. The ends of such pipes and ducts shall be sealed to approval after drawing in of the cables.

Backfilling (after bedding) of the trenches is to be carried out with a proper grading of the material to ensure settling without voids, and the material is to be tamped down after the addition of every 150mm. The surface is to be made good as required.

On each completed section of the laid and jointed cable, the insulation resistance shall be tested to approval with an approved "Megger" type instrument of not less than 500 V for low tension cables.

Earth continuity conductors are to be run with all underground cables constituting part of a low tension distribution system. Such continuity conductors are to be stranded bare copper of a cross-sectional area equal to at least half that of one live conductor of the cable, but shall not be less than 4mm² or more than 70mm². A single earth wire may be used as earth continuity conductor for two or more cables run together, branch earth wires being brazed on where required.

15.1 LAYING, JOINTING AND MAKING OFF OF ELECTRICAL CABLES

[The requirements specified hereafter, are aimed essentially at high tension cable but are also valid for low tension cable, where applicable.]

1. The use of the term "Inspector", includes the engineer or inspector of the Client or an empowered person of the concerned supervising consulting engineer's firm.
2. No cable is to be laid before the cable trench is approved and the soil qualification of the excavation is agreed upon by the Contractor and inspector.
3. After the cable has been laid and before the cable trench is back-filled the inspector must ensure that the cable is properly bedded and that there is no undesirable material included in the bedding layer.

4. All cable jointing and the making off of the cables must only be carried out by qualified experienced cable jointers. Helpers of the jointers may not saw, strip, cut, solder, etc. The cable and other work undertaken by them must be carried out under the strict and constant supervision of the jointer.
5. Before the Contractor allows the jointer to commence with the jointing work or making off of the cable (making off is recognized as half a joint) he must take care and ensure:
 - 5.1 That he has adequate and suitable material available to complete the joint properly and efficiently. Special attention must be given to ensure the cable ferrules and cable lugs are of tinned copper and of sufficient size. The length of the jointing lugs must be at least six times the diameter of the conductor,
 - 5.2 That the joint pit is dry and that all loose stones and material are removed,
 - 5.3 That the walls and banks of the joint pit are reasonable firm and free from loose material which can fall into the pit,
 - 5.4 That the necessary coffer-dams or retaining walls are made to stop the flow of water into the joint pit,
 - 5.5 That the joint pit is provided with suitable groundsheets so that the jointing work is carried out in clean conditions,
 - 5.6 That the necessary tents or sails are installed over the joint pit to effectively avert unexpected rainfall and that sufficient light or lighting is provided,
 - 5.7 That the necessary means are available to efficiently seal the jointing or cable end when an unexpected storm or cloudburst occurs, regardless of how far the work has progressed,
 - 5.8 That the cables and other materials are dry, undamaged and in all respects are suitable for the joint work or making off,
 - 5.9 That the heating of cable oil, cable compound, plumbers metal and solder is arranged that they are at the correct temperature when required so that the cable is not unnecessarily exposed to the atmosphere and consequently the ingress of moisture (care must be taken of overheating)

Flow temperatures of cable oil and compound must be determined with suitable thermometers. Cable oil and compound must not be heated to exceed the temperatures given on the containers and precaution must be taken to ensure that the tin is not overheated in one position. The whole mass must be evenly and proportionally heated.

(Temperatures of solder and plumbers metal may be tested with brown paper (testing time: 3 seconds). The paper must colour slightly - not black or burnt).

6. Before the paper-insulated cables are joined, they must be tested for the presence of moisture by the cable jointers test. This consists of the insertion of a piece of unhandled insulated impregnated paper tape in warm cable oil heated to a temperature of $130 \pm 5^{\circ}\text{C}$.

Froth on the surface of the oil is an indication that moisture is present in the impregnated insulation and the amount of the froth gives an indication of the moisture present.
7. If the cable contains moisture or is found to be otherwise unsuitable for jointing or making of the inspector is to be notified immediately and he will issue the necessary instruction to cope with the situation.
8. The joint or making off of paper insulated cables must not be commenced during rainy weather.
9. Once a joint is in progress the jointer must proceed with the joint until it is complete and before he leaves the site.

10. The jointer must ensure that the material and his tools are dry at all times, reasonably clean and absolutely free from soil.
11. Relating to the jointing of the cable the following requirements apply:
 - 11.1 All jointing must be carried out in accordance with recognized and tried techniques and comply strictly with the instructions given by the supplier of the jointing kit.
 - 11.2 The cables must be twisted by hand so that the cores can be joined according to the core numbers. If necessary the cable is to be exposed for a short distance to accomplish this. Under no circumstances may the cores in a joint be crossed so as to enable cores to be joined according to the core numbers. If it is not possible to twist the cables so that the preceding requirements can be met, then cores are to be joined in the normal way without any consideration of the core numbers.
 - 11.3 Normally the cables will have profile conductors. The conductors shall be pinched with gas pliers to form a circular section, bound with binding wire so that they do not spread, and then tinned before jointing.
 - 11.4 Jointing ferrules, the length of which are at least 6 times the diameter of the conductors, must be slid over the conductor ends to be joined and pinched tightly. Then they are soldered by means of the ladle process whilst being pinched further closed.

Use resin only as a flux. The slot opening in the ferrule must be completely filled, including all depressions.

Remove all superfluous metal with a cloth dipped in tallow. Work during the soldering process must be from top to bottom. Rub the ferrule smooth and clean with aluminum oxide tape after it has cooled down to ensure that there are not any sharp points or edges.

NB: The spaces between the conductor strands must be completely filled by soldering process and must be carried out quick enough to prevent the paper insulation from burning or drying out unnecessarily.
 - 11.5 After the ferrules have been rubbed smooth and clean, they and the exposed cores must be treated with hot cable oil (110°C) to remove all dust and moisture. These parts are to be thoroughly basted with the oil.
 - 11.6 The jointer must take care that his hands are dry and clean before the joint is insulated. Also the insulating tape which is to be used must first be immersed in warm cable oil (110°C) for a sufficient period to ensure that no moisture is present.
 - 11.7 After the individual cores have been installed they must be well basted with hot cable oil and again after the applicable separator and/or belt insulation tape is applied before the lead joint sleeve is placed in position.
 - 11.8 The lead joint sleeve must be thoroughly cleaned and prepared before it is placed on the cable and must be kept clean during the whole jointing process. Seal the filling apertures of the sleeve with tape until the sleeve is ready for compound filling.
 - 11.9 The plumbing joints employed to solder the joint sleeve to the cable sheath, must be cooled off with tallow and the joint sleeve is to be filled with compound while it is still warm. Top up continuously until the joint is completely filled to compensate for the compound shrinkage.
 - 11.10 The outer joint box must be clean and free from corrosion. After it has been placed in position it must be slightly heated before being filled with compound. Top up until completely full.
12. As far as cable end boxes are concerned the requirements as set out above are valid where applicable.

15.2 FIXING OF CABLES TO TRAYS OR STRUCTURES

1 Installation

Cables may be installed in one of the following ways:

- (a) On horizontal cable trays.
- (b) Against vertical cable trays with suitable clamps.
- (c) Against horizontal or vertical metal supports or brackets with suitable clamps.
- (d) On clamps which are fixed to the structure.

2 Clamps

Suitable clamps (cleats) which will secure cables without damage shall be used. Metal clamps or drilled hard wood blocks shall be used. Clamps shall consist of adjustable metal wings which clamp to a metal support, or consist of two halves that are bolted together. The correct clamp size to fit the cable shall be used. Cables of different sizes may only be fixed by a common clamp when the clamp is specially made to accommodate the various cables.

3 Spacing of Supports

Two methods of supporting cables are found in practice. The most generally known method is the restrained installation where the distance between supports is small enough to prevent any noticeable sag in the cable. The alternative method is the unrestrained installation where the distance between supports should be great enough to ensure that there will be obvious sag in each span between supports.

4 Spacing of Supports of Unrestrained Cables

Large single core cables shall always be installed according to this method. Generally, single core cables with conductors exceeding a cross sectional area of 185mm² should be supported at spacings in excess of 2m since the sag between supports will safely accommodate any thermal expansion.

Reducing the spacing between the supports to 1,5m or less shall be avoided at all costs, as expansion cannot be taken up by a change of sag and chances of sheath failure become considerable.

5 Spacing of Supports of Restrained Cables

Additional cleats shall be installed at each bend or offset in the cable run. The maximum distance between supports or cleats for multi-core control cables shall be 20 times the outside diameter of the cable with a maximum spacing of 550mm for unarmoured cables and 30 times the outside diameter of the cable with a maximum spacing of 900mm for armoured cables. Spacing of supports for cables for high voltage lighting shall be in accordance with Table 8 of SANS 10142. A minimum of 20mm ventilation clearance shall be maintained between cables and the wall to which they are cleated.

16. SCHEDULE OF ELECTRICAL ACCESSORIES

[illegible]

17. LIGHTING SCHEUDLE

AS ATTACHED

18. IDENTIFICATION

Labels indicating the circuit number shown on the 'As-built' records shall be provided on all cover plates. The label shall be permanently fixed and shall indicate the dB from which it is fed and the circuit number i.e. dB -1/L2.

All isolators, dedicated socket outlets, telephone and TV outlet boxes and junction/terminal boxes shall be labelled using engraved plastic sandwich type labels fixed by means of epoxy adhesive.

All cables shall be labelled using approved durable labels. Labels shall be provided at the distribution boards as well as on both sides of underground sleeves crossing roadways and hardened areas.

Fixing equipment and materials shall be selected and engineered to suit the climatic and environmental conditions found on site. Wherever possible, special precautions shall be taken to avoid contact between dissimilar metals in order to prevent corrosion. Stainless steel fixings in aluminium housings shall be by means of special stainless steel 'helicoil' inserts to prevent corrosion and the screw from being fastened to the housing. Contact between aluminium and concrete surfaces shall also be avoided.

Light weight equipment mounted against walls or concrete ceilings may be installed with suitable wall plugs to the approval of the Engineer. Holes in joints between brick walls will not be permitted. The depth of the hole shall be equal to the length of the plug plus the thickness of the plaster.

Mounting of equipment against wood shall be done by means of appropriately sized greased screws and against board ceilings inaccessible from the back with toggle screws.

All heavy weight equipment shall be fixed to brick or concrete by means of expansion bolts. All exposed parts of the bolts shall be painted to have the same colour finish as the equipment. All expansion bolts used outdoors shall be hot dip galvanised or stainless steel. Electro-plated galvanised expansion bolts will not be permitted outdoors.

All mounting brackets for outdoor use shall be hot dip galvanised steel after manufacture. All fixings used outdoors shall be hot dip galvanised, stainless steel or brass as appropriate. No electro-plated galvanised steel fixings shall be used outdoors.

The Contractor shall adequately label all switches, socket outlets, isolators, telephone and TV outlet boxes and all junction/terminal boxes using engraved plastic sandwich type labels fixed by means of epoxy adhesive.

18. COMPLETION OF WORKS

Completion of works will occur and delivery shall be given only after the following procedure has been certified by the Department's Representative as having been carried out in accordance with the Specification:

1. After the defects are made good and approval of the Department's Representative is obtained, physical completion has been reported to the Department's Representative by the Contractor and the Department's Representative has given approval for "start-up".
2. "Start-up" has taken place.
3. Commissioning and testing has taken place as specified and test results have been witnessed (where required), recorded and finally approved by the Department's Representative.
4. Spares as specified have been handed over to the Department's Representative.
5. Three copies of indexed loose leaf manuals containing complete Operating Instructions and Maintenance Manuals have been furnished to the Department's Representative after approval by the Department's Representative, for all mechanical and electrical systems, equipment and controls for all equipment or systems specified under this Contract.

19. TESTING, COMMISSIONING & INSPECTIONS

On completion of the entire installation or any particular section thereof, as may be decided by the Engineer, tests shall be carried out in full accordance with the current edition of the SANS 10142 "Code of Practice for the Wiring of Premises", in the presence of the Engineer or his authorized Representative.

The Contractor should note that where applicable at least the following tests (but not limited to) must be carried out:

1. Insulation test
2. Continuity test
3. Loop Line Earth Impedance test
4. Polarity test
5. Earth Leakage Circuit Breaker test
6. Any further test to meet the local Supply Authority requirements or as deemed necessary by the Engineer.
7. Earth termination test

Note:

- All instrumentation necessary for testing shall be provided by the Electrical Sub-Contractor.
- The results of the above tests must be clearly recorded, signed and handed to the Engineer.
- Once the Engineer has inspected the complete installation and satisfied himself that all testing has been completed and the Contract is complete in all respects, may the Engineer be approached in writing with the above documentation with a view to arranging a hand- over date.
- On completion of the Contract, the Electrical Sub-Contractor shall provide the Engineer with a completed and signed Certificate of Compliance for Electrical Installations for all distribution boards as required by the Occupational Health and Safety Act as amended.
- **Inspections by the Engineer will take place on a sampling basis only. The Engineer is not responsible to ensure that the Contractor meets with the requirements of the Specification, but will assist the Contractor in an effort to identify problem areas at an early stage. At no time will an inspection by the Engineer alleviate the Contractor of his responsibility to provide the Employer with a Contract Works which conforms in all respects with the requirements of the Specification.**
- The Contractor is required to balance the load as equally as possible over multi-phase supplies.
- The mandatory "Certificate of Compliance" shall be issued by the Contractor to the Supply Authority, with a copy to the engineer prior to first delivery being taken.
- The installation shall be tested by the Contractor as the service progresses or as required by the Head: Works and upon completion, for earth continuity and insulation. The final test before the taking over of the installation shall be made in the presence of the engineer.
- On all completed new work or where specifically called for in the Tender Document, the Contractor shall, on completion of the works, submit to the Client representative, a marked up site plan indicating the exact underground cable reticulation.
- Upon successful completion of all testing the Contractor shall submit a fully completed test report together with a Certificate indicating that the installation fully complies with the Specification and all relevant statutory requirements.

20. TRAINING

After successfully testing and commissioning the installation, the Contractor will be required to thoroughly train and instruct at least two Operators/Supervisors designated by the school in the correct use, operation and supervision of the Electrical installation, School Siren installation, Generator installation, Lightning Protection installation and Intruder Alarm installation. The Contractor shall allocate a competent member of his staff for this purpose and shall allow adequate time for this in his price.

A comprehensive operator-training programme shall be provided, and shall cover all aspects of the installations so as to provide a first line local support to the staff, both operational and managerial. The training sessions shall comprise lectures and on-site (hands-on) demonstrations, and shall conduct over a minimum 2-day period. The Contractor shall provide a training plan and syllabus to the Department's Representative for approval. Approval of the training plan and syllabus shall be a condition for issue of a Certificate of Practical Completion for the installation. No training shall commence without the

Department's Representative's approval of the final draft Operating and Maintenance Manual for the installation. Training registers are to be signed by all members receiving training and a copy of all signed registers are to be included in the respective handover files.

The training shall include the following topics as a minimum:

1. Hardware-

- (a) Overview and functioning of system and equipment.
- (b) Network and cabling.
- (c) Components and field replacement.
- (d) System maintenance and specific tasks related to preventative maintenance.
- (e) Interpretation and understanding of the Operating and Maintenance Manuals, with specific reference to requirements in cases of corrective and breakdown maintenance.

2. Support-

- (a) Trouble shooting problems /queries.
- (b) Support programme and procedures.
- (c) Support communications.

Training certificates shall be issued at the end of the training, when the Contractor is satisfied that the persons trained have an adequate understanding of how the system functions, and are able to operate the system effectively. Copies of the certificates shall be included in the operating and maintenance manual.

21. OPERATING, MAINTENANCE AND INSTRUCTION MANUALS

The Contractor shall be responsible for the compilation of a complete set of Operating, Maintenance and Instruction Manuals for the entire Electrical installation, Intruder Alarm installation, Generator installation, Lightning Protection installation and School Siren installation.

The manual shall be bound in hardcover plastic-coated A4 lever-arch files as per 'Bantex' or similar and approved. Sections of the manuals shall be clearly partitioned using labelled coloured plastic sheets. Pamphlets, bound leaflets/booklets. And drawings shall be placed in clear plastic pockets.

The manual shall contain at least the following headings:

- 1. Introduction
 - (a) Scope of the manual
 - (b) General arrangement of the manual
 - (c) Description of installation
 - (d) Specifications
- 2. Schedule of equipment installed with pamphlets, names of Agents and Suppliers.
- 3. Parts and components list
- 4. Operating procedures
- 5. Maintenance
 - (a) Purpose of maintenance
 - (b) Preventative maintenance
 - (c) Trouble-shooting
 - (d) Planned service maintenance programme
- 6. Breakdown maintenance and repair, and name, address and telephone number of Contractor and after hours service.

7. Appendices including testing, commissioning data and training registers.
8. Drawings and diagrams

A draft copy of each Operating, Maintenance and Instruction Manual shall be submitted to the Department's Representative for approval. The manual will be reviewed and checked by the Department's Representative and returned to the Contractor with comments, where necessary. The Contractor shall make the necessary changes and amendments to the manual to incorporate the Department's Representative's comments.

The final draft copy of each Operating, Maintenance and Instruction Manual shall be submitted to the Department's Representative at least one week prior to commencement of testing on commissioning. This set of manuals will not be accepted without the Contractor's verification of the information contained in the manuals and the professional language editing thereof. The Department's Representative shall return the manual to the Contractor, who shall make the final corrections.

The Contractor shall include all test certificates and all details of the Electrical installation. All such information and certificates shall be to the approval of the Department's Representative. Electronic copies of the final manual shall be handed over to the department's Representative upon approval of the Operation, Maintenance and Instruction Manual.

Approval of final Operating, Maintenance and Instruction Manual shall be a prerequisite for issuing of a Certificate of Practical Completion for the installation.

PART 3: QUALITY SPECIFICATION FOR MATERIALS AND EQUIPMENT OF ELECTRICAL INSTALLATIONS

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PART 3: QUALITY SPECIFICATION FOR MATERIALS AND EQUIPMENT OF ELECTRICAL INSTALLATIONS

- 1 **SWITCHGEAR**
- a) GENERAL

Switchgear, which includes circuit breakers, iron-clad switches, interlocked switch-socket outlet units, contactors, time switches, etc., is to be in accordance with the Departmental Quality Specifications which form part of this specification and shall be equal and similar in quality to such brands as may be specified.

For uniform appearance of switchboards, only one approved make of each of the different classes of switchgear shall be used throughout the installations.

Circuit breakers shall be of the size and type as directed and specified for the service. They shall comply with SABS Specification 156 and SABS IEC 60947-2.

Switchgear manufactured in South Africa shall be given first preference and far as possible be used. Switchgear where applicable shall bear the SABS mark and comply with the requirements of the appropriate B.S. or I.E.C. specification and applicable standards below.

Imported materials shall comply with the requirements of the appropriate B.S. or I.E.C. specification and applicable standards below.

Circuit breakers and all switchgear shall be approved by the Department's Representative. Boards with fault level ratings less than 10 kA shall comply with SANS 1765 and fault levels equal to or greater than 10 kA with SANS 60439-1. Surge arresters for use in distribution boards shall comply with SANS IEC 61643-1.

b) APPLICABLE STANDARDS

Number	Title	Use
IEC/EN – 60947 - 2	Low-voltage switchgear and controlgear – Part 2: Circuit-breakers	Applies to circuit-breakers, the main contacts of which are intended to be connected to circuits, the rated voltage of which does not exceed 1 000 V a.c. or 1 500 V d.c.
IEC/EN 60364	Low-voltage electrical installations	
IEC/EN 61643-1	Low-voltage surge protective devices	This part of IEC 61643 is applicable to devices for surge protection against indirect and direct effects of lightning or other transient overvoltages.
IEC/EN – 61643-11	Part 11: Surge protective devices connected to low-voltage power systems - Requirements and test methods	
IEC/EN – 60 898	Circuit breakers for over current protection for household and similar installations.	Double standard conformity
IEC/EN – 61008-1	Residual current operated circuit-breakers without integral over current protection for household and similar uses	
IEC/EN 60479-1	Effects of current on human beings and livestock Part 1: General aspects	
IEC/EN 61000-4-5	Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test Reference	
IEC/EN 60755	General requirements for residual current operated protective devices	
IEC/EN 61009-1	Residual current operated circuit-breakers with integral over current protection for household and similar uses (RCBOs).	

c) PROTECTIVE DEVICES CHARACTERISTICS

The breaking devices must be capable of heavy-duty operation and to that end; the manufacturer shall guarantee the following performance levels:

- Suitability for isolation
- Positive contact indication through a green strip indicator operating independently to the toggle position
- Rated insulation voltage: 500 V (visisafe)
- Pollution degree: 3
- Rated impulse-withstand voltage: 6 kV (visisafe)

They will also provide, on their front face, an integrated indication of welding contacts.

To ensure the longest possible service life, switching mechanisms shall be designed to make the contact-closing speed totally independent of the operator's action. (Fast closing)

Contact positions, for breakers and residual current devices, shall be clearly indicated on the front of devices and marked:

- "I - ON", standing for device contacts closed, circuit energised,
- "O - OFF" with a green background, standing for device contacts open, circuit disconnected.

The breakers and residual current devices shall all provide a dedicated and integrated indication, enabling to identify a fault-driven tripping. (Visitrip)

For safety insurance, accessible parts of the devices, when installed in a suitable enclosure, shall feature:

- degree of protection IP40
- Insulation class II.

d) BREAKERS GENERAL CHARACTERISTICS AND OPERATION

Circuit breakers characteristics:

Circuit breakers shall comply with international standards IEC/EN 60898 and IEC/EN 60947-2. Compliance with these standards shall be certified by an independent organisation and its quality mark shall be visible on the devices.

Circuit Breakers Operation:

Circuit breakers shall be capable of operation under ambient temperature up to 50 °C, without de-rating of their overload tripping threshold with respect to their rated operating current.

Where the line supplying the switchboard is protected by a circuit breaker rated 125 Amps or more, the protection provided by this one shall be totally selective with respect to circuit breakers located in the switchboard (up to 63 A, type B or C).

e) RESIDUAL CURRENT DEVICES GENERAL CHARACTERISTICS

RCCB general characteristics:

RCCBs shall comply with international standard IEC/EN 61008.

Compliance with the standard shall be certified by an independent organization and its quality mark shall be visible on the devices.

The rated making and breaking capacities shall be at least equal to 1.5 kA both for fault currents between live conductors (I_m) and for earth-fault currents ($I_{\Delta m}$).

The rated conditional short-circuit currents (I_{nc} and $I_{\Delta c}$) shall be greater than or equal to the prospective short-circuit current at the point of installation (I_{sc} as per IEC 60364). The manufacturer shall guarantee these values do not differ from the rated breaking capacity of the circuit breaker providing short-circuit protection of the RCCB.

RCBO general characteristics:

RCBOs shall comply with international standard IEC/EN 61009.

Compliance with the standard shall be certified by an independent organisation and its quality mark shall be visible on the devices.

The RCBOs shall provide 2 integrated fault indications: one to indicate a tripping due to overload or short circuit and one to indicate a tripping due to residual current.

RCD with reinforced immunity:

RCDs located upstream of the following loads shall have a reinforced immunity to restrict power outages to the strict minimum required for user safety:

- Sets of fluorescent lighting, halogen lighting supplied with LV or ELV power,
- Groups of PCs and work stations,
- Motors driven by single-phase variable-speed drives...

The reinforcement in performance means that the RCDs shall not trip in the following situations:

- Continuous 1 kHz leakage current, 8 times higher than the rated tripping threshold
 - Leakage currents and transient over voltages due to lightning strikes, switching, decoupling capacitance discharges, etc.:
 - 5 kV peak voltage for a 1.2/50 μ s wave (IEC/EN 61000-4-5),
 - 3 kA leakage current for an 8/20 μ s wave (IEC/EN 61008),
 - 400 A leakage current for a damped sinusoidal 0.5 μ s / 100 kHz ring wave (IEC/EN 61008),
 - residual current equal to 5 times the rated residual operating current for a duration less than or equal to 10 ms,
 - Very high-frequency inducted or conducted disturbances (starting at 150 kHz).
- The RCDs must trip for fault currents with a DC component (type A as per IEC 60755).
The same is required for residual current devices located downstream of UPSs.

f) SURGE ARRESTERS CHARACTERISTICS AND OPERATION

Protection of loads against destruction by lightning shall be implemented in final distribution switchboards: each load shall be protected by a surge arrester

Therefore, final distribution switchboard shall embed a surge arrester compliant with IEC 61643-1 / EN 61643-11 standard. Compliance shall be proved by a quality label printed on the device.

Type 1 SPD (Class 1)

When a Type 1 is required the value of I_{imp} shall not be less than 50kA for each mode of protection [IEC60364-5-534].

Type 2 SPD (Class 2)

When a Type 2 is required, the nominal discharge current I_n shall not be less than 20kA for each mode of protection [IEC 60364-5-534]

Note: Where Class 1 & Class 2 combination is used, Class 1 shall be 50kA/(10/350 μ s) and Class 2 shall be 50kA/(8/20 μ s)

Type 3 SPD

An additional SPD is required when the length between the Type 2 and the sensitive electrical equipment is higher than 10 meters. The Open circuit Voltage U_{oc} value preferred is 10kV

Surge arresters operation

Its operating voltage U_c will not be less than 340 V between live and earth as well as phase to neutral.

It will be made of withdrawable cartridges, with rated maximum discharge capacity 8 kA.

The surge arrester will be set so as to ensure the distance between its earth terminal and the incoming earth terminal block not to be more than 15 cm.

Surge protection out of order (missing cartridge, replacement required) will be:

- Notified by an indicator on front
- Reported to Supervision centre by means of an indication switch.

According to IEC 61643-1 / EN 61643-11, the surge arrester shall be associated with a dedicated disconnector, the opening of which will not disturb or turn off power supply to any downstream located load. This disconnector will be made of a circuit-breaker, compliant with IEC / EN 60 898 standard. Disconnecting

circuit-breaker shall be integrated with the surge arrester: in case of trip, it will be possible to reset it only once all required cartridges have been replaced.

g) PROTECTIVE DEVICES MAINTENANCE

RCDs shall be tested every 6 months using the test button. When conditions are extreme (saline environment, chlorine, high level of dust), it is recommended that testing be done every 3 months.

h) SUSTAINABLE DEVELOPMENT

Production site organisation shall comply with the requirements of the ISO 9002 and ISO 14001 standards. For the devices, the manufacturer should be able to provide following arguments:

- Hazardous substances content (RoHS conformity declaration & REACH assessment referring to last update of SVHC candidate list).
- Environmental impacts characterized by several indicators (through Life Cycle Analysis & Product Environmental Profile) with at least:
 - Raw material depletion
 - Energy depletion
 - Global warming / carbon footprint
 - Water depletion
- Recyclability information (Product Environmental Profile / End of Life Instruction).

The devices shall be delivered in packaging compliant with European Directive 2004/12/CE

2 LUMINAIRES

LED LIGHTS

All Light fittings installed for this project is to be of the LED type, unless otherwise stated.

The following international standard specifications and South-African Bureau of Standards shall apply to the LED luminaire specification as revised:

SANS 475	Luminaires for interior lighting, street lighting and floodlighting – Performance and requirements
SANS 10114-1	Interior lighting part 1: Artificial lighting of interiors
SANS 10114-2	Interior lighting part 2: Emergency lighting
SANS 60598-1	Luminaires part 1: General requirements and tests
SANS 60598-2.1	Luminaires part 2: Particular requirements section 1 – Fixed general purpose luminaires.
SANS 60598-2.2	Luminaires part 2: Particular requirements section 2 – Recessed luminaires.
SANS 60598-2.3	Luminaires part 2: Particular requirements section 3 – Luminaires for road and street lighting.
SANS 60598-2.5	Luminaires part 2: Particular requirements section 5 – Flood lighting.
SANS 61347-1 to 13	Lamp control gear
SANS 62031	LED modules for general lighting – Safety specifications
SANS 62384	DC or AC supplied electronic control gear for LED modules – Performance requirements.
SANS 62560	Self-ballasted LED lamps for general lighting services with supply voltages > 50V – Safety specification.
SANS 62612	Self-ballasted LED lamps for general lighting services with supply voltages > 50V – Performance requirements
EN 55015	Limits and methods of measurement of radio disturbance of electrical lighting or equipment.
EN 61000-3.2	Electromagnetic compatibility (EMC) limits for harmonic current emissions.
EN 61000-3.3	Electromagnetic compatibility (EMC) limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems.
EN 61547	Equipment for general lighting purposes: EMC immunity requirements.
IEC-EN 62471	Photo biological safety of lamps and lamp systems for LEDs
IES LM-79-08	Approved method: Electrical and photometric measurement of solid-state lighting products.
IES LM-80	Approved method: Measuring lumen maintenance of LED light sources.

General requirements:

The luminaire shall be suitable for operation with mid-power LEDs.

The luminaire shall be suitable for operation on a 230V single phase 50Hz mains supply.

Power factor capacitors shall be supplied to correct the power factor to at least 0.95 or higher.

The luminaire shall be marked with identification labels stating the brand name and model and shall bear the SANS approval mark.

The driver shall comply with IEC 61347-1 and IEC 61347-2B as applicable and shall be suitable for operation on 230V $\pm$ 10%, 50Hz single phase system and it must be insured that harmonics filter is provided as per SANS 61000-3-2. The drivers and LED circuitry shall be protected against lightning and power surges. Suitable surge arrestors with a 10kA rating shall be provided for indoor installations and 20kA for outdoor installations.

Colour rendering (Ra) shall be not less than 80 and lumen depreciation of not more than 30% L70 at 50 000 hours @ T 25°C. Colour temperature of the LED lamp shall be 4000K, unless otherwise stated.

Thermal requirements:

The luminaire must be able to withstand an ambient temperature of 35°C. Storage temperature of this luminaire should be able to handle $-40^{\circ}\text{C} < T < 60^{\circ}\text{C}$.

To this end internal electrical and mechanical components shall not be allowed to exceed their maximum temperature ratings of 75°C. Test reports from an independent authorised testing facility proving this requirement shall be made available on request.

Noise requirements:

The noise level emitted from the luminaire shall be kept as low as possible. Drivers/electronic components shall therefore fully comply with the latest edition of SANS 55015.

3 EARTHING ELECTRODES

1. GENERAL

This section covers uncoated, coated and metal clad circular rod electrodes intended to provide an earth in soil for electrical and lightning arrestor systems.

2. CATEGORY AND TYPE

2.1 Only the following type of earth rods shall be used: (Type to be approved by Client Representative)

- 1(a) - Solid copper.
- 1(b) - Solid stainless steel.
- 2 (a) - Solid steel with bonded copper protection.
- 2 (b) - Solid steel with plated copper protection.
- 2 (c) - Solid steel with a shrunk-on copper jacket.
- 3 - Solid steel with a shrunk-on stainless steel jacket.
- 4 - Galvanised steel.

2.2 Bare aluminium is not acceptable as an electrode material.

2.3 All rods shall be solid and of circular cross section with length as specified in the Detail Technical Specification.

2.4 The nominal diameter of the earthing rods shall not be less than 16mm unless the rods are specified for placing in pre-drilled holes in which event the minimum nominal diameter shall not be less than 12mm.

3. COUPLINGS AND CONDUCTOR CLAMPS

3.1 Earthing electrodes shall be provided with (n-1) couplings where n = number of rods supplied.

3.2 Rods designed for coupling by means of external sleeves shall be provided with an adequate quantity of hydrocarbon or silicon grease to be applied to the coupling before the joint is made.

3.3 Rods designed for coupling by means of internal pins or splines shall be provided with thin-walled tubes and hydrocarbon or silicon grease to seal the joint.

3.4 Conductor clamps shall be provided to suit the type and size of rods provided and the type and size of conductor specified in the Detail Technical Specification.

3.5 The material of the clamps shall be electrolytically compatible with the rod and conductor materials.

3.6 Where brazed or welded connections are specified, the supplier of the rods shall stipulate at least two types of metals which are compatible with the rod and conductor materials.

3.7 An adequate number of driving caps or bolts shall be supplied with the rods to protect the ends of the earthing rods whilst being driven into hard soil.

PART 4: LIGHTNING PROTECTION SPECIFICATION

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PART 4: LIGHTNING PROTECTION SPECIFICATION

1. GENERAL

This specification shall be read in conjunction with the relevant, Bills of Quantities and General/Standard specification for this installation.

The following general requirements shall also apply:

- The work shall at all times be carried out under the supervision of a competent Representative of the Contractor, who will be able and authorized to receive and carry out instructions on behalf of the Contractor.
- Rates shall include all anti-vibration equipment necessary to ensure that the installation is acceptable to the Secretary of Works.
- The complete installation must be guaranteed against defective parts and workmanship for a period of twelve months after the date of issue of the Completion Certificate. This period shall run concurrently with the maintenance period.
- Rates shall include commissioning and testing of the complete installation and handing over in working order to the satisfaction of the Secretary of Works.
- Rates shall include all equipment, electrical wiring and controls necessary to complete the installation as specified.
- All work shall be carried out by competent workmen skilled in their trade. All workmanship will be subject to the approval of the Secretary of Works.
- All apparatus, component parts, fittings and materials employed in the execution of the Contract shall be new and unused and shall be the latest type or pattern of the particular manufacture employed. S.A.B.S. mark bearing items shall be used wherever possible.
- **The Specification identify the system concepts and standards of performance and quality required, but do not purport to identify all problem areas and their solution, which shall be the responsibility of the Contractor.**
- **By submitting a tender, the tenderer warrants that it is competent in the construction of works of the type specified, and that all work will be suitable for the intended purpose and complying with all relevant statutory regulations.**
- **The Contractor shall be responsible for identifying any ambiguity or incompleteness in the Contract Documents, and obtaining clarification instructions prior to proceeding with any work that may be affected by the ambiguity or incompleteness.**

2. SCOPE OF WORK

The lightning protection specialist contractor is to be a registered installer with the relevant installation body such as ELPA – Earthing and Lightning Protection Association.

The successful contractor, shall be required to provide the complete lightning protection installation for the works.

The work covered by this specification comprises the Lightning Protection installation, manufacture, supply, installation, connection, testing and commissioning and handing over to the client of the complete installation in an approved and satisfactory working order, the installation described herein, in such a manner that the whole forms a complete working system with the rest of the engineering services without any additional material or equipment being required. It includes the provision of record documentation for the installation of the following as specified:-

- Lightning protection installation for buildings
- All conductors and junction boxes
- Trenching and backfilling
- Testing and commissioning of the complete installation and ensuring **all required bonding** as per SANS 10313 and SANS 62303-1 to SANS 62305-3.

- Issue certificate of compliance for each building in accordance with the relevant SANS and IEC codes of practise - not limited to - SANS 10313 and SANS 62303-1 to SANS 62305-3.

The Specialist Contractor shall be responsible for the detailing, checking and ensuring that all work, as specified in this specification both intended and implied, fully conforms to SANS 10313 and SANS 62303-1 to SANS 62305-3.

3. WORK UNDERTAKEN BY OTHERS

The following particulars do NOT form part of the works to be provided under his installation: -

- Making good of chases in walls and floors after the installation of conduit, conduit outlet boxes and other accessories;

4. PARTICULAR REQUIREMENTS OF EQUIPMENT, MATERIALS AND INSTALLATION:

4.1 INSTALLATION

The Contractor shall prepare and submit the following documentation to the Department's Representative for reviewing:

- Testing and commissioning data.
- Operating, Maintenance and Instruction Manuals.
- Inspection Record Checklists.

4.2 SPECIALIST CONTRACTOR

The Contractor shall note that only Specialists in Lightning and Earthing Protection may undertake this work and shall produce proof of previous work completed to SANS 10313 and SANS 62303-1 to SANS 62305-3 standards. The specialist contractor is to review the design and advise on any short comings which prevent conformity to the above standards.

The lightning protection specialist contractor is to be a registered installer with the relevant installation body such as ELPA – Earthing and Lightning Protection Association.

4.3 CONTACT BETWEEN DISSIMILAR METALS

Precautions and steps shall be taken to prevent electrolysis from occurring due to the use and connection of dissimilar metals. Where necessary the joint between dissimilar metals shall be sealed with a suitable waterproof material or compound to prevent the ingress of water into the joint. The material or compound used shall be to the approval of the Department's Representative.

4.4 COMPLETION OF WORKS

Completion of works will occur and delivery shall be given only after the following procedure has been certified by the Department's Representative as having been carried out in accordance with the Specification:

After the defects are made good and approval of the Department's Representative is obtained, physical completion has been reported to the Department's Representative by the Contractor and the Departments Representative has given approval.

Commissioning and testing has taken place as specified and test results have been witnessed (where required), recorded and finally approved by the Department's Representative.

4.5 TESTING AND COMMISSIONING

Each earth point shall be tested for resistance to earth readings. These readings shall be logged and the actual method of test shall be recorded in detail so that future test may be carried out under similar conditions. A copy of all logged readings shall be forwarded to the Department's Representative for approval and record.

On completion the Contractor shall be required to carry out testing in accordance with SANS Code of Practice 03, and provide a set of marked-up 'As-Built' record drawings to the Department's Representative.

Copies of all the test certificates shall be included.

5. GENERAL INSTALLATION SPECIFICATION

5.1 SATISFACTORY INSTALLATION

The whole of the installation shall be carried out in accordance with:

(a) The latest S.A.B.S. Code of Practice for the Protection of Structures against Lightning - S.A.B.S. 03 ; SABS IEC 61024 (1) , 61024 (1 -1); SABS IEC 61312 (1) ; SABS IEC 61662 & NRS 042 and including - SANS 10313 and SANS 62303-1 to SANS 62305-3.

(b) The Municipal By-Laws and any other special requirements as deemed necessary by the Local Supply Authority;

(c) Local Fire Regulations.

5.2 S.A.B.S. APPROVED DRAWINGS

SABS Approved drawings are not required for this project.

5.3 TEST ON COMPLETION

Upon completion of the lightning protection system, the following tests shall be witnessed by an appointed representative of the Employer. The results shall be recorded on suitable test certificates which must be signed by both the Contractor and the Employers representative. A sketch must be included on each test certificate indicating the positions of each earth electrode in relation to some permanent reference point. It must also indicate the positions at which tests were carried out, the type of test and the results of these tests.

5.3.1 Earth Resistance Test

The Earth Resistance Test shall involve measuring the resistance to earth of each rod-type electrode, or group of rod-type electrodes, or trench earth which would normally be connected to one down-conductor or earth terminal. This test must be made with the electrodes completely disconnected from any part of the structure or lightning protection system.

5.3.2 Electrical Continuity Tests

(a) External Down-Conductors

Electrical continuity between the lower ends of external down-conductors which must all be disconnected from the earthing system during the test shall not exceed 1 (one) ohm.

(b) Metallic Services

Electrical continuity between any metallic structures of services (e.g. rainwater pipes) which form an integral part of the lightning protection system shall not exceed 1 (one) ohm. These tests should be carried out with all other components of the lightning protection system disconnected from the component being tested.

5.4 DESCRIPTION OF MATERIAL

5.4.1 Air Terminals and Down-conductors

All conductors must be in accordance with the requirements of BSS 1474 or American Standards Specification 6063. All aluminium conductors shall have a cross-section area of not less than 50 mm² or 70 mm² for all other applications.

5.4.2 Conductor Guides

The conductor must be mounted in aluminium alloy guides conforming to the material specification given in 4.1 above. The guides must allow for free longitudinal movement of the conductor to cater for expansion and contraction of the system caused by temperature variation. The minimum thickness of any part of the guide shall not be less than 3 mm. The guides must be securely attached to the structure using two stainless steel screws and plugs, the use of plated screws is not permitted.

The conductor system shall be supported in guides so that an air gap exists at all times between the aluminium and the surface of the structure, the guides being seated upon plastic or other similar insulating material. Should conductors be installed directly upon the surface of concrete or cement plaster, an insulating strip is to be installed over its whole length to prevent contact between the two surfaces. Guides shall be installed to support the conductor at intervals not exceeding 1, 2 metres horizontally or 1, 5 metres vertically.

N.B.: No part of an aluminium conductor system must be allowed to come into direct contact with concrete or cement plaster as this may cause the aluminium to corrode.

5.4.3 Expansion Loops

Where conductors are installed horizontally without deviation from a straight line over long distances, expansion loops must be provided at distances not exceeding 30 metres. These expansion loops must have a cross-sectional area which is at least equal to that of the conductor.

5.4.4 Protection of Down-conductors

Where external down-conductors are installed in areas which are readily accessible to the public, the lower ends of the conductors shall be enclosed in a semi-rigid insulating material. In the case of a circular section conductor this shall comprise a 2 metre length of 20 mm diameter P.V.C. conduit. This conduit shall be securely attached to the wall by means of galvanized steel saddles fixed with stainless steel screws and plugs, spaced at intervals not exceeding 1 m. Where a flat section conductor is used this shall be covered by a similar length of 25 mm P.V.C. conduit. The lower end of the conduit shall be positioned as close as practicable to ground level, i.e. immediately above an aluminium to copper joint. The ends of the conduit shall not be sealed.

5.4.5 Earthing Electrodes

Earthing electrodes must consist of either copper-clad steel rods not less than 12 mm in diameter and having a minimum copper thickness of 0,20 mm driven into the ground, or a 70 mm² bare copper conductor buried in a trench, or a combination thereof. Where copper clad steel electrodes are used they must have a suitable bond between the steel core and copper exterior to prevent moisture ingress between the two metals. Where it is necessary to extend earth rods, an electrolytically compatible corrosion resistant, coupling device, which prevents ingress or moisture into the joint shall be used. The copper conductor below the down-conductor joint shall be covered by a semi-rigid P.V.C. conduit for a distance of approximately 200 mm above ground and 400 mm below ground.

5.4.6 Joints above Ground

Circular section aluminium conductors shall be joined by aluminium ferrules or lugs which are securely crimped into place. Aluminium lugs must be bolted together using 10 mm diameter aluminium bolts and washers. The material specification for these components must conform to that laid down in paragraph 4.1. Alternatively heavily tinned copper lugs and ferrules may be used. The lugs should be joined together by means of 10 mm diameter copper, brass or bronze bolts and washers. Care should be taken to inhibit corrosion where dissimilar metals are used by thoroughly cleaning the surfaces of the metal before assembly and subsequently sealing the joint with an inert tenacious compound or tape.

Flat section aluminium conductors shall be joined by double riveting, using aluminium rivets which comply with the material specification laid down in 4.1. Alternatively 2 x 6 mm diameter stainless steel bolts, nuts and washers may be used. Fold over type bends will not be permitted.

Down-conductors are to be terminated approximately 200 mm above finished ground level. Circular section aluminium is to be joined to a 70 mm² stranded copper conductor by securely crimping in place two heavily tinned lugs and bolting these together using 10 mm diameter copper, brass or bronze nuts, bolts and washers.

N.B.: Under no circumstances shall aluminium conductors be buried in the ground.

5.4.7 Joints below Ground

A joint in the stranded copper conductor which forms part of the earthing system must be made by using a crimped copper ferrule clamping (not lugs) using two copper line taps of suitable dimensions, or exothermic welding. The copper earth conductor must be joined to an earth rod by either clamping, using a standard earth rod clamp or copper line tap or by exothermic welding. Joints which are made between dissimilar metals (i.e. copper conductor to galvanized steel water main), must be thoroughly cleaned before assembly. They shall be rendered watertight using waterproof adhesive tape on a suitable compound for a minimum distance of 200 mm in all directions from the joint.

5.4.8 Bonds

Where it is necessary to bond the aluminium conductor to any other metallic surface, this must be done by bolting or riveting. When attaching aluminium to a dissimilar metal the joints are to be thoroughly cleaned and sealed to prevent corrosion.

5.5 GENERAL INSTALLATION SPECIFICATION

5.5.1 Air Terminals for Non-metallic Pitched Roofs

Aluminium conductors are to be installed along all ridges of roofs and projections such as dormer windows, etc., terminating at the ends with conductors running downwards over the surface of the roof and the eaves. Non-metallic chimneys must be protected by means of a finial of sufficient length to cover the chimney within a 45° angle struck downwards from its point. Alternatively it should have a conductor installed in the form of a closed loop upon the upper surface. The conductors are to follow the outer contour of the stack and must be bonded at a convenient point to the nearest component of the air terminal system.

N.B.: This bond may run in a horizontal or downward direction, but under no circumstances must any part of it run above horizontal.

Conductors may be dead-ended (i.e. have one end free and unbonded), providing that the length of such a conductor does not exceed 10 metres and that the unbonded end is either at the same level or higher than the bonded end. This technique may be used where ridge conductors are installed over dormer windows, etc.

In all cases where metallic gutters have been installed along the eaves of a pitched roof, these must be bonded to the air terminal system. Where metallic gutters do not exist, however, a conductor must be installed over the surface of the roof at eaves level to which the remainder of the air terminal system is to be bonded, with the following exceptions:

(a) Where the maximum distance from the ground level to the eaves of the building is less than 4 metres and the pitch of the roof is more than 1 in 2 (27° from the horizontal).

(b) Where the maximum distances from ground level to the eaves is less than 7 metres and the pitch of the roof is more than 1 in 1,5 (34° from the horizontal).

(c) Where the distance from the ground level to the eaves is more than 7 metres and the pitch of the roof is more than 1 in 1 (i.e. the included angle at the apex of the roof is less than 90°).

Under these circumstances eaves conductors need not be installed.

Any non-metallic objects which protrude above the general roof lines, such as Cape Dutch gable ends, must be protected as described above with a suitable air terminal system. Any metallic objects which protrude above the general roof line, such as hot water expansion pipes must be bonded as directly as possible to the nearest eaves conductor, gutter or other part of the lightning system.

N.B.: These bonding conductors must run in a horizontal or preferably a downward direction, from the vent pipe, etc., to the lightning protection system.

5.5.2 Air Terminals for Metallic Pitched Roofs

Buildings with roofs covered with electrically continuous metal sheets do not require separate air terminals but must be earthed via down conductors generally as described in 5.6 and 5.7. Any non-metallic objects projecting above the general roof line must be separately protected as described in 5.1 and bonded to the metal roof covering.

5.5.3 Air Terminals for Non-metallic flat or Mono-pitched Roofs

For flat or mono pitched roofs of non-metallic construction the air terminal system must consist of aluminium alloy conductors installed around the outer perimeter of each section of the roof structure. These conductors must be installed on top of parapet walls if these exist. Lift motor rooms, tank rooms, penthouses, etc., which protrude above the general roof line must have air terminal conductors installed around the outer perimeter of each roof slab or parapet wall. Any metallic objects which protrude above the roof line, such as expansion pipes, signs, flag poles, handrails, etc., must be bonded directly to the nearest component of the lightning protection system as described in 5.1.

N.B.: It is not permissible for the ends of conductors to be bonded directly to the perimeter air terminal system if the latter is installed upon a parapet wall having a height exceeding 500 mm above roof slab level. In these circumstances the conductors are to be bonded directly to the down conductors.

5.5.4 Air Terminals for Metallic flat or Mono Pitched Roofs

Metallic flat or mono pitched roofs do not require separate air terminal conductors, providing that there is electrical continuity between the metallic roofing sheets, (see 5.2). A metallic roof surrounded by a non-metallic parapet wall shall have conductors installed at the top of the parapet wall and these must be bonded to the metallic roof at intervals not exceeding 20 metres. If the parapet wall is clad with metal over its upper surface or a handrail is installed which affords good electrical continuity, separate air terminal conductors need not be installed. Under these circumstances the metal handrail or cladding must be bonded to the metal roof covering at intervals not exceeding 20 metres.

All non-metallic covering such as slates, tiles, asbestos cement sheeting, etc., supported by a steel structure being electrically continuous throughout may be treated as being of a complete metal construction. In these circumstances no separate air terminal system need be installed providing the steel roof structure is bonded to earth at intervals given in 5.5.

5.5.5 Down Conductors for Non-metallic Structures

Down conductors must be installed at regular intervals around structures and to run as directly as possible between the air terminal and earthing system. They must, where practicable, be positioned at the external corners of the structure. The maximum separating distance between down conductors around the perimeter of the structure must not exceed 30 metres. In the case of very tall buildings having a slender base (i.e. chimney stacks, water towers, etc.), a minimum of two down conductors must be installed.

The lower ends of down conductors are to be terminated and bonded to the earthing system approximately 200 mm above finished ground level. Under no circumstances must aluminium conductors be buried underground. Test joints must be provided between the down conductors and earthing system. Down conductors must run vertically between the air terminal and earthing systems. Where this is impracticable, their course may be deviated to run at any angle up to and including horizontal.

Where it is necessary to run conductors horizontally over the upper surface of a structural protrusion, such as an exposed concrete slab, the conductor may run down vertically over the edge of the slab and return to the main structure, so that the distance between the upper and lower conductors exceeds one third of the length of the horizontal run. Looped down conductors are not permitted. Down conductors must not run over the underside of large overhangs which are less than 6 metres above ground level, or other areas where people are likely to be present during a thunderstorm.

External or internal metallic rainwater pipes may be used as down conductors providing these are of substantial section and are joined by screwing one length into another or welding. Thin gauge galvanized steel pipes whose sections are held together by friction, rivets or screws must not form part of a lightning protection system.

5.5.6 Down conductors for reinforced concrete framed structures

The steel reinforcement of this type of structure may be used in place of down conductors. Where the reinforcing system is used, the air terminal system must be bonded to it at a maximum of 30 metre intervals using steel clamps. This bond may be achieved by clamping, with a steel clamp, a steel conductor to a selected reinforcing bar, the opposite end of this conductor must terminate at a corrosion resistant metallic terminal such as Grade 316 stainless steel.

The reinforcing system of prefabricated concrete buildings must not be used unless special provision is made for bonding the various prefabricated sections together.

The terminals should be mounted flush with the face of the concrete. An aluminium alloy bond must then be taken from the air terminal system and be connected to the stainless steel terminal by means of a heavily tinned crimp lug for circular section aluminium, or a suitable bi-metallic joint in the case of flat section aluminium. A similar system must be used to bond the reinforcing system at ground level to the earthing system at points directly below the air terminal bonds. Here copper conductors must be used as the external bonding material.

Under no circumstances must copper, or other non-ferrous material be allowed to come into contact with steel reinforcing bars, as this may cause severe corrosion and subsequent structural damage. The lightning protection system must not be bonded to any part of the structure which is electrically isolated from the remainder of the building, i.e. cantilevered sections. In these circumstances, or where it is otherwise impracticable to use the reinforcing system, external down conductors must be installed as described in 5.5.

5.5.7 Down conductors for steel framed structures

Where the framework of a building is constructed of structural steel columns, these may be used in place of down conductors providing the separating distance between them does not exceed 30 metres. The upper ends of the columns must be bonded to the air terminal systems and the lower ends to the earthing system.

5.5.8 Earthing by means of vertically installed rod type electrodes

Rod-type electrodes must be driven into the ground at a position directly below each down connector. The maximum earthing resistance of each electrode or number of electrodes bonded to any one down conductor shall not exceed $N \times 30$ ohms, where N equals the total number of down conductors which are bonded to a common air terminal system, or 200 ohms whichever is the lower value.

The minimum horizontal separating distance between rod-type electrodes bonded together must not be less than their installed depth. The upper ends of installed rod-type electrodes are to be terminated approximately 500 mm below finished surface level. A 50 mm² copper bonding conductor must be installed to run between each earthing electrode system and the lower ends of the adjacent down conductors. A joint is to be made between each of these bonding conductors and the down conductors at a position approximately 200 mm above finished ground level. These bonding conductors must be installed in P.V.C. conduit securely affixed to the wall (see 3.4). The length of this P.V.C. conduit must be approximately 600 mm and must be installed so that approximately 200 mm protrudes above ground level, the remainder being buried into the soil.

5.5.9 Earthing by means of metallic water mains

Where two or three down conductors are installed the water mains may serve as an earth terminal for one of these. Where three or more down conductors are installed the water mains may serve as an earth terminal for two of these. Regardless of whether the water mains are used as an earth terminal or not, the incoming metal water pipe must be bonded to the lightning protection earthing system underground.

5.5.10 Earthing by means of trench type electrodes

Where the soil conditions prevent the satisfactory installation of rod-type electrodes, a trench earth system must be installed. This method is to comprise a 50 mm² stranded copper conductor installed horizontally into a trench at a depth of 500 mm below finished ground level. The conductor is to follow the general outline of the structure to be protected and be installed 1 metre away from the outside walls. Where the building stands on rocky ground, the trench earth may be attached to the lower part of the wall in areas where rock protrudes through the soil. The conductor must, however, be buried wherever possible as described above.

Each down conductor must be bonded to the trench earth system as directly as possible by means of a copper conductor.

Trench earth systems must have a maximum earth resistance of 1 ohm. An isolated length of trench earth mat must be bonded to the down conductor system in such a way as to reduce the length of dead-ends to the minimum.

Should trench earths be installed beneath pathways where people are likely to be present during a thunderstorm, a plastic, bitumastic or ceramic pipe must be installed having a length similar to the width of the pathway and the trench earth conductor run inside it.

N.B.: The maximum useful length of a dead-ended trench earth is 80 metres.

PART 6: BILLS OF QUANTITIES

PREAMBLE

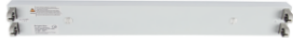
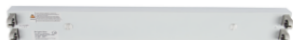
1. The descriptions in these bills of quantities shall be read in conjunction with the specification.
2. The unit rate for each item in the Bills of Quantities shall include for all materials, labour, profit, transport, etc., everything necessary for the execution and complete installation of the work in accordance with the description.
3. The Bills of Quantities shall not be used for ordering purposes. The Contractor shall check the lengths of cables and overhead conductors on site before ordering any of the cables. Any allowance for off-cuts shall be made in the unit rates.
4. The rates shall exclude Value-Added Tax and the total carried over to the final summary.

Luminaire Schedule

EZEMVELO WILDLIFE : MIDMAR

[illegible]

KZN WILDLIFE ORIENTPARK MIDMAR

							TYPE					
SUPPLIER CODE	PROPOSED LIMINAIRE	QTY to be removed	Luminaire to be removed	OFFICE	AREA	Supply Qty	S1	B1	F1	F2	P1	P2
Lihlelight SM 2x24w 1500MM led IP65		8		Reception		12	12					
Lihlelight SM 2x24w 1500MM led IP65		4		Kitchen	Training centre	4	4					
Lihlelight SM 2x24w 1500MM led IP65		4		Office Bongumusa	Training centre	4	4					
Lihlelight 2x9w led		4		Passage	Training centre	4		4				
Lihlelight SM 2x24w 1500MM led IP65		4		Office Pasela	Training centre	4	4					
Lihlelight SM 2x24w 1500MM led IP65		4		Storeroom	Training centre	4	4					

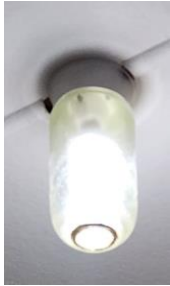
KZN WILDLIFE ORIENTPARK MIDMAR

							TYPE					
SUPPLIER CODE	PROPOSED LIMINAIRE	QTY to be removed	Luminaire to be removed	OFFICE	AREA	Supply Qty	S1	B1	F1	F2	P1	P2
Lihlelight SM 2x24w 1500MM led IP65		4		Office Warren	Training centre	4	4					
Lihlelight 2x9w led		4		Toilet	Training centre	4		4				
Lihlelight SM 2x24w 1500MM led IP65		4		Office Ayanda	Training centre	6	6					
Lihlelight 2x9w led		4		Passage	Training centre	4		4				
Lihlelight 2x9w led		4		Toilet	Training centre	4		4				
Lihlelight 2x9w led		4		Bathroom	Training centre	4		4				

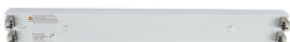
KZN WILDLIFE ORIENTPARK MIDMAR

							TYPE					
SUPPLIER CODE	PROPOSED LIMINAIRE	QTY to be removed	Luminaire to be removed	OFFICE	AREA	Supply Qty	S1	B1	F1	F2	P1	P2
Lihlelight SM 2x24w 1500MM led IP65		4		Office Silindile	Training centre	6	6					
Lihlelight 2x9w led		4		Arc-hives	Training centre	4		4				
Lihlelight 30w led floodlight		4		Exterior	Training centre	4			4			
Lihlelight 2x9w led		4		Front Exterior	Training centre	4		4				
Lihlelight 60w led post top		7		Exterior	Training centre	7					7	
Lihlelight 2x9w led		6		Exterior	Chalets	6		6				

KZN WILDLIFE ORIENTPARK MIDMAR

							TYPE					
SUPPLIER CODE	PROPOSED LIMINAIRE	QTY to be removed	Luminaire to be removed	OFFICE	AREA	Supply Qty	S1	B1	F1	F2	P1	P2
Lihlelight 2x9w led		18		Room	Chalets	18		18				
Lihlelight 2x9w led		6		Toilet	Chalets	6		6				
Lihlelight 2x9w led		6		Passage	Chalets	6		6				
Lihlelight E27 pedestal		4		Exterior	Manager Chalets	4						4
Lihlelight 2x9w led		20		Interior	Manager Chalets	20		20				
Lihlelight SM 2x24w 1500MM led IP65		3		Pantry	Kitchen	3	3					

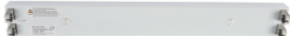
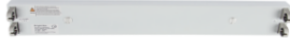
KZN WILDLIFE ORIENTPARK MIDMAR

							TYPE					
SUPPLIER CODE	PROPOSED LIMINAIRE	QTY to be removed	Luminaire to be removed	OFFICE	AREA	Supply Qty	S1	B1	F1	F2	P1	P2
Lihlelight 2x9w led		3		Passage to pantry	Kitchen	3		3				
Lihlelight 2x9w led		1		Laundry	Kitchen	1		1				
Lihlelight SM 2x24w 1500MM led IP65		6		Dining room	Kitchen	6	6					
Lihlelight SM 2x24w 1500MM led IP65		3		Pantry	Kitchen	3	3					
Lihlelight SM 2x24w 1500MM led IP65		12		Exterior	Kitchen	14	14					
Lihlelight 30w led floodlight		2		Exterior	Kitchen	2			2			

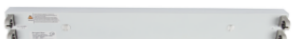
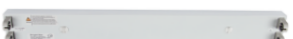
KZN WILDLIFE ORIENTPARK MIDMAR

							TYPE					
SUPPLIER CODE	PROPOSED LIMINAIRE	QTY to be removed	Luminaire to be removed	OFFICE	AREA	Supply Qty	S1	B1	F1	F2	P1	P2
Lihlelight 60w led streetlight		4		Kitchen exterior	Kitchen	4				4		
Lihlelight SM 2x24w 1500MM led IP65		3		Filing	Kitchen	3	3					
Lihlelight SM 2x24w 1500MM led IP65		3		Storeroom	Kitchen	3	3					
Lihlelight SM 2x24w 1500MM led IP65		3		Laundry	Kitchen	3	3					
Lihlelight 2x9w led		5		Male toilet	Kitchen	5		5				
Lihlelight 2x9w led		2		Female toilet	Kitchen	5		5				

KZN WILDLIFE ORIENTPARK MIDMAR

							TYPE					
SUPPLIER CODE	PROPOSED LIMINAIRE	QTY to be removed	Luminaire to be removed	OFFICE	AREA	Supply Qty	S1	B1	F1	F2	P1	P2
Lihlelight 2x9w led		2		Room	Cottage	2		2				
Lihlelight 2x9w led		1		Exterior	Cottage	1		1				
Lihlelight SM 2x24w 1500MM led IP65		8		Classroom	Classroom	8	8					
Lihlelight SM 2x24w 1500MM led IP65		4		Reloading Room	Classroom	4	4					
Lihlelight SM 2x24w 1500MM led IP65		1		Office next to Reloading room	Classroom	1	1					
Lihlelight 30w led floodlight		2		Exterior	Classroom	2			2			

KZN WILDLIFE ORIENTPARK MIDMAR

							TYPE					
SUPPLIER CODE	PROPOSED LIMINAIRE	QTY to be removed	Luminaire to be removed	OFFICE	AREA	Supply Qty	S1	B1	F1	F2	P1	P2
Lihlelight 2x9w led		2		Exterior	Classroom	2		2				
Lihlelight SM 2x24w 1500MM led IP65		1		Strong room	Classroom	2	2					
Lihlelight SM 2x24w 1500MM led IP65		9		Classroom 2	Classroom	9	9					
Lihlelight SM 2x24w 1500MM led IP65		8		Classroom 1	Classroom	8	8					
Lihlelight 2x9w led		8		Interior	Staff accomadation	8		8				
Lihlelight 30w led floodlight		2		Exterior	Staff accomadation	2			2			

KZN WILDLIFE ORIENTPARK MIDMAR

							TYPE					
SUPPLIER CODE	PROPOSED LIMINAIRE	QTY to be removed	Luminaire to be removed	OFFICE	AREA	Supply Qty	S1	B1	F1	F2	P1	P2
Lihlelight 2x9w led		14		Interior	Staff accomadation top	14		14				
Lihlelight SM 2x24w 1500MM led IP65		2		Toilet & Shower	Staff accomadation top	2	2					
Lihlelight SM 2x24w 1500MM led IP65		2		Kitchen	Staff accomadation top	2	2					
Lihlelight 2x9w led		10		Inside bathroom	Main gate staff accomadation	10		10				
Lihlelight 2x9w led		6		Outside bathroom	Main gate staff accomadation	6		6				
Lihlelight 30w led floodlight		4		Exterior	Main gate staff accomadation	4			4			

		Tender	
	ELECTRICAL BILL NO. 1.1 EZEMVELO WILDLIFE - MIDMAR ELECTRICAL INSTALLATION - LV NETWORK	Rate	Amount
1	<u>LV NETWORK</u> <u>Existing External Kiosks</u> Electrical contractor to rewire,refurbish, neaten & test existing external kiosks. The contractor is to make the existing electrical installation compliant,thereafter issue a certificate of compliance for the exisitng installation.		
A	Test and once complete provide detailed report indicating items to be rectified No. 4		
B	Provisional amount for making the existing electrical installation compliant. Thereafter issue electrical certificate of compliance for existing EXTERNAL KIOSKS No. 4	R 2 500,00	R 10 000,00
	<u>Existing Main Switchboard</u> Electrical contractor to rewire,refurbish, neaten & test existing distribution board. The contractor is to make the existing electrical installation safe to obtain a certificate of compliance for the exisitng installation.		
C	Test and once complete provide detailed report indicating items to be rectified No. 1		
D	Provisional amount for making the existing electrical installation compliant. Thereafter issue electrical certificate of compliance for existing MAIN DB Sum 1	R 8 000,00	R 8 000,00
	<u>Existing SUB-DISTRIBUTION BOARDS located in each building</u> Electrical contractor to rewire,refurbish, neaten & test existing distribution board. The contractor is to make the existing electrical installation compliant to ensure a certificate of compliance (CoC) can be issued.		
E	Test and once complete provide detailed report indicating items to be rectified No. 25		
F	Provisional amount for making the existing electrical installation compliant. Thereafter issue electrical certificate of compliance for existing MAIN DB Sum 25	R 1 500,00	R 37 500,00
	<u>Existing PLUG and LIGHT points</u>		
G	Test each plug point and provide detailed report No 150		
H	Test each light point and provide detailed report No 316		
	Carried to Collection		

		Tender	
		Rate	Amount
2	<u>SWITCHGEAR:</u> <u>Switchgear in existing switchboards</u> Supply and install switchgear in existing switchboard/ kiosk. DP/SP/TP CB's to be of the normal thermal magnetic type with adjustable trip unit where applicable.		
A	250A/15kA TP MCB		
	No	1	
B	150A/15kA SP MCB		
	No	1	
C	100A/10kA TP MCB		
	No	1	
D	60A/10kA SP MCB		
	No	4	
E	CLASS I SURGE PROTECTION DEVICE		
	No	10	
	POWER QUALITY ANALYSIS		
A	CONDUCT A POWER QUALITY ANALYSIS FOR A PERIOD OF 7 DAYS AT THE MAIN DISTRIBUTION BOARD.THE ANALYSIS SHALL RECORD AND PROVIDE A DETAILED TEST REPORT INDICATING THE FOLLOWING CURRENT, CURRENT HARMONICS,KVA,KVAr,POWER FACTOR,KW		
	No.	1	
4	<u>EXISTING INSTALLATION:</u>		
A	Remove all redundant existing switchboards and any redundant cabling, wiring and electrical equipment and handover back to client.		
	Item	1	
5	<u>TESTING AND COMMISSIONING :</u>		
A	Test and commission complete electrical distribution and cabling installation as specified. Including all electrical certificates of compliance		
	Item	1	
	Carried to Collection		

		Tender	
		Rate	Amount
ELECTRICAL BILL NO. 1.1 EZEMVELO WILDLIFE - MIDMAR ELECTRICAL INSTALLATION - LV NETWORK COLLECTION		Page No Total brought forward from page 1 2	
Carried to Summary			

			Tender	
	ELECTRICAL BILL NO. 1.2 EZEMVELO WILDLIFE - MIDMAR		Rate	Amount
2	<u>WIREWAYS AND ACCESSORIES :</u> <u>Conduit -</u> Supply and install conduit placed in position for casting into concrete or screed, for building-in or chased into concrete or brickwork and for surface mounting in ceiling or other surfaces including bending, jointing draw boxes, couplings and saddles. All conduit and assessories to be SABS Approved. Metal conduit and assessories to be hot dip galvanized			
A	20 mm diameter galvanized metal	m	0	
B	20 mm diameter PVC	m	150	
C	20 mm diameter flexi PVC	m	0	
D	25 mm diameter PVC	m	0	
	<u>Conduit boxes -</u> Supply and install round conduit boxes placed in position for casting into concrete, building or chased into brickwork, surface mounted or mounted flush in ceilings including locknut and bushes. Metal conduit and assessories to be hot dip galvanized			
E	50 mm deep metal for 20 diameter conduit	No	0	
F	50 mm deep PVC for 20 diameter conduit	No	0	
3	<u>CONDUCTORS AND CABLES:</u> Supply and install 600/1000V grade PVC insulated stranded copper conductors drawn in conduit, trunking or powerskirting. All conductors to be SABS Approved. <u>Conductors-</u>			
A	2,5 mm ²	m	150	
B	6 mm ²	m	0	
	<u>Earth wire -</u>			
C	2,5 mm ²	m	75	
D	6 mm ²	m	0	
	Carried to Collection			

			Tender	
			Rate	Amount
5	<u>POWER SKIRTING - Galvanized metal, powder coated</u>			
	3 compartment 2 tier cover, powder coated galvanized steel, power skirting complete with end stops, duct dividers, elbows and all other required material.			
	<u>Powerskirting with covers-</u>			
A	Supply			
		m	0	
B	Install			
		m	0	
	<u>Bends-internal & External</u>			
C	Supply			
		No	0	
D	Install			
		No	0	
	<u>End caps-</u>			
E	Supply			
		No	0	
F	Install			
		No	0	
4	<u>APPLIANCES :</u>			
	Supply and install appliances complete with cover plates fixed in flush boxes, powerskirting or in surface boxes as applicable, complete with all accessories, fixings and labels. Boxes are measured separately. All appliances below to be SABS Approved.			
	<u>Switched Sockets Outlets (SANS type) -</u>			
A	SANS 164-1 & SANS 164-2 Combination plug, 250 V, 16 A in flush 100x100x50 box - Type PP1	No	35	
C	SANS 164-1, 250 V, 16 A Plug in Power Skirting power skirting - Type PP3	No	25	
D	SANS 164-2, 250 V, 16 A Plug in Power Skirting power skirting - Type PP4	No	25	
E	SANS 164-4, 250 V, 16 A, Red Dedicated Plug in Power Skirting power skirting - Type PP5	No	0	
	<u>Isolators-</u>			
G	20A, 250V, DP in flush 100x100x50 box - Type 'lp1'	No	15	
H	30A, 250V, DP in flush 100x100x50 box - Type 'lp2'	No	0	
I	20A, 250V, TP in flush 100x100x50 box - Type 'lp1'	No	0	
J	30A, 250V, TP in flush 100x100x50 box - Type 'lp2'	No	0	
	Carried to Collection			

			Tender	
			Rate	Amount
	<u>Light Switches (SANS type) -</u>			
C	16A, 250V 1 lever, 1-way in surface 100x50x50 box - TYPE Ls1			
		No	35	
C	16A, 250V 2 lever, 1-way in surface 100x50x50 box - Ls2			
		No	0	
C	16A, 250V 3 lever, 1-way in surface 100x50x50 box - Ls3			
		No	0	
5	<u>LIGHT FITTINGS</u>			
	Light fittings installed over round boxes in brickwork or ceiling, fixed to surface including all fixings, brackets, supports, connectors, wiring, flexible cable, connections and installation of lamps as specified. All light fittings to be SABS Approved			
	<u>Type 'S1'</u>			
A	Supply			
		No	120	
B	Install (N.B. - IP integrity to be maintained)			
		No	120	
	<u>Type 'B1'</u>			
A	Supply			
		No	180	
B	Install (N.B. - IP integrity to be maintained)			
		No	180	
	<u>Type 'F1'</u>			
A	Supply			
		No	16	
B	Install (N.B. - IP integrity to be maintained)			
		No	16	
	<u>Type 'F2'</u>			
A	Supply			
		No	6	
B	Install (N.B. - IP integrity to be maintained)			
		No	6	
	<u>Type 'P1'</u>			
A	Supply			
		No	10	
B	Install (N.B. - IP integrity to be maintained)			
		No	10	
	<u>Type 'P2'</u>			
A	Supply			
		No	6	
B	Install (N.B. - IP integrity to be maintained)			
		No	6	
	Carried to Collection			

		Tender	
		Rate	Amount
7	<u>EARTHING AND BONDING</u>		
A	Allow for earthing and bonding as required by the applicable Supply Authority and Regulations		
	Item 1		
8	<u>TESTING AND COMMISSIONING :</u>		
A	Test and commission complete electrical installation Including certificate of compliances for all distribution boards		
	Item 1		
9	<u>EXISTING INSTALLATION:</u>		
A	Remove and make safe all redundant existing switchboards and any redundant cabling, wiring, light fittings, plug points, electrical equipment, cables and handover back to department.		
	Item 1		
10	<u>ATTIC STOCK</u>		
A	Contractor to allow for 10% of lamps as attic stock		
	Item 1		
11	<u>Provisional amount</u>		
A	provisional amount to be used at engineers discretion		
	Item 1	R 150 000,00	R 150 000,00
Carried to Collection			

		Tender	
ELECTRICAL SUMMARY EZEMVELO WILDLIFE - MIDMAR			Amount
Bill No.	Description	Page No.	
1.1	ELECTRICAL INSTALLATION - LV NETWORK	3	
1.2	ELECTRICAL BILL NO. 1.2	8	
1.3	P & G's		
1.4	HEALTH AND SAFETY FILE		
SUB_TOTAL			
VAT			
TOTAL			