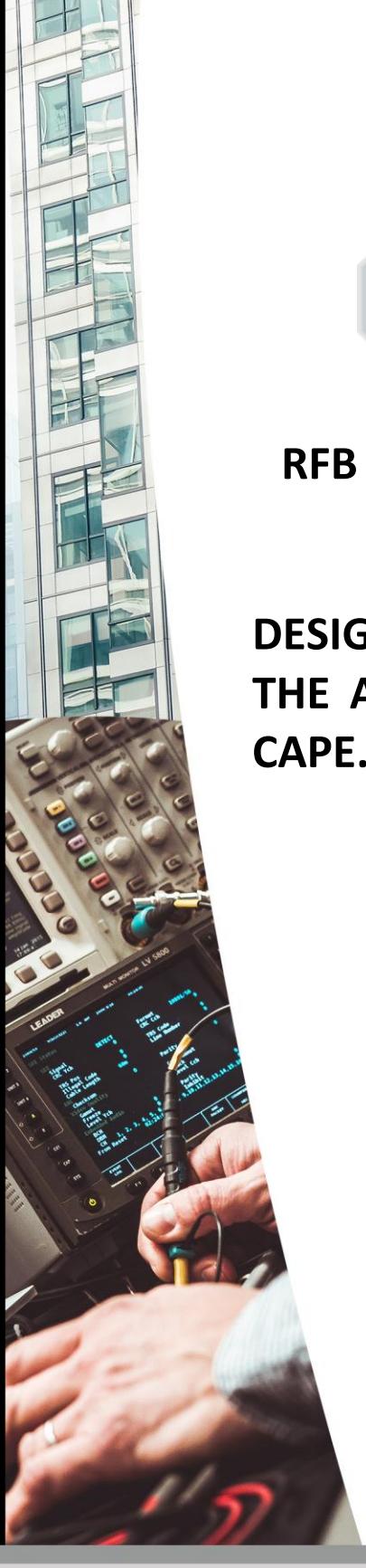


ARMSCOR
Armaments Corporation of South Africa SOC Ltd

RFB Nr: R&D/IMT-2023/024 ANNEXURE A.

DESIGN AND INSTALLATION OF A UPS AT THE ARMSOCR IMT BUILDING, WESTERN CAPE.

Tender Document

Rev 3

23 June 2023

Head Office

1283 De Villebois Mareuil Drive
Moreleta Park
Pretoria
0181

Tel: 012 997 3676/3376
Fax: 086 403 3719

www.med-techengineers.com

MED-TECH
ENGINEERS

APPROVAL BY MED-TECHENGINEERS

Company:	**Name:**	**Signature:**
Prepared by (Med-TechEngineers)	Sesha Ngoae	
Checked by (Med-TechEngineers)	Thulani Phahla	
Approved by (Med-TechEngineers)	Gift Mphefu	
Contact No.	083 358 6522	
Email Address	giftm@med-techengineers.com	

APPROVAL BY CLIENT (ARMSCOR)

Company:	**Name:**	**Signature:**
Checked by (Armscor)		
Approved by (Armscor)		
Contact No.		
Email Address		

APPROVAL BY THE USER CLIENT (IMT BUILDING)

Company:	**Name:**	**Signature:**
Checked by (IMT BUILDING)		
Approved by (Armscor)		
Contact No.		
Email Address		

1. Table of Contents

2. NOTICE TO TENDERERS

The tenderer shall submit additional information regarding the Electrical Installation together with the returnables enclosed with the tender enquiry documents.

The Contractor, on acceptance of his tender for this contract shall submit within the period stated, the information indicated on the forms following immediately after the Summary of the bills of quantities for this installation.

3. GENERAL

3.1 TESTS

After completion of the works and before practical completion is taken, a full test shall 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 client's Representative/Agent, 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.

3.2 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 12 month free 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 client Representative/Agent or the Client, at his own expense replace the whole of the installations or such parts thereof as the client Representative/Agent or the Client may deem necessary with apparatus specified by the client Representative/Agent or the Client.

3.3 REGULATIONS

The installation shall be erected and tested in accordance with the following Acts and regulations:

a) SANS 10400: The Application of The National Building Regulations
b) SANS 10142-1; Code of Practice for the Wiring of Premises
c) SANS 10142-2; Medium Voltage Installations Above 1kV not exceeding 22kV ac and up to and including 3 000KW installed capacity
d) SANS 10114 – Part 1 and 2: Code of practice of Interior Lighting
e) SANS 1029: Miniature Substations for Rated ac Voltage up to and including 24kV
f) SANS 10313: Protection Against Lightning – Physical Damage to Structures and Life Hazard
g) SANS 62305: Part 1 to 4: Protection Against Lightning
h) SANS 10199: The Design and Installation of Earth Electrodes
i) SANS 556-1: Low voltage switchgear Part 1 – Circuit breakers

j) SANS 8528 – Series 1 to 9: Reciprocating internal combustion engine driven alternating current generating set
k) SANS 204: Part 1 to 4: Energy Efficiency in Buildings
l) SANS 507-3: Electrical Cables with Extruded Solid Dielectric Insulation Part 3 – PVC Distribution Cables
m) The Occupational Health and Safety Act, 1993 (Act 85 of 1993) as amended,
n) 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.
o) The Fire Brigade services Act 1993 Act 2000 (Act 14 of 2000) as amended,
p) The Post Office Act 1998 (Act 124 of 1998) as amended,
q) The Electricity Act 1996 (Act 88 of 1996) as amended and
r) The Regulations of the Local Gas Board where applicable.
s) SANS 1474: Uninterruptible Power Systems

3.4 NOTICES AND FEES

The Contractor shall give all notices required by and pay all necessary fees, including any 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 Client.

3.5 SCHEDULE OF FITTINGS

In all instances where schedule of light, socket outlet and power points are attached to or included on the drawings, these schedules are to be regarded as forming part of the specification.

3.6 QUALITY OF MATERIALS

Only materials of first class quality shall be used and all materials shall be subject to the approval of the client Representative/ Agent or the Client. The specifications for various materials to be used on this Contract are attached to and form part of this specification.

Wherever applicable the material is to comply with the relevant South African National Standards, specifications, or to British Standard Specifications, where no SANS Specifications exist.

Materials wherever possible, must be of South African manufacture.

3.7 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 3 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 National Standards.

a) Screwed metallic conduit and accessories: SABS 1065, parts 1 and 2.
b) Plain-end metallic conduit and accessories: SABS 1065, parts 1 and 2.
c) Non-metallic conduit and accessories: SABS 950

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 3 of this specification or indicated on the drawings.

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 conduits 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 screeding 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 client's representative or agent, 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 SABS 763.

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.

3.8 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 in close proximity to the boards.

3.9 SURFACE MOUNTED CONDUIT

Wherever possible, the conduit installation is to be concealed in the building work; however, where unavoidable or otherwise specified under Part 3 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 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.

3.10 CONDUIT IN CONRETE SLABS

In order not to delay building operations the Contractor must ensure that all conduits and other electrical equipment which are to be cast in the concrete columns and slabs are installed in good time.

The Contractor shall have a representative in attendance at all times when the casting of concrete takes place.

Draw-boxes, expansion joint boxes and round conduit boxes are to be provided where necessary. Sharp bends of any nature will not be allowed in concrete slabs. Draw and/or inspection boxes shall be grouped under one common cover plate, and must preferably be installed in passages or male toilets.

All boxes, etc., are to be securely fixed to the shuttering to prevent displacement when concrete is cast. The conduit shall be supported and secured at regular intervals and installed as close as possible to the neutral axis of concrete slabs and/or beams.

Before any concrete slabs are cast, all conduit droppers to switchboards shall be neatly spaced and rigidly fixed.

3.11 FLEXIBLE CONNECTIONS FOR CONNECTING UP STOVE, MACHINES, ETC.

Flexible tubing connections shall be of galvanised steel construction, and in damp situations of the plastic sheathed galvanised steel type. Other types may only be used subject to the prior approval of the client's site electrical representative.

Connectors for coupling onto the flexible tubing shall be of the gland or screw-in types, manufactured of either brass or cadmium or zinc plated mild steel, and the connectors after having been fixed onto the tubing, shall be durable and mechanically sound. Aluminium and zinc alloy connectors will not be acceptable.

3.12 WIRING

Except where otherwise specified in Part 3 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 any wiring is commenced.

Unless otherwise specified in Part 3 of this specification or indicated on the service drawings, 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 4mm²-earth conductor. In certain instances, as will be directed in Part 3 of this specification, the sizes of the aforementioned 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 or indicated on the drawings. 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 SABS 150.

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.

3.13 SWITCHES AND SOCKET OUTLETS

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

No other than 16A 3 pin sockets are to be used, unless other special purpose types are distinctly specified or shown on the drawings.

Where conventional light switches are used, all light switches shall be installed at 1,4m above finished floor level and all socket outlets as directed in the Schedule of Fittings which forms part of this specification or alternatively the height of socket outlets may be indicated on the drawings.

3.14 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 Project Technical 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 Project Technical Specifications shall be used throughout the installations.

3.15 SWITCHBOARDS

All boards shall be in accordance with the types as specified, be constructed according to the detail or type drawings and must be approved by the client Representative/ Agent 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 board proposed, as an alternative to that specified must have the prior approval of the client Representative/ Agent.

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 is to be according to the lay-out drawings or as directed by the client's Representative/ Agent and must be confirmed on site. Flush mounted boards to be installed with the top of the board 2,0m above the finished floor level.

3.16 WORKMANSHIP AND STAFF

Except in the case of electrical installations supplied by a single-phase electricity supply at the point of supply, an accredited person shall exercise general control over all electrical installation work being carried out.

The workmanship shall be of the highest grade and to the satisfaction of the client Representative/ Agent and the Client.

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

3.17 CERTIFICATE OF COMPLIANCE

On completion of the service, a certificate of compliance must be issued to the client's Representative/Agent in terms of the Occupational Health and Safety Act, 1993 (Act 85 of 1993). Certificate of compliance shall be issued by the person qualified to do so for this type of installation.

3.18 EARTHING OF INSTALLATION

3.18.1 Main earthing

The type of main earthing must be as required by the supply authority, and in any event as directed by the Client's representative, 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 Client's authorised representative.

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 insulation.

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 16 mm² stranded (not solid) bare copper wire or such conductor as the Client'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 0,8mm perforated for 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.

3.18.2 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 0,8mm 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.

3.18.3 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 conductor 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.

3.18.4 Sub-circuits

The earth conductors of all sub-circuits shall be connected to the earth busbar in the supply board in accordance with SANS 10142-1 as amended.

3.18.5 Ring Mains

Common earth conductors may be used where various circuits are installed in the same wire way in accordance with SANS 10142-1. 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.

3.18.6 Non-metallic Conduit

Where non-metallic conduit is specified or allowed, the installation shall comply with the Project Technical 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.

3.18.7 Flexible Conduit

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

3.18.8 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.

3.19 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 as indicated on the drawings must be adhered to as far as possible and must be confirmed with the Client's representative.

Fluorescent 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 ¾ of the length of the luminaires apart.

Fluorescent 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 ¾ 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".

4. INSTALLATION DETAILS

4.1 CABLE SLEEVE AND PIPES

Where cables cross under roadways, other services and where cables enter buildings, the cables shall be installed in sleeves, 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.

4.2 NOTICES

The Contractor shall issue all notices and make the necessary arrangements with Supply Authorities and other authorities as may be required with respect to the installation.

4.3 ELECTRICAL EQUIPMENT

All equipment and fittings supplied must be in accordance with the attached Project Technical Specification (Part 4 of this document), suitable for the relevant supply voltage, and frequency and must be approved by the Client's representative.

4.4 DRAWINGS

The drawing(s) generally show the scope and extent of the proposed work and shall not be held as showing every minute detail of the work to be executed. For this project, only a distribution boards single line diagram drawing has been prepared.

4.5 BALANCING OF LOAD

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

4.6 SERVICE CONDITIONS

In addition to the specification provided, the appointed contractor shall ensure that all plant to be installed on this project shall be designed for the climatic conditions of where it will be installed. This project is at Armscor IMT Building which is situated in Simons Town. The actual IMT Building is at the sea, less than 50m from the sea.

4.7 SWITCHES AND SOCKET OUTLETS

The installation of switches and socket outlets must conform to clause 13 of Part 2 of this specification.

4.8 LIGHT FITTINGS AND LAMPS

The installation and mounting of luminaires must conform to clause 19 of Part 2 of this specification.

All fittings to be supplied by the Contractor shall comply with the Client's Specification. Incandescent lamps shall bear the approved mark of the S.A.B.S. and shall have the British light centre length.

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

4.9 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 18 of Part 2 of this specification and to the satisfaction of the Client's representative.

4.10 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 user of the building and the Client's representative.

4.11 EXTENT OF WORK

The work covered by this contract comprises the following complete electrical installation, in working order, as shown on the drawings and as per this specification, including the supply and installation of all fittings and also the installation of such equipment supplied by the Client.
This contract involves the supply and installation of a new UPS at Armscor IMT Building in Simons Town, Western Cape Province.

4.11.1 Electrical Supply

There is an existing electricity service connection to site. This project covers internal low voltage reticulation, distribution boards, and supply and installation of a new UPS. A need to liaise with electricity supply authority is not envisaged as switching off power to site will not be necessary.

Contractor's Responsibility

The Contractor shall be responsible for the supply, installation, testing, commissioning and free maintenance during the guarantee period of the installation detailed herein.

The Contractor shall provide all materials, equipment, labour and services necessary for the complete, safe and efficient operation of the electrical installation in accordance with the intent of this Specification and Drawings.

The works shall be carried out strictly in accordance with the following:

All regulations, standards and codes of practice are

SANS 10142-1: Code of practice for the wiring of premises.

SANS 1474: Uninterruptible Power Systems

In terms of Government Notice No 17548, it is the Contractor's responsibility to ensure that all electrical

fittings installed comply with the relevant SANS safety standards, applicable to the particular class of fitting. In the event of fittings specified by the Engineer/Architect which do not comply with the SANS safety standards, it shall be the Contractor's responsibility to notify the Engineer immediately in writing, so that alternative fittings which do comply with the SANS safety standards may be timeously selected.

The Contractor shall not install any fitting under any circumstance which does not comply with the SANS safety standards unless specifically instructed in writing by the Engineer on an item for item basis.

Where a product is claimed to comply with the SANS safety standard by compliance to an alternative foreign safety standard recognised and accepted by the SANS, the Contractor shall obtain and submit proof of such acceptance. Where the SANS grants a permit for the use of equipment which does not carry the SANS/SABS mark, the Contractor shall submit copies of the permits and test reports to the Engineer at the time of tender.

All equipment tendered shall comply with the SANS safety standard as required by the above legislation. The Electrical Contractor shall provide copies of SANS certificates of compliance for electrical fittings upon request by the Engineer. No claim will be considered on the basis that equipment tendered did not comply with the relevant SANS standard.

4.11.2 Uninterruptible Power Supply (UPS)

A new 150kVA three phase in, three phase out, double conversion, online UPS shall be supplied and installed. The UPS shall provide a backup time of 2 hours.

The UPS shall be housed in a new UPS room. The existing generator room shall be cleaned, refurbished and used as a UPS room. Air-conditioning required in the UPS room forms part of this contract.

The UPS to be supplied shall meet or exceed the specification of Delta HPH Series UPS in terms of performance.

Intent of this Part of the Specification

The specification is intended to cover the complete installation of the uninterrupted power supply (UPS). The minimum equipment requirements are outlined, but do not cover all the details of design and construction. Such details are recognised as being the exclusive responsibility of the contractor.

In all cases where a device or part of the equipment is referred to in the singular, it is intended that such reference shall apply to as many devices as are required to complete the installation.

Standards and Codes

SANS 1474: Uninterruptible Power Systems

Scope of Work

The scope of work involves the supply, delivery, installation and commissioning of an uninterrupted power supply (UPS) at the IMT Building in Simons Town in the Western Cape.

The appointed electrical contractor shall ensure that the space allowed is sufficient for the installation of the UPS and that the ventilation of the plant room is adequate. If any changes to the design have to be made the contractor must inform the consulting engineer in writing.

The UPS shall be installed in a new UPS room.

Schedules of technical information, where the parameters of the UPS and batteries offered are to be filled shall be submitted with this tender.

The contractual matters pertaining this contract are dealt with elsewhere in this document.

Ambient Operating Conditions

a) Ambient Temperature: 17°C to 26°C
b) Relative Humidity: 76%
c) Altitude: 25m above sea level
d) Dust: Medium
e) Corrosion: High

Site Information

The scope of work involves the supply, delivery, installation and commissioning of an uninterrupted power supply (UPS) at the IMT Building in Simons Town in the Western Cape. The UPS shall be placed or housed in a fairly clean environment.

Electrical supply to the UPS shall be provided by the Contractor installing the UPS as well as the general electrical installation.

Co-ordination

Due to the nature of the installation, a fixed sequence of operation is required to properly install the complete uninterrupted power supply. The work shall be closely scheduled in order not to delay the entire project.

The contractor shall familiarise themselves with the requirements of the other trades and shall examine the plant and specification covering each of these sections.

The space requirements shall be carefully checked with the other trades to ensure that the equipment can be installed in the proper sequence in the space allocated.

Test Certificates and Inspections

The following tests are to be carried out:

(a) After completion of the works and before practical completion is taken, 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 installation will be inspected and the contractor shall make good, to the satisfaction of the Representative/Agent, any defects which may arise.

(b) 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 installation at completion.

(c) Test reports of both tests as specified under (a) and (b) are to be submitted to the Department.

Guarantee and Maintenance

The Contractor shall guarantee the complete plant for a period of twelve months after practical completion has taken place.

If during this period the plant is not in working order, or not working satisfactorily owing to faulty material, design or workmanship, the Contractor will be notified and immediate steps shall be taken by him to rectify the defects and/or replace the affected parts on site at his own expense.

The Contractor shall maintain the plant in good working condition for the full twelfth month period to the final delivery of the installation. However, should the Contractor fail to hand over the plant in good working order on the expiry of the specified twelfth months, the Contractor shall be responsible for further monthly maintenance until final delivery is taken.

During this period the contractor will undertake to arrange that the plant be inspected at regular intervals (whatever number of visits the contractor deems necessary to fully maintain the equipment) by a qualified member of his staff who shall: -

(a) Check the mechanical soundness of all parts

(b) Check and adjust all the output and control values of the system (voltage, frequency, control voltages, etc.)

(c) Take control measurements on the major system components and record these measurements.

(d) Replace all defective components.

(e) Service batteries.

(f) Check ventilation of UPS equipment.

(g) Clean all equipment and/or rooms as required.

(h) Provide 24 hour standby maintenance and repair service at all times, including statutory holidays.

Note: At each visit, which shall be arranged in advance with the client's representative, a record of maintenance carried out shall be kept. The time and date of visits shall be entered in a logbook, which shall be kept in the plant room.

12-Month Maintenance Contract

Over and above the 12-month free maintenance period, the appointed contractor shall enter into a 12-month maintenance contract with the client. This 12-month maintenance contract shall run concurrently with the 12-month free maintenance contract. The tenderer shall in this tender price for this 12-month maintenance contract.

The 12-month maintenance contract shall be as follows:

- Maintenance Obligations
- Fulfilling of Maintenance Obligations
- Maintenance Service Exclusions
- Fault Handling Procedures
- Service Provided

Maintenance Obligations

The Contractor shall:

- Undertake such preventative maintenance service and remedial maintenance services of the UPSs and air-conditioning unit as is necessary to maintain the systems in good working order and in accordance with the engineering systems as published by its original Manufacturer in the relevant technical manuals, appropriately revised from time to time (the Manufacturer's specifications).

- Carry out all maintenance services during normal maintenance hours which, for the purposes of this agreement, shall be between the hours of 08:00 and 17:00 Monday through to Friday. Any after hour's work that may be required is to be coordinated with the Client and will be at no additional cost to the contract.

- The Client may request the Contractor to provide maintenance service outside the normal maintenance hours in which event the Contractor shall be entitled to charge for such service at half the normal service rates as published by the Contractor from time to time.

- Where any hardware is removed from the premises pursuant to any repair required, the Contractor may, at its discretion, provide hardware on loan until such time as the original hardware is returned, installed and is fully functional and operative.

Fulfilling of Maintenance Obligations

The Contractor shall:

- Use its best endeavours to ensure that the systems are operational during peak periods of business as may be notified to the Contractor from time to time.

- On request, furnish information regarding the status of repair and/or location of any systems.

- Maintain accurate and complete records detailing each service action undertaken, (the service records).

- Ensure that each service record is signed by a duly authorized representative of the Client who shall confirm that the maintenance service has been performed.

- Train the Client's staff regarding the basic user maintenance of the systems.

- Participate in all meetings and service review sessions called by the Client, upon reasonable notice, to address issues related to the systems.

- Agree with the Client on the measurement criteria to be employed to measure the performance of the Contractor (as specified in this service level agreement).

- Supply the Client with an agreed report on a monthly basis.

Maintenance Service Exclusions

This agreement shall not cover repair of damage, replacement of parts or increase in service time necessitated by:

- Disaster or acts of God (including water, fire and lightning).
- Vandalism, accident or neglect by the Client, its Employees, Agents, Sub-agents or Tenants.
- Faults to the systems caused by the Client's improper use of the UPSs
- The use by the Client of the UPSs for purposes other than those for which they were designed.
- The repair, service, inspection, tampering or alteration of the systems by personnel who are not employed or managed by the Contractor.
- The maintenance of repair of telecommunication lines, networking and apparatus connected to, but external to, the systems.

Fault Handling Procedures

- The Contractor shall only accept calls placed by the Client's appointed representatives in terms of this agreement.

- Whenever the Client, with the Contractor's reception, places a call, a fault number shall be allocated by the Contractor and given to the Client's representative.

- The Contractor shall dispatch all calls received from the Client to suitably qualified and

  experienced Engineers or Technicians employed by the Contractor, who shall perform their maintenance obligations and duties according to the service level criteria specified in this agreement.

- A service docket shall be completed and signed by the Contractor for those calls placed by the Client and attended to by the Contractor.

- Upon request by the Client, a copy of each service docket signed by both the Contractor and the Client shall be delivered or posted to the premises, marked attention for one of the Client's appointed representatives.

Service Provided

The following services are to be provided:

- Administration.
- Provision of assistance of reports
- Monthly reports on services rendered in terms of technical support and system administration.
- Technical support.

- Maintenance of UPSs.
- Ongoing preventative maintenance.
- Analysis of system performance.

Materials and Workmanship

(a) The work throughout shall be executed to the highest standards and to the entire satisfaction of the Representative/Agent who shall interpret the meaning of the Contract Document and shall have the authority to reject any work and materials, which, in his judgement, are not in full accordance therewith. All condemned material and workmanship shall be replaced or rectified as directed and approved by the Engineer.

(b) All work shall be executed in a first-class manner by qualified tradesman.

(c) The Contractor shall warrant that the materials and workmanship shall be of the highest grade, that the equipment shall be installed in a practical and first-class manner in accordance with the best practices and ready and complete for full operation. It is specifically intended that all material or labour which is usually provided as part of such equipment as is called for and which is necessary for its proper completion and operation shall be provided without additional cost whether or not shown or described in the Contract Document.

(d) The Contractor shall thoroughly acquaint himself with the work involved and shall verify on site all measurements necessary for proper installation work. The Contractor shall also be prepared to promptly furnish any information relating to his own work as may be necessary for the proper installation work and shall co-operate with and co-ordinate the work of others as may be applicable.

(e) All components and their respective adjustment, which do not form part of the equipment installation work, but influence the optimum and safe operation of the equipment shall be considered to form part of, and shall be included in the Contractor's scope of works.

(f) All control equipment and serviceable items shall be installed and positioned such that they will be accessible and maintainable.

(g) The Contractor shall make sure that all safety regulations and measures are applied and enforced during the installation and guarantee periods to ensure the safety of the public and the User Client.

(h) The Contractor is to include for all scaffolding required to complete the work required where required.

Brochures

Detailed brochures of all equipment offered shall be presented together with the tender documents.

Submittals

The following information must accompany the tender documents

(a) The information requested in the schedule of information.

(b) A paragraph by paragraph schedule of compliance with detailed description of any deviations from this specification.

(c) If alternative systems are offered, a clear description of the operating characteristics and special features of the equipment along with a motivation for offering the alternative.

(d) Descriptive and illustrated brochures and other information pertaining to the inverter and ventilation equipment and switchgear.

(e) The proposed layout as stated.

(f) Arrangement of batteries.

(g) A sample test report as stated.

(h) The circuit diagram requested.

(i) The information requested.

(j) Tenderers shall submit a list of successful installations completed in the Republic of South Africa.

QUALITY, STANDARDS AND REGULATIONS

All material and equipment supplied for this contract shall be new and the best of their respective kind. All new materials and equipment supplied, shall comply fully with the requirements laid down in the specification. The whole of the works shall be executed in accordance with best practice and to approval of the engineer. The equipment shall comply with the latest issues of the following standard specifications:

South African Bureau of Standards

SABS 150	Insulated wire.
SANS 1091	Colour standards for paint.
SANS 0142	Wiring code of practice.
SANS 1474	UPS units.

Regulations and Rights of Engineer

Apart from any other authority, which the engineer may have in terms of the contract, he shall have the right to set the standard and to accept or reject part of the specified equipment depending on the quality of material and workmanship offered.

The contractor shall be notified if the quality of such materials and/or workmanship is not acceptable. In such an event, the contractor shall replace the specific part or repair it to the satisfaction of the engineer, all at the cost of the contractor. Such an instruction shall not exempt the contractor from any of his obligations in terms of the contract.

The installation shall be erected and carried out in accordance with:

a) The Basic Conditions of Employment Act and the Machinery and Occupational Safety Act of 1983, as amended.

b) The local Municipality by-laws and Regulations as well as the regulations of the local Supply Authority.

c) The local Fire regulations.

d) The Regulations of the Department of Posts and Telecommunications.

e) The Standard Regulations of any Government Department or public service company where applicable.

In addition the contractor shall at his cost issue all notices in respect of the installation to the local authorities, and shall exempt the client from all losses, costs or expenditures which may arise as a result of the contractor's failure to comply with the requirements of the regulations enumerated above.

It shall be assumed that the contractor is conversant with the above-mentioned requirements. Should any requirements, by-law or regulation, which contradicts the requirements of this document, apply or become applicable during erection of the installation, the contractor shall immediately inform the engineer of such a contradiction. Under no circumstances shall the contractor carry out variations to the installation in terms of such contradictions without obtaining the written permission to do so from the engineer.

UNINTERRUPTED POWER SUPPLY (UPS)

Definitions

(a) **UPS** shall denote the complete UPS unit with associated controls, remote alarm panel and batteries and any accessories required by the system for its successful operation.

(b) **Power Converter Module** shall denote a rectifier, battery charger, inverter, electromechanical by-pass switch and manually operated by-pass switch.

(c) **Rectifier** shall denote that portion of the converter module containing the equipment and controls to convert the incoming AC power to regulated DC power required by the inverter.

(d) **Inverter** shall denote that part that converts the DC supplied by the rectifier to AC satisfying the load requirements.

(e) **Electro-mechanical** by-pass static switch shall denote a by-pass system provided break free switching from inverter to mains operation and vice versa.

(f) **Battery charger** shall denote that portion of the power converter module containing the equipment and controls to convert the incoming AC power to precisely regulated DC power required for battery charging.

(g) **Critical load** denotes the load as presented to the UPS by the computer or other load requiring constant supply and associated circuits and apparatus.

(h) **Mean-Time-Between-Failure (MTBF)** shall denote an overall MTBF of the UPS as a complete system.

(i) **A system failure** shall denote any interruption to, or degradation of the critical load bus voltage or frequency beyond the limits set forth herein.

(j) **Efficiency** shall denote the ratio of real output power (kW) to real input power (kW) with the UPS operating at a defined load power at the defined power factor, the battery fully charged and with nominal input voltage.

System Requirements (The Required Input and Output Voltages)

Input to the UPS

(a)	Input voltage	:	400/231V ± 10% or 231V ± 5%
(b)	Frequency	:	50Hz ± 4%
(c)	System	:	1 phase 2 wire or 3 phase 4 wire with operative earth conductor, supplied from utility network or standby generator set. Refer to detail specification.
(d)	Power factor		Not less than 0, 8 lagging.
(e)	Max starting current	:	10 times full load current for not more than ½a cycle with rectifier soft starting facility.

Output to Load

(a)	Rating	:	120kW
(b)	Output voltage	:	400/ 231V
(c)	Frequency	:	50 Hz ± 0, 5 Hz.
(d)	System	:	1 phase 2 wire or 3 phase 4 wire with operative earth conductor. Refer to detail specification.
(e)	Voltage regulator	:	± 10% maximum deviation of steady state voltage recovering to within 5% in less than 50 ms and to within 1% less in that 100 ms.
(f)	Frequency stability	:	Normally automatically synchronised to mains frequency if the latter is within 50 Hz ± 2% (adjustable window) Runs free at 50 Hz ± 0,5 Hz at any load when mains is out of limits.
(g)	Harmonic content	:	Less than 4% total distortion.

(h) Amplitude modulation : Less than 2%

Overall Performance

Efficiency (overall) : 80 - 85%

Ambient Operating Conditions

Refer to Section 1, General – Clause 5

System Description

The system shall consist of a static UPS complete with the following components:

(a) Rectifier/charger.

(b) Inverter.

(c) Battery.

(d) Automatic electronic no-break bypass circuit and switch.

(e) Separate manual bypass switch.

(f) Protective devices and measuring equipment.

(g) The required controls and necessary equipment.

The system shall be capable of providing an uninterrupted supply to the load with the output characteristics as specified for a minimum period of **two hours** during a total mains failure (i.e. normal mains and standby generator supply failure). The batteries shall be rated at an AC load power factor of 0,8 lagging.

The complete system, including all controls shall be designed in such a way that the failure of any one vital central component will **NOT** cause a complete system failure. If necessary such a failure must be avoided by connecting the load directly to the mains by means of the bypass switch.

The UPS shall operate satisfactorily synchronous with the mains supply even under severe conditions of up to 100% unbalanced load.

The UPS shall be amply rated to carry the stated full load current. The UPS shall furthermore be capable of withstanding the following overloads.

Static Overloads: 100% of full load continuously.

125% of full load for 5 minutes.

150% of full load for 2 minutes.

165% of full load for 1 second with inductive decay after initial equipment switch on surge current.

Dynamic Overload: 300% for less than 5 msec.

1000% for less than 1 msec.

All component parts, cables and other connections shall be amply rated to withstand the overloads stated and maintain the input voltage **at the load** within the tolerances stated.

The equipment shall be designed for the maximum operating efficiency. The efficiency shall be determined when the system is delivering full load at 0,8 power factor with the batteries fully charged. The load required by the auxiliary equipment (controls, alarms, etc). electronic switches and cabinet fan shall be included in he determination of overall efficiency. A typical test report clearly showing how the efficiencies are calculated, shall be submitted with the tender.

It shall be the responsibility of the successful tenderer to ensure satisfactory operation of the complete system for the load to be supplied. It is, therefore, essential that the tenderer acquaint himself fully with typical load conditions before the tender closing date.

All cabinets containing thyristors shall be adequately screened and earthed to prevent direct radio frequency radiation.

Tenderers shall submit with their tenders a schematic diagram showing :

Input circuit breakers.

System busbars.

Rectifiers.

Batteries.

Inverters.

Electronic switches.

Bypass circuit.

Detour circuit.

Fuse protection.

Output circuit breakers.

Oscillator.

Power supply circuits to oscillator, alarms, controls, etc.

Battery isolator.

Inverter Oscillator

The inverter shall contain an oscillator capable of operating and maintaining the inverter output frequency as specified. The inverter oscillator shall be capable of frequency synchronisation and phase locking to the mains (or standby generator) power source frequency. When operating as a slave to the mains or standby power and a failure occurs in the slaving signal, the invertor oscillator shall automatically revert to a free running state and maintain the specified limits. All

changes in output frequency to free run or synchronise shall be gradual to suit the load requirements.

Rectifier

The UPS shall have its own rectifier and rectifier transformer which shall operate satisfactorily from the mains or standby supply.

The rectifier shall be of the solid state type providing full wave rectification of the input voltage suitably regulated to suit the input requirements of the inverter. Where necessary, a high grade DC filter shall be utilised to limit the output ripple to within acceptable levels for the inverter input. Current limiting features shall be provided to protect the rectifier. The current limiting settings shall be variable for final adjustment on site.

Voltage free contacts shall be provided for the malfunction alarms of the rectifier.

An input monitoring circuit shall be provided for the rectifier. This circuit shall switch off the rectifier when the r.m.s. value or frequency of the input voltage falls below present values.

The necessary protection circuitry shall be provided to switch off the rectifier if any one of the rectifier phases should fail, thus presenting an unbalanced load to the incoming supply.

The output of the rectifier shall be connected in parallel to the battery and inverter.

The rectifier shall have over temperature protection. Temperature sensing probes shall be placed on the thyristor housing, thyristor mounting, or on the heat sink close to the thyristor. The sensing of the off coming air temperature alone is not acceptable.

Tenderers shall take into account the possible effects of harmonics that may be present on the input supply due to non-sinusoidal waveforms at the rectifier input, phase commutation, the effect of reactance during phase commutation etc. The input voltage monitoring circuits of the rectifiers shall be adequately filtered and buffered to ensure reliable load control and to prevent continuous on-off switching of the rectifiers.

Inverter

The inverter shall be adequately protected against any excessive overload or short circuits that occur in the load. Reactive current limiting or other methods shall be employed to render the thyristors short circuit proof. The successful tenderer shall replace any thyristors or any inverter components at his own expense if these should be damaged.

The necessary feedback and control circuits shall be incorporated to ensure satisfactory operation separately or in synchronisation with the mains supply under all conditions of dynamic load variations, stated overloads, severe unbalanced conditions and high operating temperatures. The thyristor bridge shall contain the necessary auxiliary circuitry to ensure satisfactory operation.

The output of the inverter shall be connected in parallel with the thyristor switch output.

Each inverter shall have over temperature protection similar to the over temperature protection for the rectifier.

A discharge device shall be provided across the D.C. input to the inverter, which will discharge any capacitors in the inverter module when it is switched off.

Battery charger

The battery charger shall be a solid state, constant voltage type providing full wave rectification of the input voltage with the output regulated to an accuracy as specified. A high grade D.C. filter shall be utilised to limit the output ripple to the stated tolerance. Current limiting features shall be provided. The value of the current limit setting, shall be in accordance with the maximum allowable charging current that the batteries can withstand.

The maintained voltage on float charge shall be such as to give maximum life to the batteries whilst maintaining the maximum charge conservation and minimising gas formation and water loss. The optimum float charge voltage shall be specified by the battery manufacturer but is expected to be approximately 2,23 volts per cell. The voltage shall be kept within ± 0,5% of the nominal value for all loads from no load to the full rated battery charger current when supplying the full output with batteries discharged.

Computer rooms/office UPS installation

The rectifier shall be equipped with **2 independent** over voltage shutdown contacts for maximum charger security.

The battery charger shall be designed to charge the batteries to 90% of its fully charged capacity within 14 hours and to 100% capacity within 20 hours.

The battery charger shall be capable of boost charging the batteries to 2,6 volt per cell. The boost facility shall be manually operated.

The battery charger shall be provided with a current limiting circuit.

The current limit setting shall be variable for easy adjustment on site.

The necessary voltage free contacts for the alarms and battery charger failures shall be allowed for in the tender price.

The battery charger shall have over temperature protection similar to the protection specified for the rectifier.

Battery

The battery capacity shall be sufficient to provide full load for the specified time. The capacity shall be rated at a maximum specific gravity of 1,245 at 25 C and correctly filled.

Tenderers shall state the discharge capacity of the battery after 10 hours of charge and the battery voltage at its terminals under various conditions. The inverter shall switch off on low battery voltage.

The battery cells shall be of the maintenance free type. The battery shall be a sealed maintenance free type battery, lithium ion.

The batteries shall give satisfactory service for a minimum period of **5 years**. Tenderers shall state the maximum expected lifetime of the batteries and motivate their statement, and provide a statement by the battery manufacturer supporting this and stating that the charger offered is suitable for the battery.

The cells must be mounted in a matching steel cabinet or in the same cabinet as the control equipment. The vented type cells should be mounted on a wooden stand, consecutively, numbered with positive and negative terminals clearly marked in a ventilated battery room.

The batteries shall be complete with cell inter-connectors and row inter-connectors. The output terminals shall be robust and adequately dimensioned for the output cable terminations.

The inter-connectors between cells and shall be made in a manner giving the lowest volt drop and maximum resistance to corrosion.

All connections to cells must consist of flexible cable to avoid mechanical stress at the cell terminals.

The tenderer shall describe the method of removal and replacement of a faulty cell.

The battery shall be complete with a battery fuse isolator capable of breaking the full load current drawn by the inverter. These battery fuse isolators shall be installed in the inverter unit room or cabinet.

Terminal posts should be effective for the expected lifetime of the battery and should be effective even if the cell is overfilled.

The battery may be resistance grounded through 5000 ohm to 10000 ohm for the purpose of ground fault.

Tenderers shall submit full details with dimensioned drawings of the batteries offered.

Tenderers shall submit the calculations and motivations complete with curves supporting the selection of a specific battery cell.

All cabling for the battery shall be installed on PVC cable trays and fitted to the satisfaction of the engineer.

Automatic by-pass switch

An integral automatic bypass switch shall be provided to transfer the critical load without break to the mains should the UPS unit fail. The latter unit shall simultaneously be disconnected from the critical load bus. This transfer shall, however, be inhibited if the mains is out of synchronism with the UPS output. Retransfer to the UPS output shall be on a manual or automatic command. This switch must have a cover fitted screwed to the panel so as to make the operating of this switch impossible without having first removed the cover. This switch cover must also have the following words etched in white with a red background mounted on or adjacent the cover:

CAUTION: BYPASS SWITCH ONLY : ONLY TO BE OPERATED BY QUALIFIED PERSONNEL

The static switch should prevent "hunting" and after trying unsuccessfully to switch a maximum of **three** times the static switch should be inhibited from further switching.

CONSTRUCTION OF CUBICLES AND SWITCHBOARDS

All the converter equipment shall be housed in totally enclosed, free standing, floor mounted cubicles, designed top provide adequate ventilation for the equipment.

All cubicles shall be rigid with suitably braced doors providing front access.

All cubicles shall be vermin proof.

All equipment shall be mounted on the metal framework suitably arranged to provide safe operation and ease of access. Fuses and switchgear in particular should be safely accessible even under load conditions.

All power bridges, filters and other major components both in the inverter and rectifier, shall be completely withdrawable to facilitate rapid repair and/or replacement. The method of withdrawal shall be such that a complete module can be extracted in the operating condition so that checks and measurements may be made while in operation and access to all components facilitated.

All electronic printed circuit cards shall be of a good quality and shall be easy and simple to interchange.

All auxiliary power supplies shall be duplicated and shall be connected so as to operate in parallel redundancy. At least two primary sources of power shall be provided for each of the power supplies in the system.

Flexible wires shall not be soldered directly onto terminals but shall have a crimped tab, which is soldered onto a terminal or post. The wire wrapping technique shall be employed for electronic circuits where possible.

The front panel alarms shall be clearly and adequately marked in both official languages. A single line mimic layout of the switchgear shall be provided on the front of the cubicles providing a graphic display of the circuitry of the equipment involved.

All input and output power cables shall be terminated using approved cable glands, onto a cable gland support bracket. The cable conductors shall terminate at the connecting busbars or shall be connected directly to the appropriate switchgear. All power cables shall be properly numbered with wrap around cable markers with punched figures to identify cables at each termination point.

INSTRUMENTATION AND CONTROLS

All the required instrumentation as indicated on the drawings shall be provided.

Supply and install all the necessary controls for the operation of the system. Facilities shall be provided for controlling the rectifier, switching the inverter on, switching the inverter output to the synchronous motor/alternator and controlling the bypass thyristor switch circuit.

All control switching of the rectifier and inverter as well as the bypass operation shall be pushbutton initiated.

Standard electronic equipment from overseas manufactures shall **not be accepted** if not duly protected with transsorbs and metal oxide varistors in power supplies and external communication lines. Standard electronic equipment not internally protected with transsorbs or MOV's may be protected externally by means of transsorbs and MOV's mounted on klippon type terminals. All external communication and remote power supply lines shall be protected by means of transsorbs and MOV's of sufficient rating mounted on klippon type terminals.

ALARMS

All alarms shall be of the tell tale type with memory features e.g. a flashing light indicates a fault coupled with an audible alarm. The pressing of the appropriate button shall cancel the audible alarm and allow the alarm lamp to burn continuously until the fault is removed.

The following minimum alarm conditions shall be monitored on the equipment:

(1) Normal

(2) Mains failure

(3) Inverter failure

(4) Shutdown imminent

(5) Load on mains

(6) Overload

(7) Charger fails

Where required a remote panel must be supplied and installed. The alarms indicated must duplicate all the alarms indicated on the UPS control panel. In addition a buzzer must be provided. Any alarm occurring must sound the buzzer to draw attention. An alarm accepts pushbutton to silence the buzzer must be provided.

Provision shall be made on all the alarms mentioned above to be remotely monitored. Normally open contacts shall be supplied at the converter for each alarm for this purpose. The contacts shall close under an alarm condition.

VENTILATION

All equipment racks shall be positioned in logical fashion on the floor in a configuration, which will ensure proper ventilation

Each cubicle containing heat-generating equipment (thyristors, transformers electronic circuitry, filters, etc) shall, where necessary, have extraction ventilation fans mounted on the top of the cubicle to assist air circulation. These fans shall be fed from the output distribution panel of the uninterrupted power supply.

QUALITY ASSURANCE

The manufacturer shall be responsible for the performance as specified herein and to prove such performances to the satisfaction of the engineer. Except as otherwise specified, the supplier must utilise facilities acceptable to the engineer.

DRAWINGS

As soon as possible after the awarding of the contract, the successful tenderer shall at his expense submit to the engineer for approval, three prints of:

(1) All general arrangement drawings.

(2) Detailed dimensioned drawings of all plant and equipment.

(3) Complete wiring diagrams and block schematic diagrams.

At the same time a list of all equipment designations, labels, etc. in both official languages shall be submitted for approval.

The approval of drawings shall not relieve the successful tenderer of his liability to carry out work in accordance with the terms of the contract.

On completion of the contract, a complete set of transparencies of all drawings of a quality acceptable to the engineer shall be handed to the engineer at the expense of the successful tenderer. These final drawings shall include:

(1) A proper and accurate as-made wiring diagram of the complete installation showing circuit numbers, terminal strip numbers and conductor colours.

(2) A schematic diagram clearly showing functions and component values. A material list showing make, model and characteristics of all components of the control equipment and switchgear is to be included.

(3) Fully dimensioned as-made physical layout drawing of the equipment, batteries and ventilation equipment.

(4) A detailed **schedule** of all wiring.

The contract shall be deemed incomplete until all drawings have been received by the client.

INSTRUCTION OF OPERATOR AND MANUALS

After completion of the installation, and when the plant is in running order, the successful tenderer will be required to instruct an attendant in the operation of the plant, until he is fully conversant with the equipment and handling thereof.

Three (3) copies of maintenance, fault-localising and operating manuals together with the drawings required shall be handed over to the engineer.

TESTS

The complete testing including the provision of test facilities, instruments, dummy loads and switchgear at the manufacturer's premises in the Republic of South Africa shall form part of this

contract. If the factory tests cannot be performed in the RSA, the client may, at his discretion and own cost, decide to attend tests at the supplier's overseas factory. Tenderers shall not allow for this.

For the test in the manufacture's premises the client shall be notified four weeks in advance in order that a representative can be sent to witness these tests.

Battery tests

(1) The output voltage of the battery unit (i.e. all the cells making up one battery) shall be tested with the incoming supply removed.

(2) The full rated load for the battery shall then be connected to it. The voltage shall be measured at 5 minute intervals for the duration discharge period.

(3) The batteries shall be left to recharge. The voltage shall be checked after 14 hours with the load and incoming supply removed as well as with the load connected but incoming supply removed.

(4) When fully recharged, the voltage and specific gravity of every cell shall be measured with the incoming supply removed.

(5) The circulating A.C. current through and the A.C. voltage across the batteries shall be measured when the rectifiers are on with the battery discharged and fully charged.

Oscillator tests

(1) Frequency within tolerances at all loads.

(2) Parallel redundancy.

(3) Auto automatic synchronisation for connection of the synchronous motor/alternator to mains via the thyristor switch.

An electronic frequency counter shall be used to measure the frequency.

Rectifier tests

(1) Output voltage of rectifiers at no load and full load with batteries charged and not charged.

(2) Current limit, both for mains failure and return to mains.

(3) Switch off value mains input monitor.

(4) Sequential switch on for return to mains.

(5) Soft start circuits.

General

Ammeters will not be acceptable to prove the above items. A wave analyser and a recording oscilloscope will be required. Photographs shall be taken of the oscillograms by the contractor in the presence of the engineer.

The overall efficiency of the complete uninterrupted power supply shall be proved to be within the specified limit at full load and at no load.

The overcurrent protection mechanisms of the A.C.B. shall be proved by current injection (either primary or secondary)

The bypass and detour circuits shall be proved.

All alarms, indications and control functions shall be proved.

The test instruments provided shall in all cases be of high quality and suitable to be able to adequately assess the quantities being measured and the equipment being tested. All instruments shall be calibrated by a testing laboratory approved by the National Calibration Service of the CSIR. The test equipment remains the property of the successful tenderer.

At the completion of the tests, a full test report shall be submitted by the contractor to the engineer in triplicate.

Continuously adjustable dummy loads of a rating suitable to comprehensively test the UPS shall be provided by the contractor as well as any temporary cables required for the connection of the dummy load to the UPS on site.

CABINET

The contractor shall supply and install a metal cabinet with lockable doors of sufficient size to house all operating and maintenance instructions, drawings, spares, tools, etc.

SCHEMATIC DIAGRAM

A schematic diagram of the complete system shall be mounted in a suitable place and shall be resin encapsulated.

AUXILIARY EQUIPMENT

Tenderers shall make all allowances for plant required (i.e. hoists, cranes, trolleys, etc.) ensuring positioning of the equipment in the UPS room.

UPS POWER PLUG OUTLET

All UPS power plug outlets must be of the red non-standard 3-pin type with the earth pin not earthed to the plug baseplate to facilitate the installation of a single earth connection earthing system. Each socket outlet must be provided with a red plug top.

Each socket outlet must be labelled with an engraved label indicating the power circuit number to which it is connected.

DISTRIBUTION WIRING

All sub-distribution wiring circuits must be wired as follows:

Mains power plug circuits

4 mm^2 PVC/copper in red and black conductors and a 2,5mm^2 bare copper earth.

UPS power plug circuit

4 mm^2 PVC/copper in blue and black and a green PVC insulated 2,5mm^2 earth wire.

The black neutral conductors must be clearly labelled at each end as follows: "UPS" or "OKT"

UPS Earthing

The main earth bar must be connected to the insulated earth bar of the UPS via a removable copper link bar.

All UPS boards must have insulated earth bars, separately earthed to a clean 1,2m earth spike be means of 70mm^2 insulated earth to obtain at least one ohm at the UPS board.

4.11.3 Low Voltage (LV) Reticulation and Distribution Boards

The existing LV reticulation on site shall be retained. There will however be minor modifications and additions to the existing LV reticulation. The appointed contractor shall prior to commencing with work in a certain area ensure that power is switched off and that it is safe to work in that area. LV reticulation scope of work shall cover but not limited to, the following;

- A new circuit breaker shall be installed in the distribution board supplied from a newly installed standby generator. This DB is situated in the existing LV main board room. This new circuit breaker shall feed the new UPS.
- A new LV cable shall be installed from the distribution board supplied from a newly installed standby generator supply power to the new UPS situated at the new UPS room. There shall also be a new LV cable installed from the distribution board supplied from a newly installed standby generator to supply the new Main Floor DB situated in the Workshop room which is situated directly below the Data Centre.
- A new Main Floor DB to be installed inside the Workshop room which is situated directly below the Data Centre
- Installation of the new Data Centre DB
- Installation of the LV reticulation cables from the new Main Floor DB to the new Data Centre DB and to various new UPS sub-distribution boards (SDB's) supplying emergency lighting
- Installation of SDBs at various locations
- Make penetration through floor slab from the Workshop room to the Data Centre to create access for new cable supply into the Data Centre
- SDBs supplying UPS power on ground floor shall be installed in the plant rooms
- SDBs on first and second floors shall be installed in the existing DB rooms in the service ducts.

The contractor is to take note that chasing and/ or making penetrations through walls and floor slabs, where permitted shall be limited. The contractor shall request permission to chase or make penetration through both walls and floor slabs before chasing or making penetration.

All the new DBs and SDBs shall be as per DBs single line diagram.

All low voltage reticulation cables shall be manufactured to SANS 1507 – 1990 and shall have stranded copper conductors with PVC insulation, PVC bedding, steel wire armouring, earth continuity conductor and PVC sheathing.

All electrical distribution boards shall be manufactured by a reputable company, with relevant experience in the manufacturing of electrical distribution boards, control panels, etc. The colour coding of the distribution boards shall be as follows;

- Frame (Outer and Inner) – White: RAL 9010 (Pure white)
- Normal section (DB face plate) – White: RAL 9010 (Pure white)
- Essential Section or Standby Generator (DB face plate) – Red: RAL 3020 (Traffic Red)
- Critical load or UPS (DB face plate) – Blue: RAL 5005 (Signal blue)

4.11.4 Normal Lighting and Emergency Lighting Installation

New normal lighting shall be installed in the new UPS room only. The scope of work covered by this contract is to ensure that the legal requirements are met in terms of power supply to the emergency lighting. There is existing emergency lighting in the building. There shall be no emergency lighting designs or drawings done as the emergency lighting already exists or installed. However, where a shortfall in emergency lighting is identified, this shall be brought to the attention of the engineer. Corrective measures shall be implemented to ensure that emergency lighting is fully compliant with regulations.

Before working on the existing installation, electrical supply shall be switched off, disconnected and installation made safe. Lighting installation shall include but not limited to, the following;

- Emergency lighting shall be supplied from UPS power
- Data centre lighting shall be supplied from the UPS power
- UPS room lighting shall be supplied from UPS power
- Reconfigure existing emergency lighting circuits
- Reconfiguration of the emergency lighting circuits by redirecting the lighting circuits from its current point of supply to the new UPS SDB's
- Emergency lighting circuits shall be supplied as shown on the SDBs single line diagram
- Installation of new containment or wire ways shall where required be carried out. This will generally be done where circuits are redirected to new points of supply.
- Installation of conductors/ lighting circuits shall where required be carried out. This will generally be done where circuits are redirected to new points of supply.
- Emergency lighting that is currently being supplied from the existing generator set will now be redirected to be supplied from the new SDB UPS section.

- New SDBs locations are discussed under Section 3.11.2
- Existing emergency lighting circuits shall be redirected from the existing DB to the new UPS SDB sharing the same service duct.
- Installation of new light fittings for the new UPS room.

4.11.5 Small Power Installation

The scope of work covered under this contract is providing UPS power to the selected loads. The selected loads are shown on the DBs single line diagram. New isolators and new switched socket outlets shall be installed in the new UPS room.

No small power layout designs shall be done as part of this contract. There shall however be small power circuiting reconfiguration to ensure that the selected switched socket outlets in certain areas are supplied from the standby generator.

Before working on the small power installation, electrical supply shall be switched off, disconnected and installation made safe. Small power installation shall include but not limited to, the following;

- The UPS load shall be supplied from the newly installed standby generator
- Data centre heating, ventilation and air-conditioning (HVAC) shall be supplied from the standby generator
- Auditorium and auditorium kitchen small power shall be supplied from the standby generator
- All meeting rooms throughout the building shall have their small power installation being supplied from the standby generator.
- Small power installation in UPS rooms shall be supplied from the standby generator
- Installation of new containment or wireways shall where required be carried out. This will generally be done where circuits are redirected to new points of supply.
- Existing small power circuits for the selected load shall be redirected from the existing DB to the new SDB Essential compartment sharing the same service duct.

4.11.6 Cable Ways and Containment or Wireways

Existing containment shall where possible be reused. New containment shall where required be installed. The new containment shall be installed in ceiling space, walls as well as in the service duct. Below is the new containment and the use thereof;

- Heavy duty cable ladder: Shall be used in ceiling spaces, service duct or risers to accommodate the electrical cables.
- Heavy duty cable tray: Shall be used to accommodate smaller electrical cables to various sub-distribution boards (SDBs) located throughout the building.

4.11.7 Earthing and Bonding

Low voltage installation including the UPS shall be earthed as required by applicable standards. The UPS shall be earthed by specialist installers. Upon completion the specialist installers shall submit the earthing diagrams for the UPS.
Low voltage installation Type 1 (Class I) surge arrestors will be provided in the main low-voltage panel(s) of the installation. Type 2 (Class II) surge arresters will be provided in all main distribution boards. The surge arresters will have a minimum rating equal to the maximum prospective short-circuit current at the point of installation. All surge arrestors will comply with the requirements in IEC 61643 & 60364.

4.11.8 Temporary Power Supply

Where required, the contractor shall provide temporary power supply on site.

4.12 SUPPLY AND CONNECTION

The electrical supply for this project is at 400/230 Volt, 50Hz.

4.13 CONDUIT AND WIRING

Conduit and conduit accessories shall be galvanized plain end conduit in accordance with SABS 162, 763 and 1007 respectively.

PVC square ducting will be acceptable where exposed – prior approval to be obtained.

All conduits, regardless of the system employed, shall be installed strictly as described in the applicable paragraphs of clauses 4 to 8 of Part 2 of the specification. Wiring of the installation shall be carried out as directed in clause 9 part 2 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.

4.13.1 Power Trunking

Where necessary, 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 and indicated on the drawings.
The power trunking must comply with SABS 1197. The Contractor must ensure that the power trunking is installed to the satisfaction of the client's representative before commencing with the wiring of the power trunking. The installation of the trunking shall be done as per the manufacturer's requirements.

The power trunking sizes shall be as indicated on the drawings and bill of material.

4.14 POWER POINTS

Allow for the installation of power points and equipment as indicated on the layout drawings and bill of quantities.

4.15 CABLES

Where necessary, the Contractor shall supply and completely install all distribution cables as indicated on the drawings, and listed in the schedule of quantities.

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.

On completion of installation of 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.

4.16 DISTRIBUTION BOARDS

In addition to clause 14 and clause 15 of Part 2 of this specification the following shall also be applicable to switchboards required for this service.

The existing distribution boards shall be retained. The electrical contractor shall ensure that all the existing DBs comply with regulations, and shall issue a certificate of compliance, CoC for each distribution board.

Where necessary, the face plates of the existing DBs shall be replaced with new. If the DB is supplied from the standby generator the face plate shall be red, and the face plate of the DB supplied from the UPS shall be blue.

The Contractor shall supply and install new distribution board as indicated on the drawings and distribution board single line diagram. The distribution board shall comply with the project technical specification in Part 4 of this specification, and be approved by the client’s representative. The switchgear installed on the distribution boards shall be supplied from the reputable manufacturers or suppliers like CBI, ABB, Schneider Electric, etc.

4.17 SCHEDULE OF LIGHT FITTINGS

The light fittings and accessories are to be according to the project technical specifications in Part 4 and shall be approved by the client’s representative.

Type A: 53W surface mounted weatherproof linear LED light fitting. The body of the light fitting shall be reinforced polyester, light grey with stainless steel fixings. The diffuser shall be highly effective, opal diffuser with low glare qualities. The lamp shall be high powered, low energy consumption LED with the colour temperature of 4000K. The light fitting shall have a 5 year warranty, full replacement.

Type J: Single sided surface mounted Emergency Exit Signage complete with 2W LED. The sign shall have a polycarbonate body and shall have a perspex diffuser with green 'EXIT' sign. The Exit sign shall have maintained 3 hour battery operation. The Exit sign shall be Cosine/ EXT/ 2W/ RM or similar and equivalent, approved.

Type K: Double sided Emergency Sign complete with 2W LED. The sign shall have a polycarbonate body and shall have a perspex diffuser with green 'running man' pictogram. The signage shall have maintained 3 hour battery operation. The Exit sign shall be Cosine/ EXT/ 2W/ RM or similar and equivalent, approved.

4.18 SCHEDULE OF POWER POINTS

The schedule of power points shall be as discussed in the document under Section 3.11.5.

4.19 SCHEDULE OF CABLES, CONDUIT AND WIRING

The schedule of cables, conduit and wiring shall be as shown on drawings, bill of quantities and as specified elsewhere in this specification.

4.20 SCHEDULE OF DISTRIBUTION BOARDS

The indicated fault current rating (kA) is the minimum value that the switchgear must comply with for connecting to the busbars of the respective distribution boards.

The DBs shall be labelled as per SANS 10142-1 requirements.

The distribution boards shall be as shown on the attached single line drawings.

4.21 SUMMARY OF SWITCHGEAR AND CIRCUITS

Switchgear and circuits shall be as shown on distribution boards single line diagrams. The switchgear installed on the distribution boards shall be supplied from the reputable manufacturers or suppliers like CBI, ABB, Schneider Electric, etc.

4.22 BUILDING COMPLIANCE

The electrical contractor shall ensure that the entire electrical installation, including existing installation complies with regulations. This exercise shall involve visual inspections and physical testing of the electrical installation. A provision sum has been made in the bill of material for restoring the entire electrical installation to a compliant state. This section of the specification will be discussed further between the appointed electrical contractor, the client representative and the engineer.

Ensuring that the existing electrical installation complies with regulations, shall involve rewiring of the electrical installation where required. In the distribution boards, replacing old or obsolete switchgear with new will take place. Where old switchgear is replaced with new, the new switchgear shall be identical or equivalent to the old one in terms of the make or

brand, voltage rating, current rating, number of phases of the switchgear, and fault level rating.

The electrical contractor shall work closely with the engineer to ensure that only work necessary to make the installation compliant is executed. Where the contractor identifies the non-conformance in the electrical installation, the contractor shall bring that to the attention of the engineer and await the instruction from the engineer to proceed with the remedial work.

The tenderer shall familiarize themselves with site prior to submitting this tender. Should the contractor be unsure of what needs to be done, a request for clarity shall be issued by the tenderer. The engineer and/ or the client representative shall not entertain claims from the contractor that is due to the contractor's negligence.

4.23 BUILDER'S WORK

Builder's work shall include making penetrations through the floor slabs and walls or beams and making good where there might have been chasing work. However, the contractor is to take note that chasing of walls, where permitted shall be limited. The contractor shall request permission to chase before chasing. The builder's work may also include installation of sleeves for electrical cables as may be necessary.

THE ELECTRICAL CONTRACTOR MUST TAKE NOTE THAT SINCE THE ELECTRICAL CONTRACTOR IS THE MAIN CONTRACTOR, THE APPOINTED ELECTRICAL CONTRACTOR WILL DO BUILDER'S WORK AS AND WHEN REQUIRED. THIS WILL INCLUDE DOING BUILDER'S WORK FOR THE AIR-CONDITIONING SPECIALIST SUBCONTRACTOR. BUILDER'S WORK SHALL BE DONE BY THE QUALIFIED PERSONNEL. NO POOR QUALITY WORK WILL BE ACCEPTED.

4.24 HEATING, VENTILATION AND AIR-CONDITIONING (HVAC)

Air-conditioning unit will be installed in the UPS room. Below is the specification outlining the requirements of the air-conditioning unit and installation thereof.

GENERAL DESCRIPTION

4.24.1 Air-conditioning Installation

UPS ROOM:

Supply, installation, commissioning and 12 months guarantee with free service and maintenance during the guarantee period of the Under-ceiling cassette systems, to the renovation of IMT Building.

The work entails new energy efficient AC systems to the UPS room.

Air-conditioning contractor is responsible to prepare builders work drawings for this and any other openings he requires.

The UPS room will be air-conditioned by inverter split type, Underceiling cassette with wall mounted controller.

Fresh air is supplied to the indoor unit in accordance with the amount specified by the National Building Regulations (NBR) wall mounted fan is to be used and should be priced complete with filters in sliding frame

All refrigerant piping systems are to be properly installed and be of hard drawn copper unless otherwise suggested by the manufacturers of the units. Every refrigerant circuit is to be properly leak tested, vacuumed, and charged with environmentally safe refrigerant, such as R410 or R407C.

R22 gas is prohibited.

A certificate for the safe handling of refrigerants will be required from the A/C contractor.

All condensate drain piping is to be Upvc and taken to nearest drain points as indicated on drawings.

Some units require condensate pumps (where indicated or whenever drainpipes are longer than 10m) and longer pipes.

All electrical power requirements for a/c units are to be supplied power and an isolator by the electrical sub-contractor. Isolators will be installed adjacent to each condenser unit on the roof or mounted on the wall.

Wiring from the isolator to the condenser unit, and from the condenser unit to indoor unit is the responsibility of the A/C contractor.

A COC certificate will be required from the A/C contractor in terms of all the electrical works he carries out related to the A/C installation.

The Under-ceiling units should come with stainless steel drip tray complete with condensate piping.

4.24.2 Fresh Air Ventilation Systems

Fresh air is supplied from outside and through wall mounted fan louvres into UPS room

The wall mounted fresh air fan should be directly connect to the indoor unit with filter in sliding frame

Power and an isolator will be provided by others.

NOTE: A fan to be of the low noise type.

4.24.3 Equipment Schedule

DX Split Type Air Conditioning Units

Unit Ref	Qty	Type	Capacity (kW)			Duty		Power			Room Noise Level (NC)	Notes
			Sensible	Total	Heating	Airflow (ℓ/s)	External Static Pressure (Pa)	Supply (V/ø/Hz)	Absorbed (kW)			
									Cooling	Heating		
UPS												
CCU-01, 02	**1**	**Under Ceiling Cassette Indoor Unit**	**3.7**	**4.7**	**2.3**	**300**	**90**	**230 /1/ 50**	**0.5**	**0.5**	**40**	**A single-phase isolator shall be supplied at the unit, by others. Minimum fresh air requirement 28ℓ/s**

4.24.4 General Items

The Contractor is responsible for:

- Producing shop manufacturing and builder's requirement drawings prior to manufacturing any equipment. Drawings are to be approved by the consultant.
- All equipment specifications must be submitted to the Engineer for approval prior to ordering any equipment.
- Ensuring that he has taken out adequate insurance to cover transport, rigging, lifting of equipment and theft or damage to equipment on site.
- Attending regular site meetings as required by the Client, Main Contractor or the Consulting Engineers at a time and date to be specified.
- Providing free samples of grilles/louvres for approval by the Architect, Client and Consulting Engineers.
- Providing a 12-month free service and maintenance during the 12 months guarantee period.
- Handing over the installation to the client once the Consulting Engineers have accepted the installation.
- Training the Client's representative in the correct operation of the system installed.
- Investigate the service runs prior to making any ducting or installations in order to avoid clashes with any other service.
- Take precaution for floors, carpets and walls by using plastic sheets or boards during ceiling work that might affect office areas or public areas.
- Provide a quality assurance and safety Procedures Manual.

- Adhering to the Armscor's regulations as regards, security, loading, delivery, etc.
- The Project Engineer of the mechanical contractor to confirm in writing that each ventilation and air-conditioning system has been inspected and has been installed to the specifications
- All flanged joints of ducts are sealed with an approved sealer suitable for the application.
- Refrigerant to be used shall be ozone friendly such as R410A, R407C, R134A and all technical staff shall be trained in the safe handling of refrigerants.

4.24.5 Design Conditions

a. The A/C units' systems have been designed to the following parameters:

Cape town ambient:

SUMMER: 32 deg C db / 22 deg C
WINTER: 0 deg C

UPS
Indoor conditions:

SUMMER: 18°C ± 1.5°C: relative humidity: 50% ±5% (Humidity is not controlled)
WINTER: 20°C ± 1.5°C

b. Altitude

The site is approximately 9m above sea level.

c. Noise Levels

The room noise level generated by the system shall not exceed 40 dbA in the shops or other areas.

4.24.6 The Site

The Contractor is responsible The site is located at Armscor IMT Building is situated at Martello Road in Simon's Town in the Western Cape.

4.24.7 Painting and Equipment Identification

The contractor is responsible for painting

- All support brackets and fixings prior to erection.
- All metal work which is not otherwise protected against corrosion.
- Matt black finishes to ducting visible through grilles
- All items of equipment shall be labelled, and such identification shall be compatible with the corresponding label on any switchboards controllers or equipment.

4.24.8 Painting and Equipment Identification

a. The A/C Contractor is responsible for the following:

- Producing wiring diagrams via the information in this tender document and from drawings issued with this document.
- Submitting the wiring diagrams for approval prior to manufacturing any DBs.
- All field wiring and accessories associated with his equipment.
- To wire to and from isolators to his equipment and to provide the regulatory safety starters and overload relays for fans.
- All remote isolators, switchgear with overload protection and motor protection to remote equipment, he supplies power to from his own distribution boards (DB) and when supplied power and an isolator by others.
- To install the equipment to normal good practice and to the local safety regulations.
- Use conduits or cable trays to support all wiring.
- Provide all requirements for the installations he is to undertake in accordance with the Standard Specification for Electrical Installations and Equipment pertaining to Mechanical Services.
- All control wiring to be installed in uPVC conduiting, and generally be supported on ducting, trusses or the concrete slab.

b. By site Electrical Contractor

Supply of the required single phase 220 V or 3-phase; 400V; 50Hz cables to the relevant HVAC controller boards.

4.24.9 Alternative Equipment

The main tender offer must be based on the equipment listed in the equipment schedules as described herein.

Unless specifically stated at the end of this clause, the Tenderer may offer alternative equipment. Any alternative equipment that differs to that listed must be detailed separately and be submitted with the tender. The Contractor shall furnish all relevant technical and financial data, including local content, for tender adjudication purposes.

Equipment and material specifications that may differ from those indicated:

Grilles, Fans etc shall be submitted for approval.

4.24.10 Provision of Surety for the Client/ Penalties

Penalties will be applied as per the contract conditions.

4.24.11 Retention

Refer to contract conditions.

4.24.12 Twelve Months Free Service

The Contractor is to guarantee the installation for a period of 12 months and provide free service and maintenance for this period. Monthly services are required.

The guarantee start date takes effect on the day the installation is handed over to the Client.

The Client Representative must sign monthly service report sheets on site as proof of the monthly service-taking place. These must be copied to the consultant for record purposes.

Should the consultant not receive the service reports, it will then imply that the guarantee and service period has not yet commenced, and that the effective commencement date of the guarantee period is extended.

4.24.13 Work by Others

No work or equipment will be provided by others for the Contractor other than items indicated in Clause 4.24.14 and in the Builders work clause.

Any requirements to undertake the full scope of works for this project must be provided by the Air-conditioning Contractor. This includes scaffolding and the relevant insurance for construction work.

4.24.14 Provision by the Client

The Client may make provision for the following:

- Area for the storage.
- Removal of existing services

4.24.15 Quality of Installation/ Disturbance/ Overtime

Any work undertaken must be to the highest standard of quality and workmanship and must always be visually appealing.

4.24.16 Drawings, Operating and Maintenance Manuals

Three sets of these documents are required and will be treated as deliverables with the same importance as the installation itself.

4.24.17 Cleaning Up After The Day's Work Manuals

It is the responsibility of the HVAC Contractor to clean up after each day's work.

4.24.18 After Hours Work

All work is to be performed during normal hours; any after hour's work that may be required is to be coordinated with the Client and will be at no additional cost to the contract.

4.24.19 Testing and Commissioning

All mechanical systems must be tested by the Contractor for design compliance prior to the Engineer, Client and Project Manager been asked to witness any tests.

All commissioning data must be recorded and issued to the Engineer for verification purposes.

This data should form part of the Operating and Maintenance Manuals.

The following tests and commissioning data must be performed and recorded:

(a) Air quantity etc

(b) Electrical checks and safeties

(c) Air quantity of each fan using a Pitot tube traverse.

In all cases, system schematics must accompany every test with the Commissioning Engineer's signature.

4.24.20 Lifting and Hoisting Equipment

The mechanical contractor is to allow for lifting and rigging all his equipment into position. He must arrange for delivery, offloading, rigging, and lifting his equipment into position and must liaise with the client, project manager, and consultant.

He is to take out adequate insurance for these operations and check that the roadways within the building complex can take the truck loads.

4.24.21 Programme

The mechanical contractor is to refer to the programme provided with the contractual documents and satisfy himself that he agrees with the completion dates.

5. PROJECT TECHNICAL SPECIFICATION

5.1 GENERAL

This Technical Specification covers the general electrical installation for the Design and Installation of UPS At The Armscor IMT Building at Simons Town, Western Cape project.

5.2 QUALITY OF MATERIAL

Only material of high quality and suitable for the climatic conditions of the site shall be used and shall be subject to approval of the ENGINEER. All material shall conform in respect of quality, manufacture, tests and performance, with the requirements of the SABS or where no such standards exist, conform to the appropriate current Specification of the British Standards Institution. 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. All materials shall be suitable for the conditions under which the materials are installed and used. Should the materials or components not be suitable for temporary use under site conditions, then the Domestic Sub-Contractor shall at his own cost provide suitable protection until these unfavourable site conditions cease to exist.

5.3 FIXING OF MATERIALS

5.3.1 Responsibility

It is the responsibility of the Domestic Sub-Contractor to position and securely fix conduits, trunking, cables and cable ladders, switchboards, fittings and all other equipment or accessories as required for the installation. The Domestic Sub-Contractor shall provide and fix all supports, clamps, brackets, hangers and other fixing materials.

5.3.2 Welding

Supports, brackets, hangers, etc. may only be welded to steel structural members where prior permission has been obtained.

5.3.3 Screws and bolts

Where holes in equipment to be fixed already exist, bolts and fixing screws shall be used.

5.3.4 Wall plugs

Where the fixing holes in brick or concrete walls are similar than 10mm diam. and where the mass of the equipment is less than 15kg, wall plugs may be used to fix conduits, cables and other equipment. Aluminium, fibre or plastic plugs only may be used. Wooden plugs are not acceptable. Plugs installed in seams between bricks are not acceptable. A masonry drill of the correct size shall be used to drill holes for plugs. Round-headed screws shall be used throughout.

5.3.5 Anchor bolts

Where the fixing holes are 10mm and larger or where the mass of the equipment is 15kg or more, equipment shall be fixed by means of expanding anchor bolts.

5.4 SWITCHBOARDS

5.4.1 SUPPLY OF SWITCHBOARDS

The Domestic Sub-Contractor shall supply and install all the boards shown on the drawings.

5.4.2 General

All switchboards shall be of ample size to accommodate all the specified switchgear with allowance of 30% of space for future switchgear.

The Domestic Sub-Contractor shall ascertain the exact position of switchboards and shall arrange timeously for the installation of cable sleeves, openings in the structure and flush draw trays behind switchboards where applicable.

In general wall mounted switchboards shall be mounted 1400mm above finished floor level - measured to the centre of the switchboard. The upper ends of switchboards may not be higher than 2.2 metres above finished floor level.

5.4.3 Construction of flush mounted switchboards

a. Bonding trays

Bonding trays for flush mounted switchboards shall be of rigidly constructed 1.6mm thick galvanized steel, braced and re-enforced. Formed gussets shall be provided at the corners. All the tray joints shall be properly welded. A brass or cadmium plated steel earth connecting stud and nut shall be provided. No flush mounted switchboards shall be installed in walls less than 230mm in thickness.

b. Architrave frame

The architrave frame shall be of 1.6mm thick sheet steel with bevelled edges. The architrave frame shall accommodate the chassis, panels and doors. The architrave shall overlap the bonding tray by at least 25mm on each side. The architrave frame shall be fixed to the tray in such a fashion to allow for depth adjustment and irregularities of the wall.

c. Chassis

The chassis for mounting of switchgear shall be of rigid construction and shall be fixed securely to the architrave frame or bonding tray by means of bolts screwed into tapped holes or bolts and nuts. Self-tapping screws are not acceptable. The chassis position shall be adjustable in the horizontal plane.

d. Panel

A stiffened panel manufactured of 2.00mm thick sheet steel shall be installed in the architrave frame for flush mounting of switchgear. The panels shall have machine punched slots for

housing the specified and future switchgear, instruments, fuse holders, isolating switches, indicator lamps, etc.

Blanking plates shall be provided in positions where future switchgear will be installed. The distance between the inside of the closed doors and the panel shall be not less than 40mm. No equipment may be mounted on the panel.

e. Fixing of panels

The panel for each switchboard shall be secured to the architrave frame by means of 6mm chromium plated studs. Alternatively, the panel may be secured to the architrave frame by means of two pins at the bottom and a latch or lock at the top of the panel. Self-tapping screws will not be allowed. Where it is required that equipment be mounted on the panel, the panel shall be securely hinged to the switchboard frame.

f. Doors

Where specified, switchboards shall be equipped with doors. The doors shall be of a smooth flat finish suitably braced to ensure stiffness and when in the closed position, shall be flush with the architrave frame. The doors shall be of 1.6mm sheet steel. The door width shall not exceed 600mm. Doors exceeding 450mm in width or height shall on all four sides be bent inwards to ensure stiffness. The corners shall be welded and smoothed.

g. Door handles and catches

All switchboard doors shall be equipped with lockable handles and catches. Where lockable doors are required and in all cases where the switchboard doors are higher or wider than 450mm, handles consisting of a pushbutton-and-handle combination with spring loaded latch or rotary handle-and-catch combination shall be installed.

Switchboard doors smaller than 450mm in height and width may be equipped with spring loaded flush mounted ring type latches. Square key operated catches are not acceptable.

5.4.4 Construction of surface mounted switchboards

a. Switchboard tray

Surface mounted switchboards shall be equipped with a 1.6mm sheet steel re- enforced tray. Securing lugs shall be provided to fix the tray to walls or any other structure. A solid brass or cadmium plated steel connection stud and nut shall be provided.

b. Construction

All joints shall be securely welded. The tray shall be square and neatly finished without protrusions. The front tray sides shall be rounded with an edge of at least 20mm to accommodate flush doors.

The requirements for chassis, panels and doors shall be as specified for flush mounted switchboards. The doors shall be hinged and shall fit flush in the frame in the closed position.

Wall-mounted surface switchboards shall accommodate top or bottom entry incoming and outgoing cables and circuits.

5.4.5 Mounting of equipment

a. Access

All equipment, busbars and wiring shall be completely accessible when the front panels are removed.

b. Mounting of chassis

The chassis of flush mounted and surface mounted boards shall be mounted on the tray, leaving sufficient space for wiring between rows of equipment and on the sides. This space shall also be adequate to pass the supply cable behind the chassis to connect to the main switch without making use of sharp bends.

c. Mounting of circuit breakers

All moulded case circuit breakers shall be flush mounted with the toggles only protruding. Miniature circuit breakers may be installed in clip-in trays mounted on the frame. All other circuit breakers shall be bolted to the frame. Special provision shall be made for large main switches when designing the framework. Circuit breakers shall be installed so that the toggles are in the up position when "ON" and down when "OFF".

d. Instrumentation

All metering instruments shall be mounted flush in the front panel unless otherwise specified. In certain instances it may be required that instruments be mounted flush in the door. In these instances the back of meters shall be covered by removable covers of isolating material fixed to the door to protect the terminals of instruments and to prevent accidental contact.

Fuses for instrumentation shall be mounted in an easily accessible position and marked clearly. Equipment mounted normally in an easily accessible position and marked clearly. Equipment mounted normally on the surface, e.g. time switches and relays, shall be mounted behind the front panel. In these cases hinged access panels shall be provided in the front panel.

e. Mounting of fuses

Fuse holders shall be mounted semi-recessed in the front panel so that fuses can readily be changed without removing the front panel.

f. Control equipment

All equipment performing control functions, e.g. control relays, not requiring adjustments, shall be mounted behind the front panel.

g. Mounting of busbars

All busbars shall be installed horizontally or vertically with the longer side of the section in the vertical plane. Busbars must be supported on resin insulators. It is of prime importance that mechanical stressing under short circuit conditions be considered when busbar supports are designed.

All busbars other than main busbars shall be mounted on suitable insulators or directly on circuit breaker terminals. Busbars shall be mounted at least 150mm away from the nearest equipment. Special attention should be given to spacing between fuse switches and busbars.

h. Covering

The main busbars shall be covered with coloured heat-shrinkable PVC. The colour shall correspond to the colour of the supply phase. Busbars may alternatively be covered with two coats of coloured insulation paint if approved by the Engineer.

5.4.6 Connections

All conductor ends shall be fitted with crimped lugs which are bolted to the busbar.

a. Neutral busbars

Neutral conductors for circuits protected by a single pole circuit breaker of fuse switch shall be connected to a neutral busbar mounted in a suitable position. The neutral busbar shall have a cross-section of at least 6 x 25mm and shall be long enough for the lugs of all the neutral conductors to be bolted separately to the busbar without overlapping the lugs.

b. Earth bars

Each switchboard shall be provided with a normal “Building” earth bar and a separate insulated “Clean” earth bar. Earth bars shall be installed in convenient positions along the entire length of the switchboard. “Building” Earth bars shall be bolted directly to the framework but “Clean” Earth bars shall be mounted on resin insulators. Earth busbars shall have a minimum cross-section 6 x 20mm and shall be installed in a suitable and easily accessible position over the full width of the board. 6mm Diam. holes shall be provided in the busbar at 25mm centres. All earth conductors shall be connected individually to the earth busbars. The holes provided shall be drilled on site to accommodate the bolts and nuts. Spare bolts and nuts need not be supplied.

All non-current carrying metal parts of the board, e.g. framework, panels, transformer cores, metal covers, etc. shall be bonded to the “Building” Earth bar.

The earthing reticulation shall be installed as part of this scope of work, with the termination of the earthing reticulation cables in the sub-distribution boards falling within the scope of this contract.

c. Bolts and nuts

Cadmium-plated steel bolts only may be employed at connecting points. All bolts shall be provided with spring washers. Hexagonal nuts shall be used. The largest possible size of bolts

that will fit into holes in lugs and fixing holes of equipment, shall be used in every instance. Bolts shall be of sufficient length so that not more than two threads protrude beyond the nut.

d. Switchgear

All switchgear supplied and installed by the Contractor shall be MERLIN GERIN or CBI switchgear rated minimum 5kA r.m.s, or as specified on the schematic diagrams.

5.4.7 Wiring

a. Current ratings

The current rating of conductors for the internal wiring shall be sufficient to carry the maximum continuous current that can occur in the circuit. This value shall be determined from the circuit breaker or fuse protection of the circuit.

b. Internal wiring

Standard 600V grade PVC insulated stranded annealed copper conductors to SABS 150 shall be employed for the internal wiring of switchboards.

All wiring shall be arranged in horizontal and vertical rows and shall be bunched and strapped using "Hellerman" or similar strapping.

Under no circumstances may PVC adhesive tape be used for the bunching of conductors or for the colour identification of conductors.

Bunched conductors shall be neatly formed to present a uniform appearance without twisting or crossing the conductors. Conductors leaving harnesses shall be so arranged that they are adjacent to the chassis. These conductors shall first be led in the same direction as the conductors in the harness and shall then be bent over the top of the harness and progress to its final destination.

Conductors to hinged panels and doors shall be secured on both the door and the frame and shall be looped between the two points. The loop shall be arranged to produce a twisting motion when the door is opened or closed. A flexible protection sleeve shall be installed over the conductors.

All wiring between different panels within the same switchboard shall be separately bunched.

Grommets shall be installed in each hole in the metalwork through which conductors pass.

All wiring shall be installed away from terminals, clamps or other current carrying parts. Wiring shall also be kept away from exposed metal edges or shall be protected where they cross metal edges.

Conductors may be joined at equipment terminals or numbered terminal strips only. Ferruled and taped or other connections are not acceptable.

Where conductors change direction, smooth bends shall be formed with a radius of at least 5 times the outside diameter of the conductor or harness.

Where neutral connections are looped between the terminals of instruments, it is essential that the two conductor ends be inserted into a common lug and are crimped or soldered together in order that the neutral connection is not broken when the conductors are removed from one of the instruments.

Wiring should be confined to the front portions of switchboards as far as possible for ease of access. This requirement is important for wiring between circuit breakers with a rating of less than 30Amp and the associated main circuit breaker as well as the wiring from circuit breakers to lighting and socket outlet circuits.

c. Load End Connections

The supply end connections to equipment shall as a rule be at the top and the load end connections at the bottom. Where the load and supply ends of the mains circuit breaker of a switchboard are not indicated the load may be connected to the top end only if the wording "LINE" and "LOAD" is correctly indicated on the circuit breaker.

d. Wiring to circuit breakers

Loop connections may only be installed for a maximum of two outgoing circuits. Where there are more than two outgoing circuit busbars shall be used and equipment connected individually to busbars. Where MCB's are mounted in a continuous row and supplied by busbars connected to each MCB, each busbar shall be supplied by a separate conductor. This conductor shall be connected to the busbar by means of a separate lug and not via an MCB terminal.

e. Conductor terminations

All conductors terminating on meters, fuse holders and other equipment with screwed-on terminals shall be fitted with lugs. The lugs shall be soldered or crimped to the end of the conductor. Sufficient insulation shall only be stripped for the end to fit into the terminal. Strands may not be cut from the end of the conductor.

f. Identification

The colour of the conductors for all 230V circuits shall correspond to the colour of the supply phase for that circuit. Neutral conductors shall be black. All other conductors in the board, supplying control circuits, etc. shall be coded in colours other than those specified above. A colour code shall be devised for each board and the colour code shall be shown on the wiring diagrams. All conductors that terminate at terminal strips and all conductors used for the internal wiring of the switchboard, shall further be identified at both ends by means of double cable marking ferrules. PVC or other tape is not acceptable. The numbers on the markers shall also be shown on the wiring diagrams.

5.4.8 Paint finish

a. Finish Required

Metal components of the framework, panels and chassis shall be finished with a high quality paint applied according to the best available method. Baked enamel, electro-statically applied powder coating or similar proven methods may be used. Care shall be taken to ensure that all edges and corners are properly covered.

b. Colour

The colour shall be as requested by the Engineer.

Before the installation is handed over the Domestic Sub-Contractor shall ensure that all paint surfaces are clean and undamaged.

c. Labelling

Care shall be taken to ensure that all equipment is fully and accurately labelled. Engraved plastic or ivory strips shall be used throughout. The strips shall bear black lettering on a white background.

d. Equipment identified

All equipment on switchboards shall be identified with the necessary labels. The circuit numbers shall appear at all grouped single pole circuit breakers. The abovementioned circuits shall be identified on a legend card, which shall be installed on the inside of the switchboard door, or in any other position where it can conveniently be observed. All fuses including instrument fuses shall have labels stating function, fuse rating and duty or type where applicable. All other equipment shall be identified separately and their functions shall be clearly indicated.

Where cascading of circuit breakers occur in a distribution board, a suitable label of notification must be provided.

e. Fixing of labels

Engraved strips shall be secured by means of brass nuts and bolts or slotted label holders. Self-tapping screws will not be allowed. Labels shall not be glued to the switchboard or stuck onto the switchboard with double-sided tape. Sufficient fixing bolts shall be provided to prevent labels from warping.

f. Testing

The Engineer shall be notified when the mechanical construction of the switchboard i.e. frame, panels and base frame, is completed in order that he or his representative may inspect it at the factory.

Function tests of all equipment, control and interlocking circuits shall be conducted to the satisfaction of the Engineer. The proper functioning of all protection relays and ammeters shall be proved by means of current injection on the primary side of the relevant current transformers.

Testing equipment and facilities including instruments, dummy loads and additional switchgear and cables, at the factory or on site, shall be provided by the Domestic Sub-Contractor at no extra cost. The Engineer shall be notified in writing two weeks in advance of any tests to be conducted, to allow him or his representative to be present at such tests. A complete report on the tests shall be handed to the Engineer. The Domestic Sub-Contractor shall allow in his tender for all costs of travel and accommodation out of inspection by the Engineer should the boards not be manufactured in Cape Town.

5.4.9 Drawings

a. Drawings for approval

A set of three prints of the shop drawings for the switchboards shall be submitted to the Engineer for approval before the boards are manufactured. The following information shall be present:

- A complete wiring diagram of the equipment on the boards.
- A complete layout of the arrangement of the switchboards indicating all equipment dimensions and the construction of the boards. The positions and method of fixing of busbars shall be shown.
- All labelling information on a separate sheet.
- The make, catalogue number and capacity of all equipment such as isolators, circuit breakers, fuses, contactors, etc.

The approval of drawings shall not relieve the Sub-Contractor of his responsibility to the Owner to supply the switchboards according to the requirements of this Specification.

b. Final Drawings

A complete set of "as-built" transparent drawings of all switchboards shall be submitted to the Engineer immediately after completion of the installation.

c. Manuals

Two sets of manuals for all switchboards shall be forwarded to the Engineer at no extra cost. These manuals shall include the following information:

- Complete information on the operation of the equipment,
- Complete information for maintenance of the equipment,
- Brochures and ordering information, and
- Complete material list indicating quantities and relevant catalogue numbers.

5.4.10 Completion

The Contract shall be regarded as incomplete unless all tests have been conducted successfully and all drawings and manuals have been handed to the Engineer.

5.5 CABLES

The Sub-contractor shall supply and install all the low voltage cables as indicated on the drawings & cable schedules. This contract will include the termination of these cables into the sub-distribution boards. Any additional cables that may be required as part of this contract will comply with the following requirements. All the cables to be used shall be earth continuity conductor cables.

5.5.1 MANUFACTURE

The Domestic Sub All cables shall consist of high conductivity annealed or hard-drawn stranded copper conductors, PVC insulated, twisted together, bedded, sheathed with PVC (preferably black), armoured with a single layer of galvanized steel wire, bedded and served with an extruded PVC outer sheath. The cables shall be manufactured to SANS 1507 of 1990 as amended.

5.5.2 Cable glands

Glands to be used for terminating PVC/SWA/PVC insulated cables, shall be of the adjustable type, suitable for general purpose 600/1000 volt cable.

Non-watertight glands shall easily be converted to watertight glands by means of a waterproofing shroud.

The glands shall be of copper plated heavily tinned bronze or brass, and shall consist of a barrel with a cone nut carrying a cone bush screwed into one end, and a hot tinned steel nipple with a heavy galvanized steel locknut screwed into the other end.

A round groove shall be provided on the cable entrance side of the barrel to accommodate the upper rim of the waterproofing shroud.

5.5.3 Installation of Cables

a. Competence of personnel

It is a definite requirement that the Domestic Sub-Contractor shall only instruct competent personnel to install and connect the various cable types.

b. Standards

All cables used shall conform to the relevant SABS specifications and shall be installed, protected and terminated according to approved methods in compliance with the manufacturer's requirements.

c. Minimum sizes

Cables with conductors smaller than 2.5mm^2 may not be used except for control wiring. Where cables are grouped together the minimum conductor size shall be 2.5mm^2.

d. Joints

All cables shall be supplied and installed without joints unless written approval is obtained from the Engineer.

Where joints are allowed the best available technique for the specific cable type shall be applied.

Cables shall be joined in cable boxes filled with hard-setting compound or with epoxy-resin cast joints. All joints shall be fully water and air tight.

e. Termination

All cable ends shall be terminated with approved glands ensuring a watertight connection between the sheath, gland and equipment.

The glands to be used shall be constructed so that the armouring of the cable is clamped between two bevelled cones with a screw-clamp.

The cable gland shall be screwed to the gland plate or equipment and fixed with a locknut.

Cable cores shall be connected to the equipment with suitable lugs.

Cable ends shall be supplied with the necessary earth connections.

f. Slack

Slack of at least 2m shall be allowed at both ends on cable routes with a length in excess of 15m.

g. Grouping of cables

Cables have been sized in accordance with the grouping correction factors applicable to SANS 10142. Cables may therefore be bunched on cable trays or in sleeves.

h. Cables on different levels

Where parallel cable runs are installed at different levels (e.g.: on parallel cable trays) and where the spacing of the layers is not specified, a minimum spacing of 300mm shall be maintained.

i. Cables for other services

Cables for telephone, communication systems and other low voltage systems (less than 50V) shall be separated from power cables. Where armoured cables are used for such other services, they shall be installed in separate cable trays or shall other- wise be at least 1m away from power cables. Where unarmoured cables are used for these other services, they shall be installed in separate conduits or metal channels.

j. Fixing of cables

Cables may be installed in one of the following ways:

Clamps

Suitable clamps (cleats) which will secure cables without damage 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 if the clamp is specially made to accommodate the various cables.

Distance between fixings

The maximum spacing between cleats (clamps) to which cables are fixed in horizontal and vertical cable routes shall be determined from the table below. Additional cleats shall be installed at each bend or offset in the cable run. The maximum distance between supports or cleats for multicore control cables shall be 30 times the outside diameter of the cable with a maximum spacing of 900mm for the armored cables.

Sleeves

Where cables penetrate floors, walls or other structural elements, suitable sleeves shall be provided. Both ends of the sleeves shall be sealed with a non- corrosive, watertight non-hardening compound.

k. Earth conductor

Earth continuity conductors shall be installed with all cables. The earth continuity conductor shall consist of a bare stranded copper conductor for the “Building” Earth, and a PVC insulated stranded conductor where a "CLEAN” Earth is required.

Unless otherwise specified, the cross-sectional area of the earth conductor shall be equal to one half that of one current carrying conductor but shall not be less than 2.5mm2 and need not be more than 70mm^2. A single conductor may be used where parallel cables supply the same load. A single conductor may be installed serving a group of underground cables.

The earth conductors shall be connected to the appropriate earth bars of the switchboards to which the associated cables are connected.

l. Identification of cables

All cables shall be identified at both ends and at all joints according to a code or number system. These numbers shall appear on the as-built drawings.

Cables shall be marked with non-deteriorating bands with raised or punched numbers.

5.6 CABLE TRAYS, LADDERS AND WIRE MESH TRAYS

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

5.6.1 Tray type

Unless otherwise specified, all cable trays shall be heavy duty type perforated galvanized cable trays.

5.6.2 Wire mesh trays

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

5.6.3 Supports

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.

5.6.4 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.

5.6.5 Fixing

Trays shall be securely bolted to supports to avoid cables being damaged during installation.

5.6.6 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 Domestic Sub-Contractor to ensure that adequate fixing is provided since cable trays and ladders that work loose shall be rectified at his expense.

5.6.7 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.

5.6.8 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.

5.6.9 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.

5.6.10 Painting

No painting of trays or ladders shall be required.

5.7 TRUNKING INSTALLATION

Trunking shall be installed as indicated on the drawings. All trunking and trunking accessories shall be similar or equal Cape Support Systems and shall be galvanized. 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-rivetted 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 Sub-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.

5.8 CONDUIT INSTALLATION

5.8.1 General

Conduit may be installed as follows:

d) In open roof spaces - PVC conduit may be installed.
- surface mounted - PVC & Bosal conduit where specified may be installed.
- in wall chases - PVC conduit may be installed.
- Cast in concrete - PVC conduit may be installed.

Where conduits are to be installed in concrete, this shall be done while the building work is still in progress. Surface mounted conduit shall only be installed after the Engineer has given his written consent to do so.

5.8.2 Other Services

Conduits shall be installed at least 150mm away from pipes which are intended for gas, steam, hot water or any other material which may affect the conduit. Where doubtful situations of this nature occur or where there are installation incompatibilities the matter shall be reported to the Engineer without delay.

5.8.3 Debris

Care shall be taken to prevent any debris or moisture from entering the conduit during and after installation of the conduits. All conduit ends shall be sealed.

5.8.4 Defects

Each length of conduit shall be inspected for defects and all burrs shall be removed. All conduits that are split, dented or otherwise damaged or any conduits with sharp internal edges shall be removed from site. The Sub-Contractor shall ensure that conduits are not blocked.

5.8.5 Continuity

Mechanical and electrical continuity shall be maintained throughout the conduit installation for galvanized steel conduits. Conduits may not be relied upon for earth continuity.

5.8.6 Inspection Type Accessories

Inspection type couplings, elbows and tees shall not be used except with the written consent of the Engineer. All outlet boxes and draw boxes shall however be of the inspection type.

5.8.7 Positions of Outlets

All accessories such as socket outlets, switches, lights, etc. shall be accurately positioned. It is the responsibility of the Sub-Contractor to ensure that all accessories are installed level and square at the correct height from the floor, ceiling or roof level as specified. It shall be the responsibility of the Sub- Contractor to determine the correct final floor, ceiling and roof levels in conjunction with the Contractor.

Draw boxes shall not be installed in positions where they will be inaccessible after completion of the installation. Draw boxes shall be installed in inconspicuous positions to the approval of the Engineer. All installed draw boxes shall be pointed out to the Engineer. The positions of all draw boxes shall be indicated on the "as built" drawings.

5.8.8 Draw Wires

Galvanized steel draw wires shall be installed in all unwired conduits e.g. conduits for future extensions, telephone/data installations and other services.

5.8.9 Bends

A maximum of two 90^0 bends or the equivalent displacement will be allowed between outlets and/or draw boxes. Draw boxes shall be installed at maximum intervals of 9m in straight conduit runs. All bends shall be made without heating the conduit or without reducing the diameter of the conduit.

5.8.10 Wall Sockets

Where more than one socket outlet is connected to the same circuit, the conduit shall be looped from one outlet box to the following on the same circuit. Where a metal channel is used, the conduit may be installed from the channel directly to the outlet box on condition that the conductors can be looped from one outlet to the next without making any joints in the wires.

5.8.11 Light Fittings

Where the conduit end is used to support light fittings, a ball-and-socket type lid shall be fitted to the pendant box in all cases where the conduit is longer than 500mm. In all other cases a dome lid may be used. Where light fittings are specified which are fixed directly to the pendant box, the pendant box shall be fixed independently of the conduit installation except where the pendant box is cast into concrete.

5.8.12 Withdrawal of Conductors

To ensure that all electrical conductors shall be easily withdrawable from conduits, the Engineer reserves the right to have the conductors of any circuit removed at his discretion and replaced at the cost of the Sub-Contractor. If the conductors are damaged during removal, the damaged conductors shall be replaced and the cost of the replacement shall be borne by the Sub-Contractor.

5.8.13 Flush Mounted Outlet Boxes

The edges of flush mounted outlet boxes shall not be deeper than 10mm from the final surface. Where this is not the case, an extension box which ends flush with the surface, shall be screwed to the outlet box. This method shall be used in partitions and cladded surfaces.

5.8.14 Excess Holes

All excess holes in drawboxes, distribution boxes, switchboards, cable ducts or trunking, power skirting, etc. shall be securely blanked off to render the installation vermin proof. Brass stopping plugs shall be used in accessories.

5.8.15 Open Roof Spaces

a. Sequence of Work in Open Roof Spaces (where applicable)

Conduit and wiring in open roof spaces above ceilings other than ceilings of concrete, shall be installed before the ceilings and walls are painted and before removable ceiling tiles are installed. In roof spaces where access is limited after installation of the ceiling, conduits and wiring shall be installed prior to installation of the ceiling. It is the responsibility of the Sub-Contractor to ensure close liaison with the Contractor in connection with the above-mentioned work.

b. Fixing

All conduits in open roof spaces shall be installed parallel and at right angles to the roof members and shall be fixed to the structure at intervals not exceeding 1 metre. Approved saddles shall be used throughout. Clout nails, clamps or wood screws shall be used to secure the saddles to wooden roof members. Suitable saddles shall be used to secure conduits against concrete slabs.

Written permission shall be obtained to secure conduits to steel beams in which case saddles shall be fixed by means of bolts, nuts and lockwashers or purpose made saddles shall be used.

c. Draw Boxes

Draw boxes with PVC cover plates shall be installed where required. Draw boxes shall as far as possible be installed near gangplanks. Socket and switch boxes will not be accepted as draw boxes in open roof spaces.

d. Conduit Ends

All conduit ends for lighting outlets in ceilings shall be securely supported.

e. Incandescent Light Fittings

Where fittings are secured directly to draw boxes in false ceilings or where ceiling roses or special connections are used, flush mounted, rear-entry round draw boxes which are independently fixed to roof beams, shall be provided.

f. Fluorescent Light Fittings

5A Socket outlets shall be installed in ceiling spaces for connection to fluorescent fittings.

5.8.16 Installation in Concrete

In order not to delay building operations, the Sub-Contractor shall ensure that all conduits and accessories which are to be cast in concrete are placed in position in good time. The Sub-Contractor or his representative shall be in attendance when the concrete is cast.

a. Draw Boxes

Draw boxes, expansion joints and round ceiling boxes shall be installed where required and shall be neatly finished to match the finished slab and wall surfaces. Ceiling draw boxes shall be of the deep type. In hollow tile slabs, rear-entry draw boxes shall be used. In columns where flush mounted draw boxes are installed, the conduits shall be offset from the surface of the column immediately after leaving the draw box.

b. Elbows

Elbows for conduits of 32mm dia. and smaller and sharp bends will not be allowed in concrete slabs.

c. Cover Plates

Draw boxes and/or inspection boxes shall where possible, be grouped together under a common approved cover plate. The cover plate shall be secured by means of screws.

d. Neutral Axis

All conduits shall be installed as close as possible to the neutral axis of concrete beams, slabs and columns. The conduits shall be rigidly secured to the reinforcing to prevent movement towards the surface of the concrete.

e. Fixing to the Shuttering

All conduits, draw boxes, etc. shall be securely fixed to the shuttering to prevent displacement when concrete is cast. Draw boxes and outlet boxes shall preferably be secured by means of a bolt and nut installed from the back of the box through the shuttering. Fixing lugs may also be used to screw the boxes to the shuttering.

Wire will not be accepted for securing boxes to the shuttering where off-shutter finishes are required. All draw boxes and outlet boxes shall be plugged with wet paper before they are secured to the shuttering.

f. Expansion Joints

As far as possible, conduits shall not be installed across expansion joints. Where this is unavoidable an expansion joint shall be provided.

g. Screeds

The installation of conduits in floor screeds shall be kept to a minimum. Where conduits are installed in screeds, the top of the conduit shall be at least 20mm below the surface of the screed. Where the screed is laid directly on the ground, galvanized conduits shall be used. This ruling will always be applicable to the lowest floor of a building. A minimum distance of twice the outside diameter of the conduit shall be left free between adjoining conduits.

Conduits shall be secured to the concrete slab at intervals not exceeding 2.0 metres. The Sub-Contractor shall ensure that conduits are not visible above the screed where the conduits leave the screed.

h. Structural Steel

Supports, brackets, hangers, etc. may only be welded to structural steel members where prior permission of the Engineer has been obtained. “CADDY” or similar fasteners may be used to fix equipment to structural steel members.

5.8.17 Surface Conduits

Surface conduits shall only be allowed when authorised in writing by the Engineer.

5.8.18 Flexible Conduit

1. In installations where the equipment has to be moved frequently to enable adjustments during normal operation, for the connection of motors or any other vibrating equipment, for the connection to thermostats and sensors on equipment, for stove connections and where otherwise required by the Engineer, flexible conduit shall be used for the final connection to the equipment.
2. The lengths of flexible conduit shall be as short as possible to comply with the requirements of the particular connection but shall not exceed 600mm, except when specified or approved by the Engineer.
3. Flexible conduit shall preferably be connected to the remainder of the installation by means of a draw box. The flexible conduit may be connected directly to the end of a conduit if an existing draw box is available within 2000mm of the junction and if the flexible conduit can easily be rewired.
4. Flexible conduit shall consist of metal-reinforced plastic conduit or PVC covered metal conduit with an internal diameter of at least 15mm, unless approved to the contrary. Connectors for coupling to the flexible conduit shall be of the gland or screw-in type, manufactured of either brass of cadmium or zinc plated mild steel.
5. Where the possibility exists that the conduit can come into contact with moisture, suitable covering and/or packing shall be installed to isolate the conduit from the moisture.
6. Flexible conduit connections shall be provided with an internal or external earth wire connection as required by the local Supply Authority, with preference given to internal earth wires where no specific local regulations apply.

5.8.19 Expansion Joints

1. Where conduits cross expansion joints in the structure, approved type draw boxes which provide a flexible connection in the conduit installation shall be installed.

2. The draw box shall be installed adjacent to the expansion joint of the structure and a conduit sleeve, one size larger than that specified for the circuit, shall be provided on the side of the draw box nearest the joint. The one end of the sleeve shall terminate at the edge of the joint and the other shall be secured to the draw box by means of locknuts.
3. The circuit conduit passing through the sleeve shall be terminated 40mm inside the draw box and the conduit end fitted with a brass bush. The gap between the sleeve and the conduit at the joint shall be sealed to prevent the ingress of wet cement. An earth clip shall be fitted to the conduit projection inside the draw box and the conduit bonded to the box by means of 2.5mm^2 bare copper earth wire and a brass bolt and nut.
4. The other end of the circuit conduit shall be secured to the draw box by means of locknuts and a brass bush.
5. In addition to an earth wire which may be specified for the circuit, a 2.5mm^2 bare copper wire shall be provided between the first conduit box on either side of the joint. The conduit boxes shall be drilled and tapped and the earth wire shall be bonded to the boxes by means of lugs and brass screws.
6. Draw boxes at the expansion joint shall be provided with a suitable steel cover plate fixed to the box by means of screws. The cover plates shall be installed before the ceilings are painted by others.
7. Where a number of conduits are installed in parallel they shall cross the expansion joint of the structure via a single draw box. A number of draw boxes adjacent to each other will not be allowed.

5.8.20 Chases and Builder's Work

1. The Sub-Contractor shall be responsible for the builder's work connected with conduits, outlet boxes, switchboard trays, bonding trays and other wall outlet boxes as well as the necessary chasing and butting of walls and the provision of openings in ceilings and floors for light fittings and other electrical outlets. The Sub-Contractor shall notify the Main Contractor of his requirements and the responsibility lies with the Sub-Contractor to ensure that these requirements are met.
2. Electrical materials to be built in must be supplied, placed and fixed in position by the Sub-Contractor when required by the Main Contractor. The Sub-Contractor shall also ensure that these materials are installed in the correct positions.
3. When the Main Contractor is not on site the Sub-Contractor is required to cover conduits installed in chases by a layer of 4:1 mixture of coarse sand and cement, finished 6mm below the face of the plaster and roughened. In all cases the conduits shall be deep enough to ensure that the top of the conduits are at least 12mm below the finished plaster surface.
4. The Electrical Sub-Contractor will be held responsible for all damage as a result of chasing work and will be required to make good to the satisfaction of the Engineer. Chases shall be made by means of a cutting machine.

5. Under no circumstances shall face brick walls or finished surfaces be chased or cut without the written permission of the Engineer. Where it is necessary to cut or drill holes in the concrete structure, the prior permission of the Structural Engineer shall be obtained to ensure that he structure is not weakened.

5.9 POWERSKIRTING

Two compartment power skirting shall be supplied and installed in the positions indicated on the relevant drawings. The Domestic Sub-Contractor shall be responsible for the complete supply and installation of all power skirting accessories and associated connections. The power skirting shall be Cabstrut Aluminium powerskirting (AL8/3) Type or equivalent.

All 90^0 bends, tees and end caps shall be purpose manufactured units and all sections of ducts and lids shall be cut square and have their edges "faced" to the approval of the Engineer.

Socket outlet, telephone outlets and infill plates shall be purpose made accessories stamped to receive respective outlets, all as detailed on the drawings.

Power skirting will only be installed after all wet trades have been completed and the Domestic Sub- Contractor shall be responsible for protecting the power skirting to the approval of the Engineer.

Conduit links indicated on the drawings shall drop down the walls from the ceiling directly behind the power skirting. Linking conduits shall not be closer than 150mm throughout their length.

Where applicable all cut-outs for service connections shall be grommeted with "U" section neoprene trim secured to the Engineer's approval.

5.10 WIRING

Except in cases where cables are specified, all wiring shall be PVC insulated, single core stranded copper conductors and bare stranded or green PVC insulated copper conductors for earth continuity in compliance with SANS 150.

All conductors shall be installed in conduits, trunking or power skirting and shall under no circumstances be installed without mechanical protection.

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 with the exception of 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 following **minimum** conductor sizes shall be used :

- Lighting circuits - 2.5mm^2 plus 2.5mm^2 earth conductor
- Plug circuits - 4mm^2 plus 4mm^2 earth conductor
- Stove circuits - 10mm^2 plus 10mm^2 earth conductor
- Motor circuits - 4mm^2
- *HWC - 4mm^2*

When wiring is installed in partitioning, the vertical and/or horizontal supports of the walls may be utilized for fixing conduit and outlet boxes.

5.11 CONNECTIONS

5.11.1 Connections to light fittings

a. Connectors

Connections to the wiring of the light fittings and other appliances where connectors are used, shall be effected by means of brass screw couplers shrouded in porcelain, neoprene or PVC or by means of approved spring steel locking connectors insulated in unbreakable material. Other types of connectors are not acceptable.

b. Knock-outs

Where knock-outs are used for the wiring of light fittings and other appliances, brass bushes or gripper glands shall be used.

c. Incandescent fittings

Connections to fittings with incandescent lamps shall be installed in a box situated behind the fitting.

d. Fluorescent fittings

Connections to fittings with fluorescent lamps other than those provided with flexible leads and plugs may be installed inside the metal body on condition that the frame and/or diffuser holder where applicable can be removed without disconnecting the conductors.

e. Screwed lampholders

The central terminal of Edison Screw (E.S.) lampholders shall be connected to the phase conductor (i.e. conductor with red insulation) and the screwed housing to the neutral conductor (i.e. conductor with black insulation).

5.11.2 Stove and kitchen appliance connections

The connection to each stove or similar appliance unless specified to the contrary, shall consist of 10mm^2 insulated conductors and a 10mm^2 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 of 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.

5.12 SWITCHES AND SOCKET OUTLETS

All switches and socket outlets shall be of the Clipsal or Crabtree range.

5.12.1 Flush wall switches

All flush wall switches shall comply with SANS 163 of 1951 as amended and shall bear the SANS mark.

Switches shall be rocker or toggle action and shall be rated at minimum 16A.

Single or double gang switches shall be installed in such a fashion that the toggle or rocker action is vertical.

5.12.2 Surface mounted switches

Surface mounted switches shall consist of single or multi-gang switch units mounted in a common box. Rocker or toggle action shall be vertical.

The box and cover shall be of heavy gauge approved metal with all corners and sides rounded. The cover shall fit neatly over the box and shall be fixed by means of at least two chromium plated counter-sunk screws. The switch toggle or rocker shall be shrouded where it protrudes through the cover.

The switch units shall bear the SANS mark and shall comply with SANS 164 of 1953 as amended and SANS 163 of 1951 as amended where applicable and with the test requirements of SANS 109 of 1950 as amended.

5.12.3 Watertight switches

Watertight switches shall be 5 Amp single pole, suitable for surface mounting. The unit shall consist of a circular or square galvanized cast iron or PVC box with watertight lid and handle.

The handle shall either be at the front or side of the box. The "on" and "off" positions shall be clearly indicated. Entry shall be through holes that have been drilled with 20mm electrical thread.

The switch interior shall be a 5 Amp switch with quick acting spring mechanism, with heavy gauge brass contacts.

5.12.4 Installation of light switches

a. Mounting height

All light switches shall be installed 1400mm above the finished floor level unless specified to the contrary. Mounting heights given shall be measured from the finished floor level to the centre of the switch.

b. Doors

Unless otherwise specified switches adjacent to doors shall be installed on the side containing the lock. If the position of the lock is not shown on the drawings, the position shall be verified before the switch box is installed. Switch boxes in brick or concrete walls, shall be installed 150mm from the doorframe. Light switches installed in partitions or doorframes shall be of the type designed for that purpose.

c. Walls

Where the wall is plastered, light switches must be installed flush with the plaster finish.

d. Cover plates

Bevelled cover plates which overlap the switchbox and which fit tightly against the wall finishes shall be installed in the case of flush mounted switch-boxes. Suitable spiral type steelwire spacers shall be used to fix the cover plate to deep set flush switch-boxes. All fixing screws in cover plates and switch grids shall be supplied and securely fitted. The colour of cover plates shall be to the Architect's choice.

Cover plates shall under no circumstances be cut unless specifically authorised in exceptional cases by the Engineer.

Switch boxes and cover plates shall be installed parallel to the relevant horizontal and vertical building lines.

e. Partitions

Light switches installed in partitions shall be of the type designed for this purpose to be accommodated in the partition design. Switches installed in the metal support do not require switch boxes. Switches may not be flush mounted in partition walls without switch boxes.

f. Waterproof switches

Switches exposed to the atmosphere or installed in damp areas, shall be category IP 55.

g. Multiple switches

Where specified, multi-gang switches shall be installed in a common box. Switches controlling different circuits shall be installed in separate switch boxes.

h. Appearance

The sides of adjacent switches, plugs, pushbuttons, etc. shall be parallel or perpendicular to each other and uniformly spaced. A common escutcheon plate shall be used for flush mounted outlets and accessories where the cover plates do not cover the cut-outlets in the finishes.

5.12.5 Socket outlets

The following different types of socket outlets will be supplied by the Domestic Sub-Contractor and installed in the building as shown on the drawings.

a. Dedicated socket outlets for workstations

Where these are installed in power skirting or alternatively in pedestal boxes or 100 x 100 conduit boxes they shall be flush mounted shaven-earth-pin SSO's with red covers.

The earth conductors connected to the earth pins of all of these sockets will be Green/Yellow insulated PVC earth conductors wired back to the Clean (insulated) Earth bar on the nearest switchboard. The metal casings of these socket outlets will be connected to the normal Building Earth bar on the nearest switchboard by means of appropriately sized bare copper earth conductors.

b. General purpose socket outlets

These shall be 16 Amp 3-pin switched type to SABS 164. They shall each be flush mounting or surface mounting as described below. The earth conductors for these socket outlets will be bare copper earth conductors wired back to the normal Building Earth bar in the nearest switchboard.

Unless otherwise specified, outlets shall be installed at the following heights above finished floor level:

Refer to power and lighting drawings for heights.

All mounting heights shall be measured from finished floor level.

5.12.6 Flush socket outlets (SANS Type)

Flush socket outlets shall each consist of a switch and 3 pin plug receptacle with 2 shuttered poles and an earth socket suitable for mounting in a standard pressed steel box under a common cover plate.

Sockets and switches shall be rated at 250V. 15A unless clearly specified to the contrary.

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

5.12.7 Surface mounted socket outlets (SANS Type)

Surface mounted socket outlets shall consist of a switch and 3 pin plug receptacle with 2 shuttered poles and an earth socket contained in a pressed steel box suitable for surface mounting.

The box and cover plate shall be manufactured of 1.6mm steel with all corners rounded. The lid shall fit neatly over the box and shall be fixed by means of two counter-sunk screws. A knock-out shall be provided on each side of the box for the termination of 20mm conduits.

The switch toggle shall be shrouded where it protrudes through the cover plate.

Sockets and switches shall be rated at 250V, 15A. The unit shall comply with SANS 163 and SANS 164 where applicable and shall be tested in accordance with SABS 109 of 1950 as amended.

5.13 LIGHT FITTINGS

5.13.1 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, as indicated on the drawings. The Sub-contractor shall be held liable for any damage to luminaires from the date of receipt until the date of handover to the Employer.

5.13.2 Installation of light fittings

The various types of light fittings required in the execution of the sub-contract are shown on the drawings.

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. The layout as shown in the Drawings shall generally be adhered to but any discrepancies or clashes with structural or other features must be referred to the Engineer before commencing erection of the installation. Should the Domestic Sub-Contractor neglect to refer such 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 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 lampholder. Screw connectors will not be allowed.

h. Fluorescent 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 Engineer.

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 70^0C. In unventilated luminaires or luminaires capable of housing incandescent laps over 60W, the interconnecting wiring from the lampholder 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.

5.14 ELECTRONIC SYSTEMS INSTALLATION

This specification covers only the supply and installation of outlet points, wire mesh trays, trunking and conduits for data, and telephone points. These wire ways shall be installed as per future drawings. The supply and installation of equipment, cabling and terminations will be carried out by others.

A welded wire mesh cable tray shall be installed for electronics systems. The installation of the welded wire mesh cable tray shall be done as per the manufacturer's recommendations.

All conduits supplied and installed by the Contractor shall be provided with galvanized steel draw wires

Conduit connections to power skirting shall be made by means of a 100 x 50 x 50mm or 60mm round draw boxes which is flush mounted immediately behind the duct or channel in which the telephone cables are to be installed. A hole shall be cut in the back of the duct or channel, immediately opposite the draw box. The edges of the hole shall be grommeted. The draw box shall be accessible from the front when the power skirting cover is removed.

Telephone outlets in walls or partitioning shall consist of flush mounted 100 x 100 x 50mm draw boxes with blank cover plates.

Where power skirting is shown the Domestic Sub-Contractor need only install the skirting with covers since the data/telephone socket outlet will be fixed directly to the cover. No other cables may be installed in the section intended for data/telephone cables and the separation between the sections shall be maintained throughout the installation.

5.14.1 Electronic Systems outlets on wire mesh trays

Cabling and the installation of the Electronic Systems sockets fixed the sides of wire mesh trays shall be by others.

5.15 AIR CONDITIONING

The electrical sub-contractor shall be responsible for the electrical supply to each isolator unit in the vicinity of the compressors. The position of these points will be coordinated on site between the electrical and A/C contractors.

The final connection from the isolator to the Air Conditioning unit shall be done by the AC contractor.

5.16 EARTHING

5.16.1 General

The installation shall be earthed properly in accordance with the latest revision of SANS 10142 and separate earthing systems shall be provided for the Building Earth and the Clean Earth. All earth conductors for the Building Earth shall be bare stranded copper conductors or stranded conductors with Green/Yellow PVC insulation when installed in power skirting. Earth conductors for the Clean Earth system shall be stranded conductors with Green/Yellow insulation.

A separate earth connection shall be supplied between the Building Earth busbar in each switchboard and the earth busbar in the Main LV Board. These connections shall consist of bare stranded copper. Similarly a separate earth connection will be supplied between the Clean Earth busbar in each switchboard and the Clean Earth busbar in the Main LV Distribution Board.

The earth conductors of all circuits shall be connected to the appropriate earth busbar of the supply board. All single phase plug circuits shall be supplied with 2.5mm2 earth conductors. All fluorescent lighting circuits shall be supplied with 2.5mm2 earth conductors. All single phase and three phase outlets, electrical appliances, equipment, electrical motors, etc. shall be earthed as stipulated in SANS 10142. All outlets in the building identified on the drawings as dedicated socket outlets shall be provided with Green/Yellow insulated earthwires and earthed to the Clean Earth bar in the appropriate switchboard.

5.16.2 Connections

Under no circumstances shall any connection points, bolts, screws, etc. used for earthing be utilized for any other purpose. It will be the responsibility of the Domestic Sub-Contractor to supply earth terminals or clamps where these are not provided by others. All earth connections shall be tin plated and fixed with approved ferrules. The entire connection shall then be soldered.

5.16.3 Wiring, trunking cable trays and ladders

The ends of all metal trunking, cable trays and ladders containing cables or conductors under load shall be earthed to the Building Earth busbar in the nearest switchboard with copper strapping or 2.5mm^2 stranded conductors. Adjoining sections shall be connected at joints with copper strapping or 2.5mm^2 conductors.

5.16.4 Conduit

All metal conduits shall be earthed. An external earth conductor shall be installed together with all non-metal flexible conduit. The earth conductor shall be connected securely to the metal parts on both ends.

5.16.5 Water pipes

Metal cold water mains shall be connected with solid 12 x 1.6mm copper strapping to the earth busbar in the Main LV Board. All other hot and cold water pipes shall be connected with 12 x 0.8mm perforated or solid copper strapping (not conductors) to the nearest switchboard.

The strapping shall be fixed to the pipework with brass nuts and bolts and against walls with brass screws at 150mm centres. In all cases where metal water pipes are positioned within 1.6m of switchboards an earth connection consisting of copper strapping shall be installed between the pipework and the board. In the vertical building ducts accommodating water pipes all the pipes shall be earthed to the nearest switchboard.

5.16.6 Medium Voltage Switchgear

An earth resistance of maximum 2 ohm is required. All MV switchgear shall be connected to the substation earth bar by a 35mm^2, bare earth copper conductor. No joints in this earthing conductor shall be allowed.

5.16.7 Minisubstations

An earth resistance of maximum 2 ohm is required, measured with all contributing earth wires connected to the earth bar.

2 x 30m lengths of 70mm^2 bare copper earth conductors shall be connected to the earth bar, one on the MV and one on the LV side of the transformer and shall be installed together with the cables running in the trenches in opposite directions from the transformer. If the earth resistance as measured should prove to be more than 2 ohm, one or more 2,4m long Copperweld earth spikes shall be installed and connected to the earth bar by means of 70mm^2 bare copper conductors.

5.16.8 Medium Voltage Cable

The cable armouring shall be connected to the earth bar of the equipment at each cable termination. Where jointing between lengths of MV cable occurs, the cable armouring of both cables shall be effectively connected.

5.16.9 Distribution and/or Metering Kiosks

An earth resistance of maximum 5 Ohm is required, with all the contributing earth wires connected to the earth bar.

2 x 10mm^2 bare copper earth conductors shall be installed with the supply cable in the same trench from the kiosk. The earth conductor(s) shall be connected to the earth bar of the kiosk.

5.16.10 Transformer Fencing (If Applicable)

All metal parts of the fence, surrounding the transformer site, shall be bonded to earth and connected to the transformer LV earth terminal with a 35mm^2 bare copper conductor.

5.17 EXISTING SERVICES

5.17.1 Existing services

The contractor shall acquaint himself with the positions of all the existing services such as stormwater pipes, water mains, gas pipes, telephone cables, etc. before any excavations are

commenced. For this purpose he shall approach the Engineer, the Local Authority, the Local Supply Authority, and any other authority that may be involved, in writing.

In the event of damage to other services or structures during operations the contractor shall immediately notify the Engineer and institute repairs. The Contractor will be held responsible for damage to any existing services brought to his attention by the relevant authorities and shall be responsible for the cost of repairs.

5.17.2 Precautions, Warnings and Inconveniences

The contractor shall take all the necessary precautions and provide the necessary warning signs, tapes and/or lights to ensure that the public and/or employees on Site are not endangered. The requirements of the Occupational Health and Safety Act, Act 85 of 1993 (as amended) shall be strictly adhered to.

The contractor shall ensure that the site operations will not endanger existing structures, personnel, other Site construction activities, or other property.

5.17.3 Mechanical Excavators

Power driven mechanical excavators may be used for trenching operations, provided that they are not used in close proximity to other plant, services or other installations likely to be damaged by the use of such machinery.

The use of power driven mechanical excavators shall be subject to the approval of the Engineer. Should the excavator produce trenches that exceed the required dimensions, payment based on volumetric excavation rates will be calculated on the required dimension only.

5.17.4 Blasting

No guarantee is given or implied that blasting will not be required.

Should blasting be necessary and approved by the Engineer, the Contractor shall obtain all the necessary authority from the relevant Government Departments and Local Authorities. The Contractor shall take full responsibility and observe all conditions and regulations set forth by the above authorities.

5.17.5 Routes

Trenches, if any shall connect the points shown on the drawings in a straight line. Any deviations due to obstructions or existing services shall be approved by the Engineer beforehand.

The Engineer reserves the right to alter any cable route or portion thereof in advance of cable laying. Payment in respect of any additional or wasted work involved shall be at the documented rates.

The removal of obstructions along the cable routes shall be subject to the approval of the Engineer.

5.17.6 Shoring and Waterlogging

The Contractor shall provide shoring for use in locations where there is a danger of the sides of the trench collapsing due to waterlogging or other ground conditions. Refer to the Occupational Health and Safety Act, Act 85 of 1993 (as amended).

The strength of shoring must be adequate for Site conditions prevailing and the shoring must be braced across the trench.

The Contractor shall provide all pumps and equipment required to remove accumulated water from the trenches. Water or any other liquid removed shall be disposed of without any nuisance or hazard.

5.17.7 Surveyor's Pegs (If Applicable)

Extreme care shall be taken not to disturb the surveyor's pegs. If the surveyor's pegs are disturbed, they shall be replaced by a qualified surveyor only and the Contractor will be liable for the cost involved, which cost the Contractor shall not recover from the Employer.

5.17.8 Cable Sleeves

Where cables cross under roads, other services areas, etc., cables shall be installed in PVC, or earthenware pipes as cable sleeves. Pitch fibre pipes are not acceptable because of adhesion that occurs after a period of time between the pipe and the sheathing or outer serving of the cables.

Cable sleeves for road crossings will be supplied and installed by the principal contractor. The Contractor shall supply and install all other cable sleeves required for the Contract Works.

Sleeves shall be joined in accordance with the manufacturer's specification to ensure a smooth inner surface along the full length of the sleeves. Sleeves shall cross roadways and railway tracks at right angles. All sleeves shall be graded 1:400 for water drainage.

Sleeves shall have a minimum diameter of 110mm for LV cables and 160mm for MV cables. They shall extend at least 1m beyond the outer road/kerb edge on both sides of the road.

Cable sleeves shall be installed to the spacings and depths required for the cables as specified for trenching above, or as follows:

a. Under roads:

All cable sleeves : 1200mm (Minimum 1000mm covering)

b. Other locations:

MV cable sleeves : 1000mm (Minimum 800mm covering)

LV cable sleeves : 800mm (Minimum 600mm covering)

Prior to the installation of cable sleeves and pipes, the ends thereof shall be sealed to prevent the insides from being soiled during the installation process. PVC or other suitable wrapping shall be wrapped around the ends and secured by means of galvanized steel binding wire.

The wrapping shall only be removed when the cables are being installed. During the installation of cables, care shall be taken to prevent soil from being dragged into the sleeves and pipes by the cables. Upon completion of the installation of the cables, the ends of all sleeves and pipes shall be sealed with a non-hardening watertight compound. Sleeves and pipes intended for future use, shall retain the wrapping around the ends, or alternatively, be sealed with the same non-hardening watertight compound.

All sleeves intended for future use, shall be provided with 2mm diameter non-corrosive draw-wires which shall extend at least 1m on both ends of the sleeves. The excess lengths in the draw-wires shall be coiled and buried at the sleeve ends.

5.18 TESTING AND COMMISSIONING DOCUMENTATION

On completion of the testing and commissioning, a set of documents shall be compiled and presented to the Engineer. This set shall include:

1. Drawings marked up "as built". (If on CAD, a memory stick must be issued)
2. Completed set of workshop drawings.
3. Completed set of test and commissioning sheets.
4. Set of schematic wiring and function diagrams.
5. File of distribution board legends.

Operating and maintenance instructions on all electrical equipment.

5.19 COMPLETION OF INSTALLATION

Before the commencement of any tests or commissioning procedures, the Contractor is to ensure that all nuts and bolts are securely fastened, and that paintwork on all items supplied has been touched up where damaged has occurred.

After successful completion of all the required tests, the Contractor shall issue the necessary certificates and submit same to the Engineer. In the case of the certificate of compliance by installation electricians which shall be issued in terms of the Act on Occupational Health and Safety, the original of the certificate shall be submitted to the local Supply Authority and a copy to the Engineer.

5.20 INSPECTION AND TESTING

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 must be carried out:

5.20.1 LV Installation

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

a. Note:

i. All instrumentation necessary for testing shall be provided by the Electrical Sub-Contractor.
ii. The results of the above tests must be clearly recorded, signed and handed to the Engineer.
iii. 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.
iv. On completion of the Contract, the Electrical Sub-Contractor shall provide the Engineer with a completed and signed Certificate of Compliance for Electrical Installations as required by the Occupational Health and Safety Act as amended.
v. 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.**

5.21 COMMISSIONING

The Contractor shall commission the Contract Works upon approval thereof by both the Engineer and the Local Authority, after which the Taking Over of the Contract Works takes place.

Where necessary, the Contractor shall supply a generator for testing and commissioning of the Contract Works.

5.22 CERTIFICATES

The Contractor shall hand over the original copies of the required test certificates to the Engineer on completion of the project:

a) Test certificates with the results of DC pressure tests, as performed by the Contractor.
b) Test certificates for outdoor switchgear, as issued by the manufacturer (as required by the Local Supply Authority) to prove the integrity of the switchgear.

c) Certificates, as issued by the manufacturer, for the CT and VT ratio's and tests done on these.

d) Test certificates for the measurements of earth resistance for each substation earthing system.

6. BILL OF QUANTITIES

6.1 PREAMBLE

1. The conditions of contract and the application of the Contract Price Adjustment Provisions (if applicable) shall be as set out in Main Contract: Preliminaries.
2. The descriptions in these bills of quantities shall be read in conjunction with the specification.
3. 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.
4. 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.
5. The rates shall exclude Value-Added Tax and the total carried over to the final summary.
6. All material covered by this **Specification** shall, wherever possible, be of South African manufacture.

7. ELECTRICAL WORK MATERIAL SCHEDULE

The Contractor shall complete the following schedules and submit them to the Representative/Agent within 21 days of the date of the acceptance of the tender.

The schedules will be scrutinised by the Representative/Agent and should any material offered not comply with the requirements contained in the specification, the Contractor will be required to supply material in accordance with the contract at no additional cost.

NB: **Only one manufacturer's name to be inserted for each item.**

Item	Material	Make or trade name	Country of origin
1.	Distribution boards		
2.	Circuit breakers 1P, 2P, 3P		
3.	On load isolators without trips		
4.	Contactors 1P, 2P, 3P		
5.	Earth leakage relays 1 & 3 phase		
6.	H.R.C. fuse switches		
7.	Kilowatt hour meter		
8.	Current transformers		
9.	Voltmeter		
10.	Maximum demand ammeter		
11.	Daylight sensitive switch		
12.	Time switch		
13.	Conduit		
14.	Conduit boxes		
15.	Power skirting		
16.	Surface switches		
17.	Watertight switches		
18.	16A flush socket outlets		
19.	16A surface socket outlets		
20.	16A watertight socket outlets		
21.	Linear LED luminaires		
	Type A		
	A1/E		

Item	Material	Make or trade name	Country of origin
	Type A2		
	Type A2/E		
22.	Bulkhead fittings		
	C1		
23.	Downlights:		
	B1		
	B1/E		
24	Floodlight		
	G1		
25.	Clocks		
26.	PVC SWA PVC ECC cable		
27.	Cable trays		
28	Cable ladders		

8. PARTICULARS OF ELECTRICAL CONTRACTOR

(To be completed by tenderers and submitted together with the tender form).

TENDER NO: _____ REFERENCE: _____
_____

SERVICE: _____

NAME OF ELECTRICAL CONTRACTOR: _____

ADDRESS _____

_____

ELECTRICAL CONTRACTOR'S REGISTRATION NUMBER AT THE ELECTRICAL CONTRACTING BOARD OF S.A.:

_____

_____ _____

DATE SIGNATURE OF TENDERER

9. DRAWINGS

9.1 SCHEDULE OF DRAWINGS

This document shall be read in conjunction with the attached drawings.

DRAWING NUMBER	DRAWING DESCRIPTION
EE-1100: 1 OF 3	Distribution Boards Single Line Diagram
EE-1100: 2 OF 3	Distribution Boards Single Line Diagram
EE-1100: 3 OF 3	Distribution Boards Single Line Diagram

The tenderer shall further submit with his tender the following;

- Completed projects; The tenderer shall submit contactable references, year the project was completed, total UPS project value in rands,
- Current projects; The tenderer shall submit contactable references, total UPS project value in rands

10. UPS DATA SHEET

150KVA UNINTERRUPTIBLE POWER SUPPLY
SCHEDULES OF TECHNICAL INFORMATION

Schedules of information to be completed by the tenderer

Tenderers shall fill in under Column Not completed for all items unless N/A has been inserted by the Engineer.

SYSTEM PARAMETERS

1.	Net output power of inverter system	kVA
2.	Power factor for which the system is rated	Lagging
3.	Nominal input voltage	Volts
4.	Maximum input voltage tolerated	Volts
5.	Minimum input voltage tolerated	Volts
6.	Maximum input frequency deviation tolerated	Hz
7.	Maximum and minimum input power factor at rated KVA	kVA
8	Maximum harmonic input tolerated for successful operation	%
9	Nominal output voltage	Volts
10	Steady state output voltage regulation	Volts
11	Dynamic output voltage regulation:	
(a)	Step load of 25% between 10% and 100% of full load	%
(b)	150% overload for 1 sec	%
(c)	Input voltage step variation of ± 15%	%
12	Time for voltage recovery to steady state:	
(a)	25% step load	ms
(b)	100% step load	ms
(c)	150% step load for 1 sec and then returned to 100%	ms
13.	Relative output phase angles at 100% unbalanced load (in degrees)	Degrees
14.	Maximum harmonic content of output voltage	%

15.	Overload capacity		
(a)	One hour		%
(b)	One minute		%
(c)	Ten seconds		%
(d)	One second		%
(e)	Five msec		%
(f)	One msec		%
16.	Total input required with batteries charged for rated full load		KVA
17.	Total input required at full load and and battery discharged		KVA
18.	Allowable temperature rise across equipment at input air temperature of:		
(a)	25 °C		°C
(b)	30 °C		°C
(c)	32 °C		°C
(d)	35 °C		°C
(e)	40 °C		°C
19.	Heat dissipation under normal full load Running conditions:		
(a)	Converter		KW
(b)	Battery		KW
20.	Efficiency of the complete UPS system	**1,0p.f.**	**0.8p.f**
(a)	Full load	%	%
(b)	80% load	%	%
(c)	75% load	%	%
(d)	65% load	%	%
(e)	50% load	%	%
(f)	40% load	%	%
21.	R.M.S. value of the A.C. **current** component through the batteries for:		
(a)	Discharged battery		Amp
(b)	Charged battery		Amp

22.	R.M.S. value of the A.C. **voltage** component through the batteries for:	
(a)	Discharged battery	Volts
(b)	Charged battery	Volts
23.	Total number of cubicles	
24.	Total floor space required	m^2
25.	Dimensions of cubicle in mm	W

10.1 BATTERY CHARGER

1.	Type	
2.	Output voltage for trickle charge	Volts
3.	Steady state regulation of output voltage trickle to full load	± %
4.	Output voltage for input voltage fluctuation	
(a)	± 10%	%
(b)	± 15%	%
5.	Ripple content (%)	%
6.	Current limit value	Amp
7.	Input voltage at which battery charger switches off	
(a)	Maximum	Volts
(b)	Minimum	Volts
8.	Maximum switch on inrush current	Ampere
9.	Battery charger overload protection (type)	
10.	Efficiency	%
11.	How is the effect of harmonics on input voltage minimised?	

10.2 OSCILLATOR

1.	Type of oscillator (RC, crystal, etc.)	
2.	Stability:	
(a)	With oscillator supply fluctuation	± %
(b)	Temperature variation	± °C
(c)	Number of power supplies in parallel redundancy	
3.	Number of batteries from which oscillator is fed	
4.	Minimum time synchronise to mains frequency	sec

10.3 INVERTER

1.	Maximum continuous power output (kVA)	KVA
2.	Nominal output voltage	Volts
3.	Maximum harmonic content	%
4.	Nominal input voltage:	
(a)	Maximum	Volts
(b)	Nominal	Volts
(c)	Minimum	Volts
5.	Input current at full load	Ampere
6.	Input power factor at full load	Lagging
7.	Efficiency at full load	%
8.	Overload protection	

10.4 STATIC SWITCH

	Does switch comply to clause 3.2.2.12	
1.	Describe electronic switch	
2.	Minimum power factor at which switches will operate satisfactorily	
3.	How does switch derive operating signal ?	
4.	Maximum break time for switchover	ms

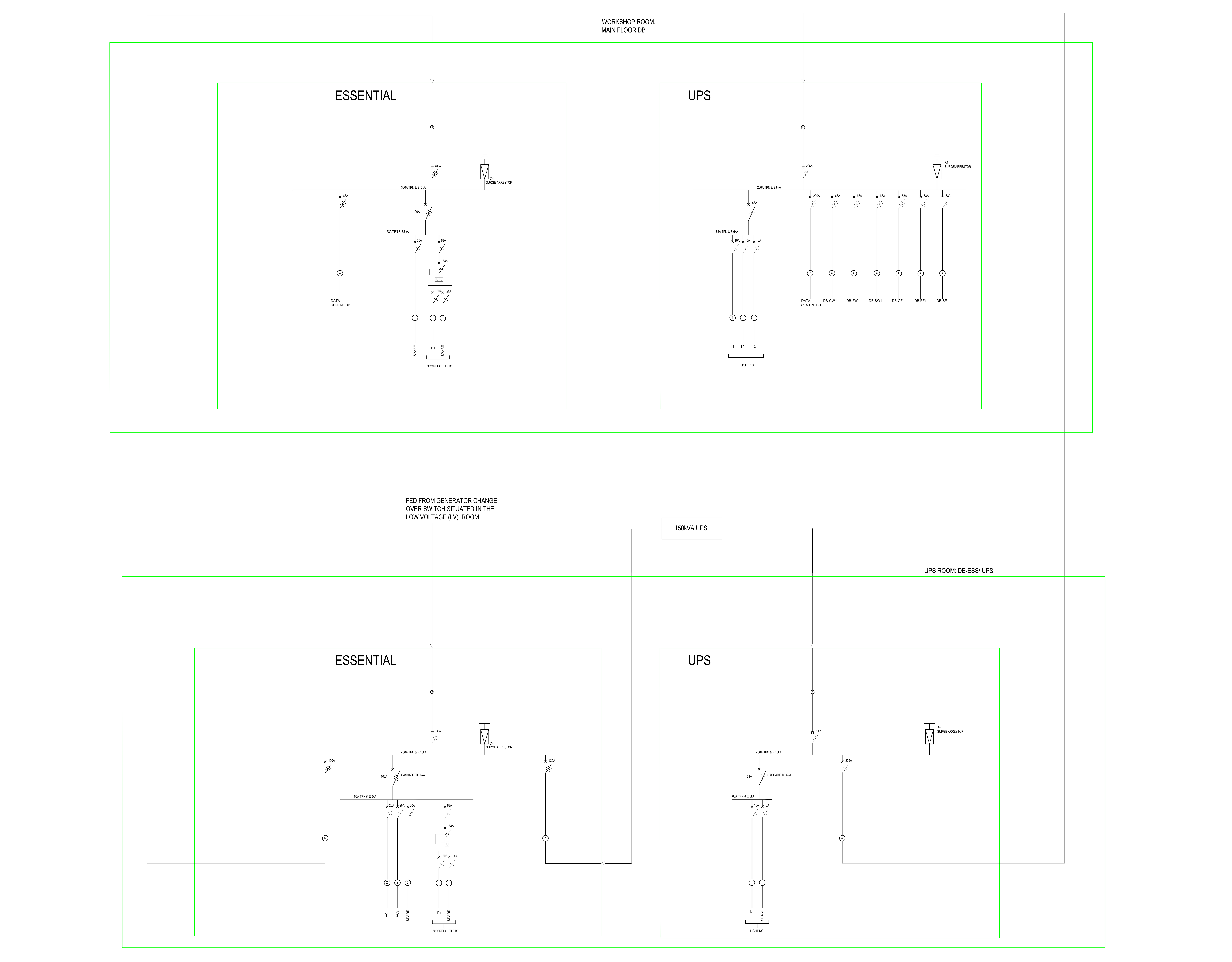
10.5 BATTERIES

1.	Manufacturer	
2.	Country of origin	
3.	Type	
4.	Type No	
5.	Total number of cells	
6.	Number of cells per inverter	
7.	Battery voltage (float conditions)	Volts
8.	Battery voltage (Boost charge)	Volts
9.	Capacity (rated for time required)	Ah at
10.	Battery time offered under load conditions. Minimum time of 120 minutes is required.	Minutes
11.	Maximum output current	Ampere
12.	Cell voltage under float conditions	Volts
13.	Cell conditions under boost conditions	Volts
14.	Cell voltage at start of discharge and full inverter load	Volts
15.	Cell voltage at end of discharge period	Volts
16.	Expected lifetime of batteries	Years
17.	Time to charge to 90% capacity	Hrs
18.	Total time to charge to 100% capacity	Hrs
19.	Material of supporting framework	
20.	Finish of framework	
21.	Dimensions of each cell	W
22.	Design of positive plate of cell	
23.	Rating of fused isolator	Ampere
24.	Cell configuration	

NOTE : ALL BATTERY CALCULATIONS INCLUDING CURVES SHALL BE INCLUDED IN THE TENDER

10.6 DETAILS OF MANUFACTURE OF UPS

1.	Manufacturer	
2.	Address	
3.	Country of origin	
4.	Make or trade name of equipment	
5.	Manufacture's type no.	
6.	Is tenderer an accredited agent ?	YES/NO
7.	Furnish details of maintenance and repair service facilities which can be rendered.	



LEGEND
SYMBOLS
TRIPLE POLE CIRCUIT BREAKER
CABLE GLAND
4 NO SURGE ARRESTORS DEHNVENTIL TYPE TT
EARTH
TRIPLE POLE ISOLATOR
SINGLE POLE CIRCUIT BREAKER
THREE PHASE, NEUTRAL & EARTH BUSBARS
ELR — RELAY WITHOUT OVERLOAD TRIP. 60A RATING, 30mA SENSITIVITY
RELAY (OPERATING COIL)
TRIPLE POLE CONTACTOR
SINGLE POLE ISOLATOR
TRIPLE POLE CONTACTOR
n — CONNECTION TO NEUTRAL
SINGLE POLE CONTACTOR
BULK METER AS PER CITY SPECIFICATION
PPM — SPLIT PREPAID METER AS SPECIFIED IN THE TENDER DOCUMENT
M — METER AS PER CITY SPECIFICATION

LEGEND	
CABLE SCHEDULE	
1	2x2.5mm² PVC + 2.5mm² BCEW
2	2x4mm² PVC + 4mm² BCEW
3	10mm² 4C PVC/SWA/PVC ECC
4	6mm² x 2C ECC PVC/SWA/PVC
5	185mm² x 4C ECC PVC/SWA/PVC
6	95mm² x 4C ECC PVC/SWA/PVC
7	70mm² x 4C ECC PVC/SWA/PVC
8	50mm² x 4C ECC PVC/SWA/PVC

owner's signature ____________

engineer's signature ____________
engineer's no. ____________

client's signature ____________
client's no. ____________

REV NO	DESCRIPTION	DATE	BY
A	ISSUED FOR TENDER	17/09/2021	S.M
B	FLOOR ESSENTIAL DB'S REMOVED	27/05/2023	S.M

CLIENT

ARMSCOR

PROJECT NAME

ARMSCOR STANDBY GENERATOR AND UPS SYSTEM

PROJECT MANAGERS

MED-TECH ENGINEERS

ELECTRICAL ENGINEERS

MED-TECH ENGINEERS

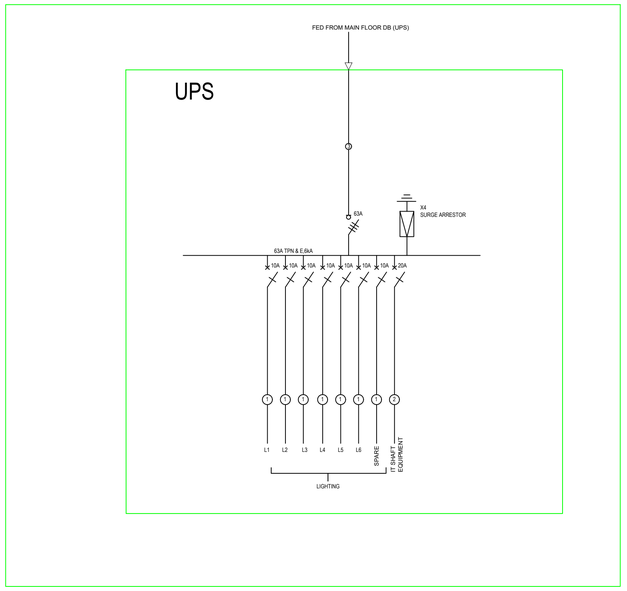
DRAWING DESCRIPTION

DISTRIBUTION BOARDS: SINGLE LINE DIAGRAMS
1 of 3

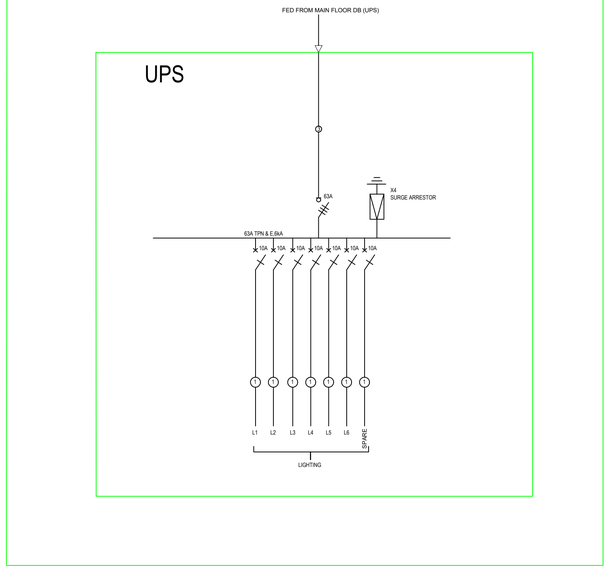
designed	drawn	checked	passed	date	scale
S.M	S.M	K.L	G.M	28/05/2021	N.T.S

Paper Size.	REVISION No.
A1	B
PROJECT No.	DRAWING No.
PEC-255	EE-1100

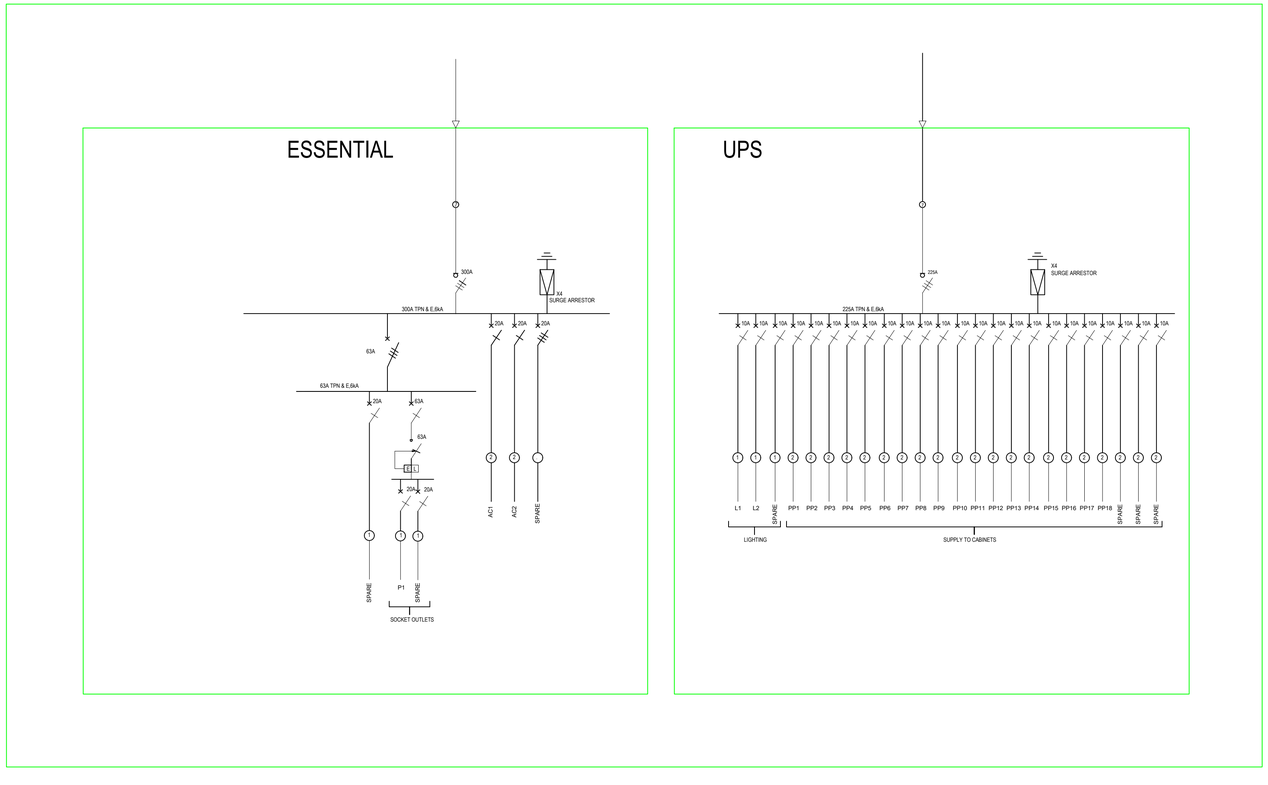
DB-GE1



DB-GW1



DATA CENTRE ROOM:
DATA CENTRE DB



LEGEND

SYMBOLS	
	TRIPLE POLE CIRCUIT BREAKER
	CABLE GLAND
	4 NO SURGE ARRESTORS DEHN/VENTIL TYPE TT
	EARTH
	TRIPLE POLE ISOLATOR
	SINGLE POLE CIRCUIT BREAKER
	THREE PHASE, NEUTRAL & EARTH BUSBARS
ELR	RELAY WITHOUT OVERLOAD TRIP. 63A RATING, 30mA SENSITIVITY
	RELAY (OPERATING COIL)
	TRIPLE POLE CONTACTOR
	SINGLE POLE ISOLATOR
	TRIPLE POLE CONTACTOR
n	CONNECTION TO NEUTRAL
	SINGLE POLE CONTACTOR
M	BULK METER AS PER CITY SPECIFICATION
PPM	SPLIT PREPAID METER AS SPECIFIED IN THE TENDER DOCUMENT
M	METER AS PER CITY SPECIFICATION

LEGEND

CABLE SCHEDULE	
1	2x2.5mm² PVC + 2.5mm² BCEW
2	2x4mm² PVC + 4mm² BCEW
3	10mm² 4C PVC/SWA/PVC ECC
4	6mm² x 2C ECC PVC/SWA/PVC
5	185mm² x 4C ECC PVC/SWA/PVC
6	95mm² x 4C ECC PVC/SWA/PVC
7	70mm² x 4C ECC PVC/SWA/PVC
8	50mm² x 4C ECC PVC/SWA/PVC

owner's signature _____

engineer's signature _____

engineer's no. _____

client's signature _____

client's no. _____

REV NO	DESCRIPTION	DATE	BY
A	ISSUED FOR TENDER	17/09/2021	S.M
B	FLOOR ESSENTIAL DB'S REMOVED	27/05/2023	S.M

CLIENT

ARMSCOR

PROJECT NAME

ARMSCOR STANDBY GENERATOR AND UPS SYSTEM

PROJECT MANAGERS

MED-TECH ENGINEERS
1301 De Villebois Mareuil Drive,
Moreleta Park,
Pretoria, 0181

ELECTRICAL ENGINEERS

MED-TECH ENGINEERS
1301 De Villebois Mareuil Drive,
Moreleta Park,
Pretoria, 0181

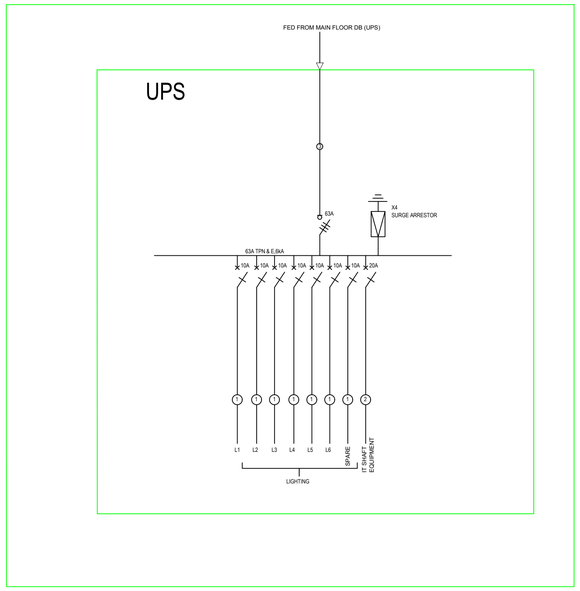
DRAWING DESCRIPTION

DISTRIBUTION BOARDS:
SINGLE LINE DIAGRAMS
2 of 3

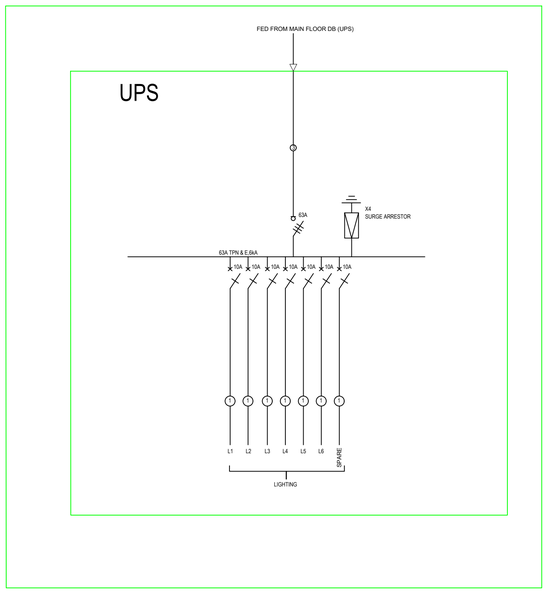
designed	drawn	checked	passed	date	scale
S.M	S.M	K.L	G.M	28/05/2021	N.T.S

Paper Size.	REVISION No.
A1	B
PROJECT No.	DRAWING No.
PEC-255	EE-1100

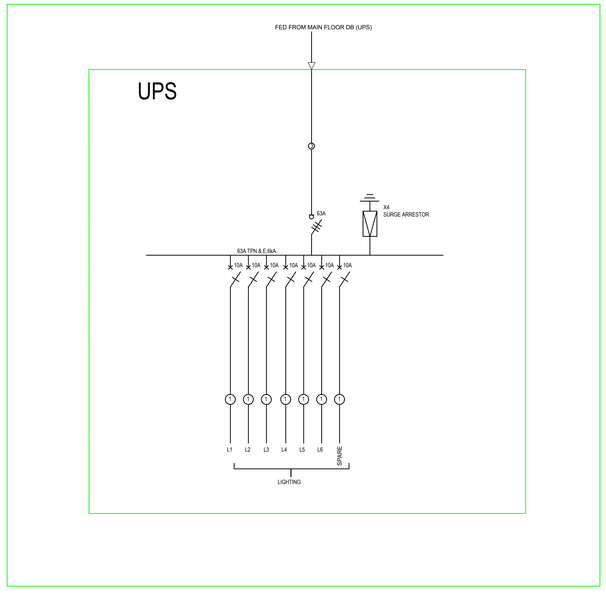
DB-SE1



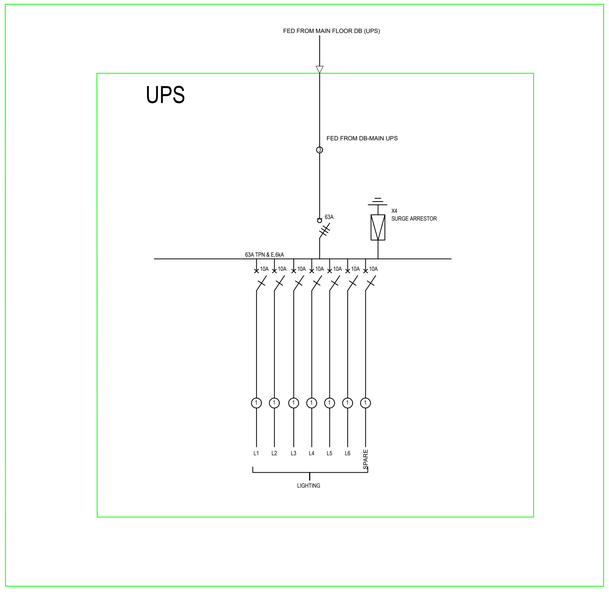
DB-SW1



DB-FE1



DB-FW1



LEGEND

SYMBOLS	
	TRIPLE POLE CIRCUIT BREAKER
	CABLE GLAND
	4 NO SURGE ARRESTORS DEHN/SVNTL TYPE TT
	EARTH
	TRIPLE POLE ISOLATOR
	SINGLE POLE CIRCUIT BREAKER
	THREE PHASE, NEUTRAL & EARTH BUSBARS
ELR	RELAY WITHOUT OVERLOAD TRIP. 63A RATING, 30mA SENSITIVITY
	RELAY (OPERATING COIL)
	TRIPLE POLE CONTACTOR
	SINGLE POLE ISOLATOR
	TRIPLE POLE CONTACTOR
n	CONNECTION TO NEUTRAL
	SINGLE POLE CONTACTOR
M	BULK METER AS PER CITY SPECIFICATION
	SPLIT PREPAID METER AS PER DETAIL IN THE TENDER DOCUMENT
M	METER AS PER CITY SPECIFICATION

LEGEND

CABLE SCHEDULE	
1	2x2.5mm² PVC + 2.5mm² BCEW
2	2x4mm² PVC + 4mm² BCEW
3	10mm² 4C PVC/SWA/PVC ECC
4	6mm² x 2C ECC PVC/SWA/PVC
5	185mm² x 4C ECC PVC/SWA/PVC
6	95mm² x 4C ECC PVC/SWA/PVC
7	70mm² x 4C ECC PVC/SWA/PVC
8	50mm² x 4C ECC PVC/SWA/PVC

owner's signature _____

engineer's signature _____

engineer's no. _____

client's signature _____

client's no. _____

REV NO	DESCRIPTION	DATE	BY
A	ISSUED FOR TENDER	17/09/2021	S.M
B	FLOOR ESSENTIAL DB'S REMOVED	27/05/2023	S.M

CLIENT

ARMSCOR

PROJECT NAME

ARMSCOR STANDBY GENERATOR AND UPS SYSTEM

PROJECT MANAGERS

MED-TECH ENGINEERS

1301 De Villebois Mareuil Drive,
Wierda Park,
Pretoria, 0181

ELECTRICAL ENGINEERS

MED-TECH ENGINEERS

1301 De Villebois Mareuil Drive,
Wierda Park,
Pretoria, 0181

DRAWING DESCRIPTION

DISTRIBUTION BOARDS:
SINGLE LINE DIAGRAMS
3 of 3

designed	drawn	checked	passed	date	scale
S.M	S.M	K.L	G.M	28/05/2021	N.T.S

Paper Size.	REVISION No.
A1	B
PROJECT No.	DRAWING No.
PEC-255	EE-1100

RFB Nr: R&D/IMT-2023/024 ANNEXURE B

Critical Criteria (page 1 of 3)

NOTE: Failure by a Bidder to comply with any of these critical criteria requirements will result in immediate elimination from the evaluation process. The onus is thus on the Bidder to submit clear proof of compliance for each and every critical criterion with the Bid/Proposal.

1.) The Prospective Bidder shall be required to attend a compulsory Bidders' Briefing where the Prospective Bidders will be exposed to the IMT facility; failure to do so shall result in automatic disqualification.

Proof of Compliance 1: The Bidder shall sign an IMT attendance register which shall be used for the evaluation of compliance with the critical criteria.

2.) The Bidder shall have a Construction Industry Development Board (CIDB) contractor grading designation of at least 5EB.

Proof of compliance 2: The bidder shall submit a CIDB registration or certificate or proof of application clearly indicating minimum Grading of 5EB or better. If the bidding entity is through a Joint Venture, the evidence shall be evaluated considering note 1 below with the completed RFB document as part of their offering; failure to do so shall result in automatic disqualification.

Note 1: Joint Ventures are eligible to submit bids subject to the following:

a) Every bidder of the Joint Venture shall be registered with the CIDB;

b) The lead partner shall have a contractor grading designation of not lower than the one level below the required grading designation in the class of construction works under consideration and possesses the required recognition status; and

c) The combined bidder(s) grading designation calculated in accordance with the CIDB regulations is equal to or higher than the bidder(s) grading designation determined in accordance with the sum tendered for **5EB or higher class** of construction work or value determined in accordance with Regulation 25(1B) or 25(7A) of the CIDB regulations.

d) The bidder shall provide a certificated copy of its signed Joint Venture agreement;

e) And in the event of the Joint Venture is an “Incorporated Joint Venture” the memorandum of Incorporation shall be provided within 14 (fourteen) days of the contract date.

3.) The bidder shall be in good standing with the Compensation Commissioner in terms of the Compensation of Occupational Injuries and Disability Act (COIDA), which shall be valid and in date by the closing date of this RFB and for the duration of the contract.

Proof of Compliance 3: The bidder shall submit a valid COIDA certificate issued by the Department of Employment and Labour or any other organization appointed by the Department of Employment and Labour and submit it with the completed RFB document as part of their offering; failure to do so shall result in automatic disqualification.

4.) The bidder shall have successfully completed at least 1 UPS project.

Proof of Compliance 4: The bidder shall submit at least one client reference letter where the supply, installation and commissioning of a UPS was completed. The reference letter must be on the client’s letterhead (not the bidder’s) and signed by a duly authorized person of the client and submit it with the completed RFB document as part of their offering; failure to do so shall result in automatic disqualification.

The letter must entail the following details:
Name of the client
Name of the bidder
Project Description
Contact details

OR

A signed completion certificate issued by the principal agent / client where the replacement of UPS project was completed.

Note: Should the completion certificate not indicate the replacement of UPS, then additional supporting documents confirming installation of UPS, issued by the Client or Principal Agent or Main Contractor shall be submitted

5.) The bidder shall provide a UPS that fully comply with the specification as per the UPS technical specification in section 10 of Annexure A.

Proof of Compliance 5: The bidder shall supply the completed Section 10 of Annexure A and a manufacturer product data sheet/ handbook/ catalogue for the UPS type and submit it with the completed RFB document as part of their offering; failure to do so shall result in automatic disqualification.

6.) The bidder shall quote ALL item numbers (1 to 9) in Electrical Bill of Quantities in Annexure C of the RFB document.

Proof of Compliance 6: The bidder shall submit a fully completed Bill of Quantities and submit it with the completed RFB document as part of their tender offering; failure to do so shall result in automatic disqualification.

RFB NR: R&D/IMT-2023/024 ANNEXURE C-ARMSCOR IMT BUILDING UPS: ELECTRICAL BOQ
ELECTRICAL INSTALLATION
SECTION 1: PRELIMINARY AND GENERAL

Item	Description	Unit	QTY	Rate	Amount (R)
1	**Preliminary and General Items**				
1.1	COMPLIANCE WITH CONTRACT				
	Allow for costs directly associated with expenses to comply with the Conditions of Contract and the Main Contract Preliminaries.				
1.1.1	Fixed cost component	Sum	1		
1.1.2	Component variable with time for completion (monthly)	Sum	5		
1.2	SITE ESTABLISHMENT				
1.2.1	Fixed cost component	Sum	1		
1.2.2	Component variable with time for completion (monthly)	Sum	5		
1.3	CONTRACT ADMINISTRATION				
1.3.1	Fixed cost component	Sum	1		
1.3.2	Component variable with time for completion (monthly)	Sum	5		
1.4	PROVISION OF 10% PERFORMANCE GUARANTEE				
1.4.1	Fixed cost component	Sum	1		
1.4.2	Component variable with time for completion (monthly)	Sum	5		
1.5	INSURANCE				
1.5.1	Fixed cost component	Sum	1		
1.5.2	Component variable with time for completion (monthly)	Sum	5		
1.6	COMPLIANCE WITH OCCUPATIONAL HEALTH AND SAFETY ACT (1993) AND THE CONSTRUCTION REGULATIONS (2014)				
1.6.1	Fixed cost component	Sum	1		
1.6.2	Component variable with time for completion (monthly)	Sum	5		
1.7	COMPLIANCE WITH THE ENVIRONMENTAL MANAGEMENT PLAN				
1.7.1	Fixed cost component	Sum	1		
1.7.2	Component variable with time for completion (monthly)	Sum	5		
1.8	PROVISION OF DEFECTS LIABILITY GUARANTEE TO THE VALUE OF 5% OF THE CONTRACT VALUE				
1.8.1	Fixed cost component	Sum	1		
1.8.2	Component variable with time for completion (monthly)	Sum	5		
Total carried forward to the next page					

SECTION 1: PRELIMINARY AND GENERAL

ITEM	Description	UNIT	QTY		
	Total carried from to the previous page				
1.9	SECURITY TO SITE FOR THE DURATION OF THE PROJECT				
1.9.1	Fixed cost component	Sum	1		
1.9.2	Component variable with time for completion (monthly)	Sum	5		
1.10	DETAILS OF ANY OTHER ITEMS THECONTRACTOR MAY WISH TO ADD:				
1.10.1					
1.10.2					
1.10.3					
1.11	General Items				
1.11.1	Allow for an infrared (IR) photographic scanning of the Main Floor DB and Data Centre DB including submission of a complete report to the electrical engineer by an independent specialist	Sum	1		
1.11.2	Testing and commissioning of the electrical installation.	Sum	1		
1.11.3	Issue certificate of compliance on the installation of the UPS including the entire electrical installation forming part of the scope of work.	Sum	1		
1.11.4	Issue certificates of compliance for all the exisiting DBs after remedial work is done on them and such work is witnessed by the engineer.		1		
1.11.5	Inspection and handing over	Sum	1		
1.11.6	Mark up As Built drawings and submit them to the engineer for As Built purposes	Sum	1		
TOTAL CARRIED FORWARD TO SUMMARY					

RFB NR: R&D/IMT-2023/024 ANNEXURE C-ARMSCOR IMT BUILDING UPS: ELECTRICAL BOQ
ELECTRICAL INSTALLATION
SECTION 2: UNINTERRUPTIBLE POWER SUPPLY (UPS)

Item	Description	Unit	QTY	Rate	Amount (R)
2	**UPS**				
	Manufacture, supply, off loading, installation and commissioning of a 150kVA UPS as described in the specification. The UPS shall be a 3 phase in, three phase out, double-conversion online UPS.				
	Include the following in the UPS price: SNMP card Rigging of the UPS				
2.1	150kVA three phase in , three phase out, double-conversion online UPS				
2.1.1	Supply	No	1		
2.1.2	Install	No	1		
2.2	Manufacture, supply, off loading, installation and commissioning of battery sets installed on stands including DC links. The battery sets to be sized suitably to provide 2 hour backup time at 120kW load. Batteries shall be sealed maintenance free type of batteries, lithium batteries.				
	Include the following in the battery sets price: Battery charger DC junction box for DC isolation during maintenance. Rigging of the batteries				
2.2.1	Supply	No	1		
2.2.2	Install	No	1		
2.3	General				
2.3.1	Testing and commisioning of the UPS.	sum	1		
2.3.2	Issue installation certificate of compliance	sum	1		
2.3.3	Provide training to staff. About four people	sum	1		
2.3.4	Compile and submit to the engineer the UPS operations and maintenance manuals.	sum	1		
2.3.5	Issue UPS maintenance logbook	sum	1		
Total Carried Forward To Summary Page					

RFB NR: R&D/IMT-2023/024 ANNEXURE C-ARMSCOR IMT BUILDING UPS: ELECTRICAL BOQ
ELECTRICAL INSTALLATION
SECTION 3: UPS AND AIR-CONDITIONING UNIT ONE YEAR FREE MAINTENANCE

Item	Description	Unit	QTY	Rate	Amount (R)
3	**UPS AND AIR-CONDITIONING UNIT ONE YEAR FREE MAINTENANCE**				
	The installer of the UPS and air-conditioning unit shall be required to enter into a one year maintenance agreement with the client. The tenderer is thus required to price for a one year maintenance of the UPS and air-conditioning unit.				
3.1	UPS and Batteries				
3.1.1	Provide bi-annual one year free maintenance for the UPS and batteries. One year free maintenance to run concurrently with the warrantee period.	no	2		
3.2	Air-conditioning unit				
3.2.1	Provide bi-annual one year free maintenance for the air-conditioning unit. One year free maintenance to run concurrently with the warrantee period.	no	2		
Total Carried Forward To Summary Page					

RFB NR: R&D/IMT-2023/024 ANNEXURE C-ARMSCOR IMT BUILDING UPS: ELECTRICAL BOQ
ELECTRICAL INSTALLATION
SECTION 4: LOW VOLTAGE DISTRIBUTION

Item	Description	Unit	QTY	Rate	Amount (R)
4	**SECTION 4: LOW VOLTAGE DISTRIBUTION**				
	CABLES				
4.1	**Supply, deliver and install the specified Low Voltage Cable as per LV feeds required from the transformer, substation and DB's:**				
	Cable from the distribution board supplied from a newly installed generator to the UPS Room DB Essential Section situated in the new UPS room: 120mm² x 4-core ECC PVC SWA PVC				
4.1.1	Supply	m	105		
4.1.2	Install	m	105		
	Cable from UPS Room DB Essentail to Main Floor DB Essential: 16mm² x 4-core ECC PVC SWA PVC				
4.1.3	Supply	m	65		
4.1.4	Install	m	65		
	Cable from UPS Room DB UPS Section to Main Floor DB UPS Section: 95mm² x 4-core ECC PVC SWA PVC				
4.1.5	Supply	m	65		
4.1.6	Install	m	65		
	Cable from Main Floor DB Essenstial Section to Data Centre Essential Section: 10mm² x 4-core ECC PVC SWA PVC				
4.1.7	Supply	m	30		
4.1.8	Install	m	30		
	Cable from Main Floor DB UPS Section to Data Centre UPS Section: 70mm² x 4-core ECC PVC SWA PVC				
4.1.9	Supply	m	30		
4.1.10	Install	m	30		
	Cable from Main Floor DB UPS Section to SDB: GWE UPS Section: 10mm² x 4-core ECC PVC SWA PVC				
4.1.11	Supply	m	50		
4.1.12	Install	m	50		
	Cable from Main Floor DB UPS Section to SDB: GEE UPS Section: 10mm² x 4-core ECC PVC SWA PVC				
4.1.13	Supply	m	80		
4.1.14	Install	m	80		
	Cable from Main Floor DB UPS Section to SDB: FEE UPS Section: 10mm² x 4-core ECC PVC SWA PVC				
4.1.15	Supply	m	78		
4.1.16	Install	m	78		
Total carried forward to the next page					

SECTION 4: LOW VOLTAGE RETICULATION					
Item	**Description**	**Unit**	**QTY**	**Rate**	**Amount (R)**
	Total carried from to the previous page				
	Cable from Main Floor DB UPS Section to SDB: FEE UPS Section: 10mm² x 4-core ECC PVC SWA PVC				
4.1.17	Supply	m	78		
4.1.18	Install	m	78		
	Cable from Main Floor DB UPS Section to SDB: FWE UPS Section: 10mm² x 4-core ECC PVC SWA PVC				
4.1.19	Supply	m	74		
4.1.20	Install	m	74		
	Cable from Main Floor DB UPS Section to SDB: SWE UPS Section: 10mm² x 4-core ECC PVC SWA PVC				
4.1.21	Supply	m	63		
4.1.22	Install	m	63		
	Cable from Main Floor DB UPS Section to SDB: SWE UPS Section: 10mm² x 4-core ECC PVC SWA PVC				
4.1.23	Supply	m	88		
4.1.24	Install	m	88		
4.2	**Termination of 600/1000V PVC grade copper**				
	cable connection MCCB's with crimped lugs				
	120mm² x 4-core ECC PVC SWA PVC				
4.2.1	Supply	no	4		
4.2.2	Install	no	4		
	95mm² x 4-core ECC PVC SWA PVC				
4.2.3	Supply	no	4		
4.2.4	Install	no	4		
	70mm² x 4-core ECC PVC SWA PVC				
4.2.5	Supply	no	4		
4.2.6	Install	no	4		
	16mm² x 4-core ECC PVC SWA PVC				
4.2.7	Supply	no	2		
4.2.8	Install	no	2		
Total carried forward to the next page					

SECTION 4: LOW VOLTAGE RETICULATION

Item	Description	Unit	QTY	Rate	Amount (R)
	Total carried from to the previous page				
	10mm² x 4-core ECC PVC SWA PVC				
4.2.9	Supply	no	14		
4.2.10	Install	no	14		
	6mm² x 4-core ECC PVC SWA PVC				
4.2.11	Supply	no	14		
4.2.12	Install	no	14		
4.3	**MAIN EARTH CONDUCTORS**				
	Supply, deliver and install all stranded earth copper conductors (both bare and PVC insulated) and lugs and the installation thereof, together with cables on trays, against structures, in sleeves and in wiring channels, including for the fixing and connecting thereof				
	70mm² bare copper				
4.3.1	Supply	m	80		
4.3.2	Install	m	80		
	25mm² bare copper				
4.3.3	Supply	m	10		
4.3.4	Install	m	10		
4.4.	**MAIN EARTH CONDUCTORS TERMINATIONS**				
	70mm² bare copper				
4.4.1	Supply	no	4		
4.4.2	Install	no	4		
	25mm² bare copper				
4.4.3	Supply	no	4		
4.4.4	Install	no	4		
4.5	**SLEEVES, CABLE BASKETS AND DUCTING**				
	The supply and installation of all cable trays installed in ceiling voids complete with support structure, bends, joints, reducing sections, cross pieces, angle pieces and expanding joints, threaded rod braces, channels and straps and accessories				
	sleeves for future use to be sealed at both ends				
	110mm sleeve				
4.5.1	Supply	m	50		
4.5.2	Install	m	50		
	50mm sleeve				
4.5.3	Supply	m	10		
4.5.4	Install	m	10		
	90 degrees slow bend for 110mm dia. Sleeve				
4.5.5	Supply	no	8		
4.5.6	Install	no	8		
Total carried forward to the next page					

SECTION 4: LOW VOLTAGE RETICULATION

Item	Description	Unit	QTY	Rate	Amount (R)
	Total carried from to the previous page				
	90 degrees slow bends for 50mm dia. sleeve				
4.5.7	Supply	no	8		
4.5.8	Install	no	8		
	1.6mm galvanised draw wire drawn into				
	conduit or sleeve				
4.5.9	Supply	m	100		
4.5.10	Install	m	100		
4.6	**Supply and install in ceiling space and on surface galvanised trunking, making allowance for support, bends and all ancillary material required for a complete installation. Galvanised covers to be included in the rate. *NB: The trunking and cover shall be galvanised and powder coated orange.***				
	P9000 trunking				
4.6.1	Supply	m	40		
4.6.2	Install	m	40		
	P9000 end caps				
4.6.3	Supply	no	6		
4.6.4	Install	no	6		
	P8000 trunking				
4.6.5	Supply	m	20		
4.6.6	Install	m	20		
	P8000 end caps				
4.6.7	Supply	no	8		
4.6.8	Install	no	8		
	P2000 trunking				
4.6.9	Supply	m	15		
4.6.10	Install	m	15		
	P2000 end caps				
4.6.11	Supply	no	6		
4.6.12	Install	no	6		
Total carried forward to the next page					

SECTION 4: LOW VOLTAGE RETICULATION					
Item	**Description**	**Unit**	**QTY**	**Rate**	**Amount (R)**
	Total carried from to the previous page				
4.7	**The Supply and installation of all heavy duty cable ladder installed in ceiling voids complete with support structure, bends, joints, reducing sections, cross pieces, angle pieces and expanding joints, threaded rod braces, channels and straps and accessories. Cable ladder to be galvanised and powder coated orange.**				
	Heavy duty 300mm wide cable ladder				
4.7.1	Supply	m	100		
4.7.2	Install	m	100		
4.8	**Supply and install heavy duty cable trays installed in ceiling voids complete with support structure, bends, joints, reducing sections, cross pieces, angle pieces and expanding joints, threaded rod braces, channels and straps and accessories.**				
	Heavy duty 300mm wide cable tray				
4.8.1	Supply	m	50		
4.8.2	Install	m	50		
	Heavy duty 150mm wide cable tray				
4.8.3	Supply	m	140		
4.8.4	Install	m	140		
4.9	**LV MAIN BOARD, MAIN DISTRIBUTION BOARDS AND DISTRIBUTION BOARDS.**				
	Supply and install distribution boards as specified and drawn on schematic diagrams and in positions as indicated on relevant drawngs				
	UPS Room DB: ESS/ UPS - Floor standing				
4.9.1	Supply	no	1		
4.9.2	Install	no	1		
	Main Floor DB: ESS/ UPS - Floor standing				
4.9.3	Supply	no	1		
4.9.4	Install	no	1		
	Data Centre DB: ESS/ UPS - Floor standing				
4.9.5	Supply	no	1		
4.9.6	Install	no	1		
	DB-GE1: UPS - Wall mounted				
4.9.7	Supply	no	1		
4.9.8	Install	no	1		
	DB-GW1: UPS - Wall mounted				
4.9.9	Supply	no	1		
4.9.10	Install	no	1		
	DB-FE1: UPS - Wall mounted				
4.9.11	Supply	no	1		
4.9.12	Install	no	1		
Total carried forward to the next page					

SECTION 4: LOW VOLTAGE RETICULATION

Item	Description	Unit	QTY	Rate	Amount (R)
	Total carried from to the previous page				
	DB-FW1: UPS - Wall mounted				
4.9.13	Supply	no	1		
4.9.14	Install	no	1		
	DB-SE1: UPS - Wall mounted				
4.9.15	Supply	no	1		
4.9.16	Install	no	1		
	DB-SW1: UPS - Wall mounted				
4.9.17	Supply	no	1		
4.9.18	Install	no	1		
4.10	**Supply and install the following switchgear on distribution boards as and when required. Switchgear shall match the existing switchgear in order to maintain the same switchgear make in all DB's.**				
	10A, 240V, 6kA circuit breaker				
4.10.1	Supply	no	2		
4.10.2	Install	no	2		
	20A, 240V, 6kA circuit breaker				
4.10.3	Supply	no	2		
4.10.4	Install	no	2		
	20A, 420V, 6kA circuit breaker				
4.10.5	Supply	no	2		
4.10.6	Install	no	2		
	50A, 420V, 6kA circuit breaker				
4.10.7	Supply	no	2		
4.10.8	Install	no	2		
	400A, 420V, 37kA circuit breaker				
4.10.9	Supply	no	1		
4.10.10	Install	no	1		
4.11	**LV Trenching**				
	Excavation 600mm deep and 400mm wide trench including backfilling and compacting				
4.11.1	In earth	m^3	10		
4.11.2	Soft rock extra over earth	m^3	3		
4.11.3	Hard rock	m^3	2		
	Imported soft sand bedding of 150mm under the cable and above cable (when required by coil conditions)				
4.11.4	Supply	m^3	5		
4.11.5	Install	m^3	5		
Total carried forward to the next page					

SECTION 4: LOW VOLTAGE RETICULATION

Item	Description	Unit	QTY	Rate	Amount (R)
	Total carried from to the previous page				
	LV cable marker tape laid in an open trench 150mm above the cable along the length of the cable				
4.11.6	Supply	m	20		
4.11.7	Install	m	20		
4.12	**Earthing**				
4.12.1	Earthing of all LV equipment or installation as required including LV room earth mat, as specified. Earth mat resistance to be less than one ohm.	sum	1		
4.13	**Penetrations and Builder's Work**				
	Make penetrations through the brick wall for the following sizes"				
4.13.1	160mm diameter penetration or coring	no	1		
4.13.2	110mm diameter penetration or coring	no	3		
4.13.3	50mm diameter penetration or coring	no	5		
4.14	**Make penetrations through the concrete floor slab for the following sizes"**				
4.14.1	160mm diameter penetration or coring	no	1		
4.14.2	110mm diameter penetration or coring	no	4		
4.14.3	50mm diameter penetration or coring	no	7		
4.14.4	Provisional sum for patching up the wall and making good after any breaking of the wall in any manner. This includes cleaning of the existing or old generator room prior to the installation of the UPS	sum	1	60 000.00	60 000.00
TOTAL CARRIED FORWARD TO SUMMARY					

RFB NR: R&D/IMT-2023/024 ANNEXURE C-ARMSCOR IMT BUILDING UPS: ELECTRICAL BOQ
ELECTRICAL INSTALLATION
SECTION 5: GENERAL POWER RETICULATION

Item	Description	Unit	QTY	Rate	Amount (R)
	SECTION 5: GENERAL POWER RETICULATION				
5.1	**CONDUITS**				
	PVC CONDUIT supplied and installed, including couplings, cutting, bending, fixing etc. as per specification in concrete, brickwork and on surface in voids.				
	20mm diameter conduit				
5.1.1	Supply	m	10		
5.1.2	Install	m	10		
	GALVANISED STEEL CONDUIT supplied and installed, including outlet Box, cover plate, couplings, cutting, bending, fixing etc. as per specification in concrete (floor slab), brickwork and on surface in voids.				
	20mm diameter conduit				
5.1.3	Supply	m	500		
5.1.4	Install	m	500		
5.2	**CONDUIT OUTLET BOXES**				
	Galvanised 100 x 100x 50mm conduit outlet box and cover plate to suit any number, size or type of entries, fixed in roofs or in and including recess in brickwork or cast in concrete				
5.2.1	Supply	no	8		
5.2.2	Install	no	8		
	Galvanised 100 x 50x 50mm conduit outlet box and cover plate to suit any number, size or type of entries, fixed in roofs or in and including recess in brickwork or cast in concrete				
5.2.3	Supply	no	6		
5.2.4	Install	no	6		
	Round galvanised conduit box (60 - 65mm) diameter				
5.2.5	Supply	no	20		
5.2.6	Install	no	20		
5.3	**CONDUCTORS**				
	PVC insulated 600/1000 V stranded copper conductors, drawn into conduit, wire ways and/or sleeves :				
	4 mm² conductor				
5.3.1	Supply	m	750		
5.3.2	Install	m	750		
	2.5 mm²				
5.3.3	Supply	m	500		
5.3.4	Install	m	500		
	Bare stranded copper earth conductors, drawn into conduit,				
	2.5 mm²				
5.3.5	Supply	m	500		
5.3.6	Install	m	500		
Total carried forward to the next page					

SECTION 5: GENERAL POWER RETICULATION					
Item	**Description**	**Unit**	**QTY**	**Rate**	**Amount (R)**
	Total carried from to the previous page				
5.4	**SWITCHES, SOCKET OUTLETS AND ACCESSORIES, ETC.**				
	Switched socket outlet complete with cover plate fixed in flush box or flush in lid of power skirting or in box on wall.				
	16A 3-pin normal single flush mounted switched socket outlet with 2-pin outlet				
5.4.1	Supply	no	2		
5.4.2	Install	no	2		
	16A 3-pin normal double flush mounted switched socket outlet				
5.4.3	Supply	no	2		
5.4.5	Install	no	2		
	16A 3-pin normal single surface mounted switched socket outlet				
5.4.5	Supply	no	2		
5.4.6	Install	no	2		
	16A 3-pin normal double surface mounted switched.				
5.4.7	Supply	no	2		
5.4.8	Install	no	2		
	100x100x50mm Cover plates where necessary				
5.4.9	Supply				
6.4.10	Install	no	8		
		no	8		
	100x50x50mm Cover plates where necessary				
5.4.11	Supply	no	8		
5.4.12	Install	no	8		
	20A double pole surface mounted isolator				
5.4.13	Supply	no	6		
5.4.14	Install	no	6		
	30A double pole surface mounted isolator				
5.4.15	Supply	no	6		
5.4.16	Install	no	6		
	20A triple pole surface mounted isolator				
5.4.17	Supply	no	2		
5.4.18	Install	no	2		
	30A triple pole surface mounted isolator				
5.4.19	Supply	no	2		
5.4.20	Install	no	2		
	Labelling of all power points, socket outlets with circuit numbers, number of socket outlet in the circuit and DB supplying that circuit.				
5.4.21	Supply	sum	2		
5.4.22	Install	sum	2		
TOTAL CARRIED FORWARD TO SUMMARY					

SECTION 6: GENERAL LIGHTING RETICULATION					
Item	**Description**	**Unit**	**QTY**	**Rate**	**Amount (R)**
	SECTION 6: GENERAL LIGHTING RETICULATION				
6.1	**CONDUITS**				
	Galvanised conduit supplied and installed, including couplings, cutting, bending, fixing etc. as per specification in concrete, brickwork and on surface in voids.				
	20 mm				
6.1.1	Supply	m	500		
6.1.2	Install	m	500		
	25 mm				
6.1.3	Supply	m	10		
6.1.4	Install	m	10		
	CONDUIT OUTLET BOXES				
6.2.	Galvanised 100 x 50 x 50mm conduit outlet box and cover plate to suit any number, size or type of entries, fixed in roofs or in and including recess in brickwork or cast in concrete				
6.2.1	Supply	no	8		
6.2.2	Install	no	8		
	Galvanised (60-65)mm diameter shallow type conduit outlet box and cover plate to suit any number, size or type of entries, fixed in roofs or in and including recess in brickwork or cast in concrete				
6.2.3	Supply	no	20		
6.2.4	Install	no	20		
	CONDUCTORS				
6.3	PVC insulated 600/1000 V stranded copper conductors, drawn into conduit, wire ways and/or sleeves :				
6.3.1	1.5 mm² Conductor				
6.3.2	Supply	m	750		
	Install	m	750		
	2.5 mm² Conductor				
6.3.3	Supply	m	500		
6.3.4	Install	m	500		
	Bare stranded copper earth conductors, drawn into conduit,				
	1.5 mm² BCEW				
6.3.5	Supply	m	500		
6.3.6	Install	m	500		
	2.5 mm² BCEW				
6.3.7	Supply	m	500		
6.3.8	Install	m	500		
	SWITCHES AND ACCESSORIES, ETC.				
6.4	16A One lever one way flush mounted light switch				
6.4.1	Supply	no	2		
6.4.2	Install	no	2		
	16A One lever one way surface mounted light switch				
6.4.3	Supply	no	2		
6.4.4	Install	no	2		
	16A one lever watertight light switch				
6.4.5	Supply	no	1		
6.4.6	Install	no	1		
	20A Photo-electric daylight sensitive switch				
6.4.7	Supply	no	1		
6.4.8	Install	no	1		
Total carried forward to the next page					

SECTION 6: GENERAL LIGHTING RETICULATION					
Item	**Description**	**Unit**	**QTY**	**Rate**	**Amount (R)**
	Total carried from to the previous page				
6.5	**SOCKET OUTLET FOR LIGHT FITTINGS**				
	FITTINGS				
	5A unswitched socket outlet to accept 5A plug top connected by a 3m cabtyre to light fitting in ceiling void or where necessary				
6.5.1	Supply	no	40		
6.5.2	Install	no	40		
6.6	**LIGHT FITTINGS SUPPLY & INSTALL**				
	Type 3: 53W weatherproof LED light fitting as specified				
6.6.1	Supply	no	8		
6.6.2	Install	no	8		
	Type D: Surface mounted single sided exit signage with 'Running Man' pictogram as specified				
6.6.3	Supply	no	5		
6.6.4	Install	no	5		
	Type D: Surface mounted single sided exit signage with 'Exit' sign as specified				
6.6.5	Supply	no	5		
6.6.6	Install	no	5		
TOTAL CARRIED FORWARD TO SUMMARY					

SECTION 7: ELECTRONIC SYSTEMS					
Item	**Description**	**Unit**	**QTY**	**Rate**	**Amount (R)**
7	**SECTION 5: ELECTRONIC SYSTEMS**				
7.1	**FIRE ALARM SYSTEM WIREWAYS**				
	Galvanised conduit in ceiling voids, in wall chases and on surface:				
	25mm Conduit:				
7.1.1	Supply	m	300		
7.1.2	Install	m	300		
	Galvanised flush mounted draw boxes with white enamel finished cover plates fitted with chromium plated screws.				
	100 x 100x 50 mm draw boxes				
7.1.3	Supply	no	15		
7.1.4	Install	no	15		
	100 x 50x 50 mm cover plates				
7.1.5	Supply	no	8		
7.1.6	Install	no	8		
	(60-65)mm diameter round draw box:				
7.1.7	Supply	no	20		
7.1.8	Install	no	20		
	(60-65)mm diameter round cover plate to fit round draw box				
7.1.9	Supply	no	20		
7.1.10	Install	no	20		
7.2	**MEDIUM DUTY WELDED MESH CABLE TRAY**				
	The supply and installation of welded mesh cable trays installed in ceiling voids complete with support structure, bends, joints, reducing sections, cross pieces, angle pieces and expanding joints, threaded rod braces, channels and straps and accessories				
	200mm Wide welded mesh cable tray				
7.2.1	Supply	m	50		
7.2.2	Install	m	50		
	200mm Wide welded mesh cable tray: Bends				
7.2.3	Supply	no	8		
7.2.4	Install	no	8		
	200mm Wide welded mesh cable tray: Tee's				
7.2.5	Supply	no	6		
7.2.6	Install	no	6		
7.3	**PVC COMPACT MINI TRUNKING**				
	Supply and install PVC compact mini trunking complete with lid and all its standard accessories as may be required when installing it				
	40mm x 16mm, YT3 mini trunking				
7.3.1	Supply	m	50		
7.3.2	Install	m	50		
	25mm x 16mm, YT2 mini trunking				
7.3.3	Supply	m	20		
7.3.4	Install	m	20		
7.4	**EARTHING**				
	300mm L x 200mm W x 3mm H earth bar with 8mm bolts and nuts for 16mm^2 insulated copper conductor from the server room to the substation earth.				
7.4.1	Supply	no	2		
7.4.2	Install	no	2		
TOTAL CARRIED FORWARD TO SUMMARY					

RFB NR: R&D/IMT-2023/024 ANNEXURE C-ARMSCOR IMT BUILDING UPS: ELECTRICAL BOQ
ELECTRICAL INSTALLATION
SECTION 8: PROVISIONAL SUM FOR BUILDING COMPLIANCE

Item	Description	Unit	QTY	Rate	Amount (R)
8	**Provisional Sum For Building Compliance**				
8.1	Refurbish and make the exising electrical installation, including distribution boards compliant with regulations, and issuing certificates of compliances as required in terms of the regulations.	Sum	1	2 000 000.00	2 000 000.00
Total Carried Forward To Summary Page					**2 000 000.00**

RFB NR: R&D/IMT-2023/024 ANNEXURE C-ARMSCOR IMT BUILDING UPS: ELECTRICAL BOQ
ELECTRICAL INSTALLATION
SECTION 9: UPS ROOM HVAC

Item	Description	Unit	QTY	Rate	Amount (R)
9	**UPS ROOM HVAC**				
	Supply, Install, Commission and handover Cooling Inverter Split Units at the UPS room, positions to be confirmed on site.				
9.1	Outdoor units				
	SOU-01-02 - 4.7kW Inverter condenser unit complete with DuraFin+ made of corrosion-resistant material to protect the condenser from rusting	No	1		
9.2	Indoor units				
	CCU-01-02 - 4.7kW Inverter Under Ceiling cassette unit complete with supports, and power connections, isolators etc.	No	1		
9.3	Controls				
	RC-1 - Wall mounted wired remote controls	No	1		
9.4	Refrigerant piping - complete with supports				
	Class type as per manufacture's recommendation				
	Liquid pipe ø6.35mm	m	38		
	Gas pipe ø9.52mm	m	38		
9.5	Refrigerant pipe insulation - (Armaflex)				
	Liquid pipe ø6.35mm	m	38		
	Gas pipe ø9.52mm	m	38		
9.6	Refrigerant				
	R410A Refrigerant	kg	11		
9.7	Condensate PVC piping				
	Ø25mm	m	20		
9.8	O & M Mnuals				
	Operating & maintenance manuals, complete with AS Built drawings	No	3		
9.9	Suppy, install and commission fresh air mounted fan with filters in slding flame				
	2 Speed Xpelair WX9	No	1		
Total Carried Forward To Summary Page					

RFB NR: R&D/IMT-2023/024 ANNEXURE C-ARMSCOR IMT BUILDING UPS: ELECTRICAL BOQ
ELECTRICAL INSTALLATION
SUMMARY OF SCHEDULES

SUMMARY PAGE

Item	Description	Amount (R)
ELECTRICAL INSTALLATION		
1	SECTION 1: PRELIMINARY AND GENERAL	
2	SECTION 2: UNINTERRUPTIBLE POWER SUPPLY	
3	SECTION 3: ONE YEAR MAINTENANCE	
4	SECTION 4: LOW VOLTAGE DISTRIBUTION	
5	SECTION 5: GENERAL POWER RETICULATION	
6	SECTION 6: GENERAL LIGHTING RETICULATION	
7	SECTION 7: ELECTRONIC SYSTEMS WIREWAYS	
8	SECTION 8: BUILDING COMPLIANCE	2 000 000.00
9	SECTION 9: UPS ROOM HVAC	
SUB-TOTAL 1		
ADD 5% CONTINGENCY		
SUB TOTAL 2		
ADD 15% VAT		
TOTAL CARRIED TO FORM OF OFFER AND ACCEPTANCE		