ELECTRICAL INSTALLATIONS
DETAILED SPECIFICATIONS

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PART B: DETAILED ELECTRICAL WORK

NOTICE TO TENDERERS

1. The tenderer for the principal contract shall submit additional information regarding the installer of the Electrical Installation together with the returnables enclosed with the tender enquiry documents
2. The Contractor, on acceptance of his tender for the principal 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.

DETAILED SPECIFICATION FOR ELECTRICAL WORK

PART 1 - GENERAL

CONTENTS

PART 1 - GENERAL

1 TESTS

After completion of the works and before first delivery 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 installations will be inspected and the Contractor shall make good at his cost, to the satisfaction of the Representative/Agent/Engineer, any defects which may arise. Contractor to provide a list of all equipment he used together with serial numbers for COC

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.

2 MAINTENANCE OF INSTALLATIONS

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

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

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

3 REGULATIONS

The installation shall be erected and tested in accordance with the Acts and Regulations as indicated in the scope of works.

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 Department.

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.

6 QUALITY OF MATERIALS

Only materials of first class quality shall be used and all materials shall be subject to the approval of the Department. Departmental 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 Bureau of Standards, specifications, or to British Standard Specifications, where no SABS Specifications exist.

Materials wherever possible, must be of South African manufacture.

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 2 of this specification.

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

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

a) Screwed metallic conduit and accessories: SANS 61386, parts 1, 21 and 23.

b) Plain-end metallic conduit and accessories: SANS 61386, parts 1, 21 and 23.

c) Non-metallic conduit and accessories: SANS 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 SANS 10142-1 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 SANS 10142-1 for the specified number and size of conductors, unless otherwise directed in part 2 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 conduit shall be manufactured of mild steel with a minimum thickness of 1,2mm for plain-end conduit and 1,6mm in respect of screwed conduit.

Under no circumstances will conduit having a wall thickness of less than 1,6mm be allowed in 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 Department's inspectorate staff, be completely removed and rectified and any wiring already drawn into such damaged conduits must be completely renewed at the Contractor's expense.

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

All metallic conduit and accessories used in areas within 50 km of the coast shall be galvanised to SANS 14713-2.
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 Department to any claim submitted by the Contractor, which may result from a lack of knowledge in regard to the supply authority's requirements.

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.

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 2 of the specification, conduit installed on the surface must be plumbed or levelled and only straight lengths shall be used.

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

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

Running couplings are only to be used where unavoidable, and shall be fitted with 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 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.

10 CONDUIT IN CONCRETE 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 preferable 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.

11 WIRING:

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

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

Unless otherwise specified in Part 2 of this specification or indicated on the service drawings, the wiring of the installation shall be carried out in accordance with SANS 10142-1. Further to the requirements concerning the installation of earth conductors to certain light points as set out in SANS 10142-1, 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 1,5mm² conductors and a 1,5mm²-earth conductor. For socket outlet circuits the wiring shall comprise 4mm² conductors and a 2,5mm²-earth conductor. In certain instances, as will be directed in Part 2 of this specification, the sizes of the 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 SANS 10142-1.

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

The wiring shall be done in PVC insulated 600/1000 V grade cable to SABS 1507 and 1574.

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.

12 SWITCHGEAR

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

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

13 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 Department before installation.

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

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

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 and Afrikaans, is to be according to the lay-out drawings or as directed by the Department's representative 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.

14 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 Department.

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

15 CERTIFICATE OF COMPLIANCE

On completion of the service, a certificate of compliance must be issued to the Department's Representative/Agent in terms of the Occupational Health and Safety Act, 1993 (Act 85 of 1993).

16 EARTHING OF INSTALLATION

Main earthing

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

Installations shall be effectively earthed in accordance with SANS 10142-1 and to the requirements of the supply authority. All earth conductors shall be stranded copper with or without green PVC installation.

Connection from the main earth bar on the main board must be made to the cold water main, the incoming service earth conductor, if any and the earth mat or other local electrode by means of 12mm x 1,60 mm solid copper strapping or 16 mm² stranded (not solid) bare copper wire or such conductor as the Department's representative may direct. Main earth copper strapping where installed below 3m from ground level, must be run in 20 mm diameter conduit securely fixed to the walls.

All other hot and cold water pipes shall be connected with 12mm x 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.

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.

Sub-distribution boards

A separate earth connection shall be supplied between the earth busbar in each sub-distribution board and the earth busbar in the Main Switchboard. These connections shall consist of a bare or insulated stranded copper conductors installed along the same routes as the supply cables or in the same conduit as the supply conductors. Alternatively, armoured cables with earth continuity conductors included in the armouring may be utilised where specified or approved. All sub-DBs to be labelled where they are fed from, together with cable sizes to the distribution board.

Sub-circuits

The earth conductors of fall sub-circuits shall be connected to the earth busbar in the supply board in accordance with SANS 190142-1.

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 by connected to the common earth conductor with T-ferrules or soldered. The common earth shall not be broken.

Non-metallic Conduit

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

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

Flexible Conduit

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

Connection

Under no circumstances shall any connection points, bolts, screws, etc., used for earthing be utilised for any other purpose. It will be the responsibility of the Contractor to supply and fit earth terminals or clamps on equipment and materials that must be earthed where these are not provided.

Unless earth conductors are connected to proper terminals, the end shall be tinned and lugged.

PART 2: INSTALLATION DETAILS

[Omit which is not applicable. Clauses 1 to 10 of Part 2 are standard clauses (which should not be altered) and must be inserted in the document in the order as set out.]

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PART 2: INSTALLATION DETAILS

1. CABLE SLEEVE PIPES

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

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

2. NOTICES

The Contractor shall issue all notices and make the necessary arrangements with Supply Authorities, Telkom, Liquid Telecom & DFA, S.A. Transport Services, Provincial or National Road Authorities and other authorities as may be required with respect to the installation.

3. ELECTRICAL EQUIPMENT

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

4. DRAWINGS

The drawings 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.

The position of power points, switches and light points that may be influenced by built-in furniture or existing position and must be established on site, prior to these items being built in.

5. BALANCING OF LOAD

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

6. SERVICE CONDITIONS

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

7. 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 1 of this specification and to the satisfaction of the Department's representative.

8. 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 Department and the Department's representative.

9. EXTENT OF WORK

The work covered by this contract comprises the 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 as specified but not limited to the following scope.

1. Installation of solar panels
2. Installation of inverters
3. Wiring of the building distribution boards.
4. Installation of lightning protection system for solar panels
5. Commissioning of all systems and issue Certificate of compliance

10. SUPPLY AND CONNECTION

Existing power supply and connection to be retained and all HT switches, LV switches, Transformers to be serviced and tested.

11. CONDUIT AND WIRING

Conduit and conduit accessories shall be black enameled/galvanised screwed conduit or black enameled/galvanised plain end conduit in accordance with SANS 61386-1, -21 and -23 respectively, or non metallic in accordance with SANS 950 where allowed.

All conduits, regardless of the system employed, shall be installed strictly as described in the applicable paragraphs of clauses 4 to 8 of Part 1 of the specification. Wiring of the installation shall be carried out as directed in clause 9 part 1 of this specification.

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

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

11.1. Power Trunking

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

Busbar trunking is installed inside the raiser shaft on the office tower building

The power trunking must comply with SABS 1197. The Contractor must ensure that the power trunking is installed to satisfaction of the Department's representative before commencing with the wiring of the power trunking.

[The method of installing and wiring of the power trunking must be bolted on the slab using steel rods screwed on the slab using steel screw anchor.]

12. CABLES

The Contractor shall supply and completely install all distribution cables as indicated on the drawings, and listed in the Schedule of Cables.

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

The cable-trenches shall be excavated to a depth of 0,9m deep below ground level and shall be 450mm wide for one to three cables, and the width shall be increased where more than three cables are laid together so that the cables may be placed at least two cable diameters apart throughout the run. The bottom of the trench shall be level and clean and the bottom and sites free from rocks or stones liable to cause damage to the cable.

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

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

Cable makers shall be provided along all HV cable routes but need only be provided along LV cable routes where specified. These should preferably be engraved Travolite.

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

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

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

On each completed section of the laid and jointed cable, the insulation resistance shall be tested to approval with an approved “Megger” type instrument of not less that 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.

12.1. Laying, Jointing and Making Off of Electrical Cables

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

1. The use of the term “Inspector”, includes the engineer or inspector of the Department or an empowered person of the concerned supervising consulting engineer’s firm.

2. No cable is to be laid before the cable trench is approved and the soil qualification of the excavation is agreed upon by the Contractor and inspector.

3. After the cable has been laid and before the cable trench is back-filled the inspector must ensure that the cable is properly bedded and that there is no undesirable material included in the bedding layer.

4. All cable jointing and the making off of the cables must only be carried out by qualified experienced cable jointers. Helpers of the jointers may not saw, strip, cut, solder, etc. The cable and other work undertaken by them must be carried out under the strict and constant supervision of the jointer.

5. Before the Contractor allows the jointer to commence with the jointing work or making off of the cable (making off is recognized as half a joint) he must take care and ensure:

5.1 That he has adequate and suitable material available to complete the joint properly and efficiently. Special attention must be given to ensure the cable ferrules and cable lugs are of tinned copper and of sufficient size. The length of the jointing lugs must be at least six times the diameter of the conductor,

5.2 That the joint pit is dry and that all loose stones and material are removed,

5.3 That the walls and banks of the joint pit are reasonable firm and free from loose material which can fall into the pit,

5.4 That the necessary coffer-dams or retaining walls are made to stop the flow of water into the joint pit,

5.5 That the joint pit is provided with suitable groundsheets so that the jointing work is carried out in clean conditions,

5.6 That the necessary tents or sails are installed over the joint pit to effectively avert unexpected rainfall and that sufficient light or lighting is provided,

5.7 that the necessary means are available to efficiently seal the jointing or cable end when an unexpected storm or cloudburst occurs, regardless of how far the work has progressed,

5.8 That the cables and other materials are dry, undamaged and in all respects are suitable for the joint work or making off,

5.9 That the heating of cable oil, cable compound, plumbers metal and solder is arranged that they are at the correct temperature when required so that the cable is not unnecessary exposed to the atmosphere and consequently the ingress of moisture (care must be taken of overheating)

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

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

In the case where non-compound type of joints or terminations are allowed, the manufacturers requirements and instructions shall be followed by the letter.

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

Froth on the surface of the oil is an indication that moisture is present in the impregnated insulation and the amount of the froth gives an indication of the moisture present.

7**.** If the cable contains moisture or is found to be otherwise unsuitable for jointing or making of the inspector is to be notified immediately and he will issue the necessary instruction to cope with the

situation.

8. The joint or making off of paper insulated cables must not be commenced during rainy weather.

9. Once a joint is in progress the jointer must proceed with the joint until it is complete and before he leaves the site.

10. The jointer must ensure that the material and his tools are dry at all times, reasonably clean and absolutely free from soil.

11. Relating to the jointing of the cable the following requirements apply:

11.1 All jointing must be carried out in accordance with recognized and tried techniques and comply strictly with the instructions given by the supplier of the jointing kit.

11.2 The cables must be twisted by hand so that the cores can be joined according to the core numbers. If necessary, the cable is to be exposed for a short distance to accomplish this. Under no circumstances may the cores in a joint be crossed so as to enable cores to be joined according to the core numbers. If it is not possible to twist the cables so that the preceding requirements can be met, then cores are to be joined in the normal way without any consideration of the core numbers.

11.3 Normally the cables will have profile conductors. The conductors shall be pinched with gas pliers to form a circular section, bound with binding wire so that they do not spread, and then tinned before jointing.

11.4 Jointing ferrules, the length of which are at least 6 times the diameter of the conductors, must be slid over the conductor ends to be joined and pinched tightly. Then they are soldered by means of the ladle process whilst being pinched further closed.

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

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

NB: The spaces between the conductor strands must be completely filled by soldering process and must be carried out quick enough to prevent the paper insulation from burning or drying out unnecessarily.

11.5 After the ferrules have been rubbed smooth and clean, they and the exposed cores must be treated with hot cable oil (110°C) to remove all dust and moisture. These parts are to be thoroughly basted with the oil.

11.6 The jointer must take care that his hands are dry and clean before the joint is insulated. Also the insulating tape which is to be used must first be immersed in warm cable oil (110°C) for a sufficient period to ensure that no moisture is present.

11.7 After the individual cores have been installed they must be well basted with hot cable oil and again after the applicable separator and/or belt insulation tape is applied before the lead joint sleeve is placed in position.

11.8 The lead joint sleeve must be thoroughly cleaned and prepared before it is placed on the cable and must be kept clean during the whole jointing process. Seal the filling apertures of the sleeve with tape until the sleeve is ready for compound filling.

11.9 The plumbing joints employed to solder the joint sleeve to the cable sheath, must be cooled off with tallow and the joint sleeve is to be filled with compound while it is still warm. Top up continuously until the joint is completely filled to compensate for the compound shrinkage.

11.10 The outer joint box must be clean and free from corrosion. After it has been placed in position it must be slightly heated before being filled with compound. Top up until completely full.

12. As far as cable end boxes are concerned the requirements as set out above are valid where applicable.

In the case where non-compound type of joints or terminations are allowed, the manufacturer's requirements and instructions shall be followed by the letter. Ferrules are to be crimped with suitable crimping pliers/equipment ensuring a proper connection between the conductors.

13. DISTRIBUTION BOARDS

In addition to clause 14 and clause 15 of Part 1 of this specification the following shall also be applicable to switchboards required for this service.

The Contractor shall supply and install the distribution boards as indicated on the drawings and listed in the distribution Board Schedule DRAWING NUMBER.

All distribution boards shall comply with the quality specification in Part 3 of this specification, and be approved by the Department's representative.

14. SCHEDULE OF DISTRIBUTION BOARDS

The front panels of normal supply, standby power and no-break supply sections shall be painted in distinctive colours as follows:

Normal supply : Light Orange, colour B26 of SANS 1091.
Standby power : Signal Red, colour A11 of SANS 1091.
No-break supply: Dark Violet, colour F06 or Olive Green, Colour H05 of SANS 1091.

Indicated is the probable fault level rating (kA) of the busbars. Refer to the Summary of Switchgear and Circuits for the minimum fault level rating of specified equipment.

15. SUPPLY AND INSTALLATION OF SOLAR PANELS

Solar Panels to be supplied and installed according to specification as stated in the bill of quantities and/or separate specification

SPECIFCATION FOR		**460W Solar Panels UPS**
Item	**Description**	**Requirement**
1	**Electrical Characteristics**	
1.1	Maximum Power at STC (Pmp)	460
1.2	Open Circuit Voltage (Voc)	41.52
1.3	Short Circuit Current (Isc)	13.96
1.4	Maximum Power Voltage (Vmp)	34.49
1.5	Maximum Power Current (Imp)	13.34
1.6	Module Efficiency at STC(ηm)	21.25
1.7	Power Tolerance	(0, +4.99)
1.8	Maximum System Voltage	1500V DC
1,9	Maximum Series Fuse Rating	25 A

2	Mechanical Specifications	
2.1	External Dimensions	1909 x 1134 x 35 mm
2.2	Weight	22.3 kg
2.3	Solar Cells	PERC Mono (120 pcs)
2.4	Front Glass	3.2mm AR coating tempered glass, low iron
2.5	Frame	Anodized aluminium alloy
2.6	Junction Box	IP68, 3 diodes
2.7	Output Cables	4.0mm2, 250mm(+)/350mm(-) or Customized Length
2.8	Mechanical Load	Front side 5400Pa/ Rear side 2400Pa
3	**Temperature Characteristics**	
3.1	Pmax Temperature Coefficient	-0.34 %/°C
3.2	Voc Temperature Coefficient	-0.26 %/°C
3.3	Isc Temperature Coefficient	+0.05 %/°C
3.4	Operating Temperature	-40 - +85 °C
3.5	Nominal Operating Cell Temperature(NOCT)	45±2 °C
8.2	Humidity	0 - 90% non-condensing
8.3	Maximum Altitude	0 - 2000m without de-rating

1. SUPPLY AND INSTALLATION OF 5KW & 10kW HYBRID INVERTER

Inverters to be supplied and installed according to specification as stated in the bill of quantities and/or separate specification

SPECIFCATION FOR		10kW Inverter
Item	**Description**	**Requirement**
1	**Battery Input Date**	
1.1	Battery type	Lead-acid or Lithium-ion
1,2	Battery Voltage Range	48V
	Max. Charging Current	210A
	Max. Discharging Current	210A
	Charging Curve	3 Stages/Equalization
	Charging Strategy for Li-Ion Battery	Self-adaption to BMS
2	**PV String Input Data**	
2.1	Max. DC Input Power	12000W
2.2	PV Input Voltage	100V – 600V
2.3	Start-up Voltage	360V
2.4	MPPT Range	210~500V
2.7	PV Input Current	25A+12,5A
2.9	No. of MPPT Trackers	2
2.10	No. of Strings Per MPPT Tracker	2+1
3	**AC Output Data**	
3.1	Rated AC Output and UPS Power	10000W
3.2	Max. AC Power	11000W
3.3	AC Output Rated Current	14.5A
3.4	Max AC Output Current	16A
3.5	Max Continuous AC Passthrough	60A
3.6	Power Factor	0.8 leading to 0.8 lagging
3.7	Output Frequency and Voltage	50-60Hz; 230Vac
3.9	DC Injection Current (mA)	<0.5%1n

4	**Efficiency**	
4.1	Max. Efficiency	97.6%
4.2	MPPT Efficiency	97.0%
4.3	Euro Efficiency	96.5%
5	**Protection**	
5.1	PV Input Lightning Protection	Integrated
5.2	Anti-islanding Protection	Integrated
5.3	PV String Input Reverse Polarity Protection	Integrated
5.4	Insulation Resistor Detection	Integrated
	Residual Current Monitoring Unit	Integrated
	Output Over Current Protection	Integrated
	Output Shorted Protection	Integrated
	Output Over Voltage Protection	Integrated
	Surge Protection	DC Type II / AC Type II
6	**General Data**	
6.1	Operating Temperature Range	-25~60°C, >45°C Derating
6.2	Cooling	Fan
6.3	Noise	<30dB
6.4	Communication with BMS	RS485; CAN
6.5	Weight	40kg
6.6	Size	650 × 440 × 220mm
6.7	Protection Degree	IP65
6.8	Installation Type	Wall-Mounted
6.9	Warranty	5 years

SPECIFCATION FOR		**5kW Inverter**
Item	**Description**	**Requirement**
1	Battery Input Date	
1.1	Battery type	Lead-acid or Lithium-ion
1,2	Battery Voltage Range	40~60V
	Max. Charging Current	120A
	Max. Discharging Current	120A
	Charging Curve	3 Stages/Equalization
	Charging Strategy for Li-Ion Battery	Self-adaption to BMS
2	**PV String Input Data**	
2.1	Max. DC Input Power	6500W
2.2	PV Input Voltage	450V
2.3	Start-up Voltage	150V
2.4	MPPT Range	125-425V
2.7	PV Input Current	11A + 11A
2.9	No. of MPPT Trackers	2
2.10	No. of Strings Per MPPT Tracker	1+1
3	**AC Output Data**	
3.1	Rated AC Output and UPS Power	5000W
3.2	Max. AC Power	5000W
3.3	AC Output Rated Current	21.7A
3.4	Max AC Output Current	25A
3.5	Max Continuous AC Passthrough	35A

3.6	Power Factor	0.8 leading to 0.8 lagging
3.7	Output Frequency and Voltage	50-60Hz; 230Vac
3.8	Grid Type	Single Phase
3.9	DC Injection Current (mA)	<0.5%1n
4	**Efficiency**	
4.1	Max. Efficiency	97.6%
4.2	MPPT Efficiency	99.9%
4.3	Euro Efficiency	96.5%
5	**Protection**	
5.1	PV Input Lightning Protection	Integrated
5.2	Anti-islanding Protection	Integrated
5.3	PV String Input Reverse Polarity Protection	Integrated
5.4	Insulation Resistor Detection	Integrated
	Residual Current Monitoring Unit	Integrated
	Output Over Current Protection	Integrated
	Output Shorted Protection	Integrated
	Output Over Voltage Protection	Integrated
	Surge Protection	DC Type II / AC Type II
6	**General Data**	
6.1	Operating Temperature Range	-25~60°C, >45°C Derating
6.2	Cooling	Fan
6.3	Noise	<30dB
6.4	Communication with BMS	RS485; CAN
6.5	Weight	20.5kg
6.6	Size	580 X 330 X 208mm
6.7	Protection Degree	IP65
6.8	Installation Type	Wall-Mounted
6.9	Warranty	5 years

2. SUPPLY AND INSTALLATION OF 7.5kWh & 10kWH BATTERIES

Batteries to be supplied and installed according to specification as stated in the bill of quantities and/or separate specification

SPECIFCATION FOR		**7.5kW BATTERIES**
Item	**Description**	**Requirement**
1	**Performance**	
1.1	Nominal Voltage	51.2Vdc
1,2	Nominal Capacity	150Ah
	Battery Energy	7.5KWh
	Charge Voltage	56V
	Discharge Voltage	44.8V
	Max Charge/Discharge Current	150A
2	**Communication**	
2.1	Display	SOC status indicator, LED indicator
2.2	Communication	RS232\ RS485 \ CAN
3	**General Specification**	

3.1	Dimension	480x650x180mm
3.2	Weight	85kg
3.3	Installation	Floor stand or Wall mounted
3.4	Working Temperature[2]	-20^{0}C~65^{0}V
3.8	IP rating	IP20
3.9	Cell Technology	LifePO$_4$ Lithium Ion Phosphate
3.10	Cycle Life[3]	6000 cycles @ 80% DOD/250C/0,5C,60% EOL
3.11	Scalability	Max 8eries in Parallel

SPECIFCATION FOR		**10kW BATTERIES**
Item	**Description**	**Requirement**
1	**Performance**	
1.1	Nominal Voltage	51.2 Vdc
1,2	Nominal Capacity	208Ah
	Battery Energy	10650 Wh
	Charge Voltage	55.68~56.16Vdc
	Discharge Voltage	45.6-56.16 Vdc
	Nominal Charge/Discharge Current	100A
	Nominal Charge/Discharge Power	5000W
	Max Charge/Discharge Current	200A
	Max Nominal Charge/Discharge Power	10000W
	Short Circuit Current	540A
2	**Communication**	
2.1	Display	SOC status indicator, LED indicator
2.2	Communication	RS232\ RS485 \ CAN
3	**General Specification**	
3.1	Dimension	550×160×836mm
3.2	Weight	90kg
3.3	Installation	Floor stand or Wall mounted
3.4	Working Temperature[2]	-20^{0}C~60^{0}V
3.8	IP rating	IP20
3.9	Cell Technology	LifePO$_4$ Lithium Ion Phosphate
3.10	Cycle Life[3]	6000 cycles @ 80% DOD/250C/0,5C,60% EOL
3.11	Scalability	Max 8eries in Parallel

= END OF SPECIFICATION

PART 3: SCHEDULE OF MATERIAL

Contractors shall complete the following schedule of materials and equipment offered for verification by the Employer's Agent as being acceptable in terms of the specification applicable, before any such materials are procured for incorporation into the works. The contractor undertakes that the actual materials and equipment supplied installed shall be in accordance with this schedule for items that are approved.

Where items are not approved alternative items shall be presented that do meet the specifications. This process shall be repeated until all items are approved.

Item	**Material**	**Make & Trade Name**	**Country of Origin**	**Is Material to Specification** (Yes / No)	**SABS Mark** (Yes / No)
5.1	Distribution Boards				
5.2	Inverters				
5.3	Moulded Case Circuit Breakers				
5.4	Earth Leakage Relays				
5.5	Solar Panels				
5.7	Armoured Cables				
5.8	PVC Insulted Conductors				
5.9	Cable Glands				
5.10	Sleeves				
5.11	Conduits: PVC				
5.12	Conduits: Steel				
5.13	Batteries				

PART 4: BILLS OF QUANTITIES

PREAMBLE

TYPICAL ITEMS/PREAMBLES TO BE INSERTED IN THE BILLS OF QUANTITIES

1. The conditions of contract and the application of the Contract Price Adjustment Provisions (if applicable) shall be as set out in Part A: Section 1: 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 in PART A.

6. All material covered by this **Specification** shall, wherever possible, be of South African manufacture.

{NB: The supply and installation of material and equipment must be measured separately}.

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

PART 5: DRAWINGS

NOTE TO CONSULTANTS

Refer to Clause 13.1 (Working Drawings) of Manual for Electrical/Electronically and Mechanical Consulting Engineers for guidance.