ANNEXURE

ELECTRICAL SPECIFICATION

PROJECT: THULASIZWE CLINIC

for

KZN Department of Health

August 2024

CONTENTS

PART A: GENERAL SPECIFICATIONS

A1. DESCRIPTION OF WORK

A1.1 RELATED DOCUMENTS

The requirements of the General Conditions, Supplementary Conditions, Technical Specifications, and Drawings apply to all Work herein and forms part of the scope of work.

A1.2 SCOPE

A1.2.1 GENERAL SCOPE

A. Overview

Provide all labour, materials, tools, machinery, equipment, supplies, transportation, storage, utilities, appliances, hauling, hoisting, excavation, backfill, supervision, and services necessary to complete the Electrical, Communications, and Electronic Work under this Contract. Coordinate Work with the Work of the other trades to resolve conflicts without impeding job progress.

B. Drawings and Documentation

Examine the Architectural, Structural, Mechanical, Plumbing, and Electrical Drawings and other Sections of the Specifications to determine the extent of Work required to be completed. Failure to examine all the Contract Documents for this Project will not relieve the Contractors of the responsibility to perform all the Work required for a complete, fully operational, and satisfactory installation.

C. Project Location

The Work to be performed under this Contract is in connection with the construction and erection of the electrical installation at **Thulasizwe Clinic, Ulundi, Kwazulu-Natal**, on behalf of **KZN Department of Health**.

D. Work Included

The Work includes, but is not limited to, the supply installation and commissioning of material and equipment associated with the following systems, equipment, and services:

A1.2.2 ELECTRICAL SYSTEM

a. Electrical service provisions, LV distribution network, LV equipment, distribution boards and small power and lighting systems,
b. Area lighting,
c. Generator System and metering systems
d. A system provisions as required for installation of the telephone, fibre, data, Main Electrical Supply, fire alarm and security systems.
e. Conduits and boxes in slabs on or below grade, inaccessible space below slabs above grade, and walls below grade, in cooperation with other trades.
f. Earthing and Lightning protection system.
g. Testing and commissioning of the full electrical system

A1.2.3 INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) SYSTEM

a. Manholes and sleeves
b. ICT Equipment where necessary

A1.2.4 SECURITY SYSTEM

a. CCTV system
b. Access control system

A2. DESIGN CRITERIA

A2.1 QUALITY ASSURANCE

A2.1.1 CODES AND STANDARDS

The following codes and ordinances were used in the design of the project and shall be complied with during construction of the project.

a. The Occupational Health and Safety Act no. 85 of 1993, as revised, whereby SANS 10142 is enclosed.
b. Government notices.
c. The Local Government Ordinance 1939 (Ordinance 17 of 1939) as amended and the municipal by-laws and any special requirements of the local supply authority,
d. The Fire Brigade Services Act 1993, Act 99 of 1987 as amend,
e. The National Building Regulations and Building Standards Act 1977 (Act 103 of 1977) as emended,
f. The Post Office Act 1958 (Act 44 of 1958) as amended,
g. The Electricity Act 1984 (Act 41 of 1984) as amended,
h. The Regulations of the local Gas Board where applicable.

A2.1.2 STANDARDS

Refer to standard specifications for general administrative/procedural requirements related to compliance with applicable standards. This Work and all materials shall meet the standards set forth in the applicable portions of the following recognized standards:

a. Building Code – SANS 10400
b. Electrical Wiring Code – SANS 10142
c. All other relevant SANS Codes
d. IUSS Health Facility Guide

A2.2 COMPLIANCE WITH STANDARD SPECIFICATIONS

Except where otherwise specified, the equipment shall comply with the current editions of the relevant specifications of the South African Bureau of Standards and the British Standards Institution or the International Electro Technical Commission recommendations.

A2.3 GENERAL REQUIREMENTS

A2.3.1 SAFE DESIGN AND STANDARDIZATION

All equipment supplied and installed under this contract shall be designed:

a. To prevent any injury to personnel employed on the construction, operation, and maintenance of the plant.
b. To facilitate inspection, cleaning, and repair of the equipment.
c. To operate continuously and satisfactorily in the prevailing site conditions.
d. To be able to withstand without damage such sudden variations of electrical load as may be met under normal working conditions, including short circuits and lightning strikes.
e. To obviate risks of accidental short-circuits due to animals, birds, and insects.
f. To avoid pockets in which water can collect in outdoor equipment.
g. To avoid condensation in closed compartments by the provision of adequate ventilation or where necessary, heaters.
h. Such that conductors can carry normal load and fault currents without overheating or other damage.
i. Such that moving parts can be readily lubricated. Grease nipples shall be provided in accessible positions for this purpose.

j. To be vermin proof.
k. To be corrosion resistant.

A2.4 QUALITY OF MATERIALS AND WORKMANSHIP

a. All materials and equipment for this Contract shall be new and undamaged. Corresponding parts shall be interchangeable.
b. Where so directed by the specification or by the Engineer, the Contractor shall provide samples and test certificates of materials for approval.
c. The labour used by the Contractor shall always be adequately qualified and experienced for the particular task.

A2.5 FIXINGS AND CONNECTIONS

A. Nuts and Bolts

Metric size nuts and bolts shall be used unless otherwise specified. Each bolt or stud shall project at least one thread but not more than 6 mm from the nut. Special spanners shall be provided where nuts and bolts are not easily accessible. The nuts on the moving plant or plant subject to vibration shall be fixed by means of locknuts, “Loctite” or other approved locking method. Bolts and studs shall be adequately sized to carry the loads, which may be imposed on them.

B. Materials of Nuts and Bolts

Only stainless-steel nuts, bolts and washers shall be used for all electrical connections.

A2.6 NON-CORRODING MATERIALS

A. Non-corroding materials shall be used in the construction of outdoor equipment and plant. This includes all cable racks, trays, and clips,
B. The permissible grades and alloys are as follows:
   a. Stainless Steel: Grade 316 or better
   b. Extruded Aluminium:6082-T6
   c. Cast Aluminium: L-2520
   d. Glass fibre: To the relevant SANS specification

A2.7 GALVANISING AND PAINTING

A. NO drilling, cutting, bending, punching, welding, and forming of the steel or any surface damage shall be allowed after galvanising or painting.
B. All the steel work shall be prepared, hot dipped galvanised and painted using the processes as per manufacturers recommendations.

A3. EARTHING AND LIGHTNING PROTECTION

A3.1 QUALITY ASSURANCE

A3.1.1 CODES AND STANDARDS

The earthing and lightning protection shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards.

a. The latest issue of SANS 10313: Protection against lightning - Physical damage to structures and life hazard Requirements of surge protective devices
b. The latest issue of SANS 61312: Requirements of surge protective devices
c. The latest issue of SANS 62305: Protection against lightning
d. The latest issue of SANS 10292: Earthing of low-voltage (LV) distribution systems.
e. The latest issue of SANS 10199: The design and installation of earth electrodes
f. The latest issue of NRS076: Earthing of distribution substations with nominal voltages up to and including 132 kV.

A3.1.2 MANUFACTURERS

If they comply with the specifications and requirements, as listed in this section, will be acceptable.

A3.1.3 INSTALLERS

The electrical contract shall appoint a specialist Earthing and Lightning Protection Contractor to design and install the earthing and lightning protection system. The specialist installer must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A3.2 SCOPE OF WORKS

The specialist contractor shall:

a. Carry out earth resistivity tests on the site of works and provide a test results certificate together with recommendations of the installation to the Engineer.
b. Once approved, Supervise the installation in compliance with SANS requirements.
c. Carry out interim earthing tests and if below required value, improve on earthing installation until earthing values are achieved.
d. Provide as-built drawings of the complete earthing and lightning protection system.
e. Provide test certificates and a sign-off certificate of the completed earthing and lightning protection system.

A3.3 DESIGN CRITERIA

a. A provisional earthing and lightning protection systems indicated on the drawings and measured in the Bill of Quantities. The earthing system shall follow the same trench and rod system as indicated on the drawings.
b. Earthing shall be installed in trenches of 600mm deep below finished ground level (FGL)
c. The tops of the earth rods shall be no less than 600mm below FGL with rods installed vertically. If this is not achievable, then rods should be installed in a horizontal position and indicated on as-built drawings.
d. Final measures will be based on installed quantities up to the Bill measured values only. Material above bill measured quantities shall be approved by the Engineer prior to installation.

A3.4 EARTHING OF SUBSTATIONS

a. All substations shall be earthed in accordance with the requirements of the supply authority. If no earthing is specified and no specific requirements of the supply authority exist, the following method shall be adopted.
b.
c. All earth wires shall be secured to the earth bar by means of 10 mm diameter brass bolts. Lock nuts shall be provided for all terminals.
d. The following connections shall be made from this earth bar system:
   - 70 mm² insulated stranded conductor to the transformer neutral.
   - Copper tape to the transformer tank.
   - 70 mm² bare copper earth conductor to LV switchgear earth bar.
   - 70 mm² copper earth conductor to switchgear frame and board.
   - 2 x 70 mm² bare copper earth conductors to earth mat/earth rods.
e. Where necessary, earth connections shall be protected against mechanical damage and corrosion.
f. Two earth rods shall be driven into the ground in the immediate vicinity of the substation at least 3m apart with their tops not less than 600 mm below ground level. The rods shall be interconnected with a 70 mm² bare copper conductor buried at a depth of not less than 750 mm. A 70 mm² earth conductor shall be taken from each of the two earth rods to the main earthing bar in the high voltage room.

A3.5 EARTHING OF SWITCH GEAR ROOM

The earthing of switch rooms shall conform to the earthing requirements of substations as described above.

A3.6 EARTHING OF OUTDOOR EQUIPMENT

a. In cases where substations contain transformers or switchgear installed outdoors, the compulsory fence, if no other method is specified, shall be earthed as follows:
b. A 70 mm² earth conductor shall be installed 400 mm below ground level and 500 mm from the fence on the outside of the substation along the entire perimeter of the fence. This earth conductor shall be earthed at each corner by means of a 1,8m earth rod and the rod and earth conductor bonded to the fence.
c. The earth conductor shall be bonded, at least at two points, to the main earthing system.
d. A 70 mm² earth conductor shall also be buried at a depth of 400 mm around each transformer and switch and bonded to the main earthing system.

A3.7 EARTHING OF BUILDINGS

a. All hot and cold-water pipes and discharge pipes shall be interconnected by means of 12 x 1,6 mm solid or perforated copper tape and clamped with brass bolts and nuts. Copper tapes shall be fixed to walls by means of brass screws at intervals not exceeding 250mm.
b. Iron roofs, gutters, down-pipes, etc., shall be interconnected in the same way.
c. Connections shall be carried out with brass bolts and nuts (not self-tapping screws).
d. Iron roofs shall be connected at intervals not exceeding 15m with a common earth conductor of bare copper wire. The common earth conductor shall run under the roof over the full length rigidly fixed to the upper purlin.
e. This earth conductor shall also be connected to the main earth conductor of every distribution board.
f. When plastic conduit is used, a 2,5mm² bare copper conductor shall be installed throughout for earth continuity.
g. This copper conductor shall be securely fixed to all metal appliances and equipment, including switch boxes, socket outlet boxes, draw boxes, switchboards, luminaires etc.

A3.8 EARTHING OF LV SYSTEMS

a. A separate earth connection shall be installed from every sub-distribution board to the earth terminal on the main distribution board. These earth connections shall consist of bare copper conductors, drawn into conduit or piping, together with PVC conductors or cables.
b. Socket outlets shall be connected with 2,5 mm² earth conductor to the earth busbar in the relative distribution board.
c. The earth terminals of lighting circuits shall be connected to the nearest earth terminals by means of 2,5 mm² stranded copper conductors.
d. A readily accessible earthing terminal shall be provided for the bonding of other services such as a telephone, an audio or a video system, and the like, to a building. Such an earth terminal shall be bonded to the consumers earth terminal by a conductor of at least 6mm² copper or equivalent and shall be identified by the earth symbol. Labels shall be fitted to all distribution boards where the readily accessible earthing terminal for the bonding of other services is provided.
e. The earth terminals on the main distribution board shall be earthed by means of a 70 mm² bare copper conductor connected to the earth mat/ring.

A3.9 EARTHING OF INSTALLATION

The trench earth shall consist of minimum 70mm² bare copper conductor buried in a 600mm trench around each building.

A3.9.1 ROOFS, GUTTERS AND DOWN PIPES

All metal parts of roofs, gutters and down pipes shall be bonded and earthed. The roof and gutters shall be connected at 15m intervals or as shown on the drawings to this conductor by means of 50mm² down conductors or equivalent as approved by the engineer in 20mm PVC conduit. All bolts and nuts to be galvanised. Self-tapping screws are not acceptable. The earth should be connected to the earth mat.

A3.9.2 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.

A3.9.3 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.

A3.9.4 NON-METALLIC CONDUIT

Where non-metallic conduit is specified or allowed, the installation shall comply with the specification for “conduit and conduit accessories”.

Stranded 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.

A3.9.5 FLEXIBLE CONDUIT

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

A3.9.6 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.

A3.10 LIGHTNING PROTECTION

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a. The lightning Protection system shall be designed and installed by a certified specialist contractor.
b. The lightning protection system of buildings and structures shall include:
   - Bonding of metal roofs and structures
   - Installation of 8mm aluminium Lightning conductor on concrete and non-metallic roof structures
   - Bonding of lightning protection system with earthing system.
c. The contractor to use approved methods for joints, terminations, and bonding.
   - Lightning conductors shall be fixed to walls and parapets by means of raised galvanised saddles and secured onto the structure.
   - If waterproofing is installed, lightning conductors to be installed above the waterproofing membrane.
   - Care must be taken to prevent damage to waterproofing membranes and any damage or penetration onto waterproofing membranes must be first approved by the waterproofing installers prior to drilling/cutting.
   - All repairs to waterproofing membranes must be done by the specialist waterproofing installers at the contractor's cost.
   - Down conductors to be 50mm copper conductor in PVC conduit to the earth mat of test points as indicated on the drawings.
   - Test points shall be installed 600mm above finished ground level in a suitably approved IP65 box with a removable cover.
   - Test points shall be provided with a bolted connection and labelled for future testing.
   - Down conductor tails from the test point to earth mat/rod shall be of $50m^2$ copper conductor and to be exothermically welded onto the earth mat/rod. No crimps or clamps will be allowed.
   - All drilling of holes onto structures and frames and re-instatement of protective coatings, e.g., paint or galvanising shall form part of this contract.
   - All connections to earth rods and conductor joints shall be by means of exothermic welds.
   - Bonding to steel reinforcing shall be by means of approved clamps.
   - All connections between different metals shall be by means of suitable bi-metal connections.

A4. LIGHTING FIXTURES

A4.1 QUALITY ASSURANCE

A4.1.1 CODES AND STANDARDS

The lighting fixtures shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards. The latest issue of the SANS codes will be applicable:

a. SANS 475: Luminaires for interior lighting, streetlighting and floodlighting - Performance requirements
b. SANS 1464: Safety of luminaires Part 22: Luminaires for emergency lighting
c. SANS 10114-1: Interior lighting Part 1: Artificial lighting of interiors
d. SANS 10114-2: Interior lighting Part 2: Emergency lighting
e. SANS 10389-1-3: Exterior lighting Part 1-3
f. SANS 61547: Equipment for general lighting purposes – EMC immunity requirements
g. SANS 62560: Self-ballasted LED lamps for general lighting services by voltage > 50V - Safety specifications
h. SANS 62031: LED modules for general lighting – Safety specifications
i. SANS 60598: Luminaires - Part 1: General requirements and tests
j. SANS 1662: Self ballasted LED Tubular lamps for general lighting services > 50V -Safety requirements.
k. SANS 62612: Self ballasted LED lamps for general lighting services with supply voltages > 50V - Performance requirements.

A4.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

a. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
b. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A4.2 LED LIGHTING FIXTURES

A. General

Furnish and install LED lighting fixtures of the types and manufacturers scheduled on the Drawings. Fixtures shall be furnished with all required accessories and trim for a complete installation in the ceiling type shown on the Architectural Drawings.

B. Lamps

LED fixtures shall be complete with lamps of the type, colour, wattage and size indicated on the Luminaire Schedule, or as specified by the lighting fixture manufacturer. Unless otherwise noted, all lamps shall be Cool white.

C. Minimum requirements
   a. The minimum lamp life should be equal or greater than 30 000 hours.
   b. The Colour Rendering Index (CRI) must be 80 or greater.
   c. Power factor must be greater than 0.9.
   d. Test reports from an approved and accredited test laboratory must be submitted when called for.
   e. Alternate fixture manufacturers shall submit computer generated illumination calculations and files (.ies) to the engineer for approval.

D. Luminaire Markings

All products shall be marked according to SANS 62031 as follows:

a. Lamp rating in Watts
b. Lamp life in hours
c. Colour Correlated Temperature (CCT) or colour name.
d. Colour Rending Index (CRI)
e. Initial lamp life output
f. Energy Efficiency Marking /label per SANS codes.

A4.3 AREA AND FLOODLIGHTING FIXTURES

a. Area and Floodlighting fixtures have been selected for specific features, beam characteristics and style. Alternate fixtures will be considered for approval based upon compliance with procedures as described below.
b. Alternate fixture manufacturers shall submit computer generated illumination calculations and files (.ies) to the engineer for approval.
c. Floodlighting fixtures shall consist of a cast aluminium housing and housing door assembly. The housing shall contain the optical components and a removable ballast drawer assembly. The unit shall be supported by cast aluminium, adjustable mounting bracket. The unit shall contain no weep or drain holes. A filtered vent hole into the fitter chamber shall be provided. The entire unit shall be classified as a sealed type. It shall bear an IP rating.
d. Housing shall be a single piece aluminium casting, forming a watertight shell. It shall contain the electrical and optical component compartments.
e. Housing door shall be cast aluminium and shall hold a tempered heat and impact resistant clear glass lens. It shall be gasketed with high temperature resistant gasket and shall be hinged to the fixture housing with a non-corrosive hinge assembly. It shall be held closed with corrosion resistant captive screws, or stainless steel, spring loaded, quick release latches.
f. All gasketing material shall be high temperature resistant rubber. All areas that are gasketed shall be of metal to metal or metal to glass interface contact design, to control gasket compression. All gasketing shall provide component compartment sealing, to prevent external atmospheric containment intrusion.
g. Ballast assembly shall be a self-contained, removable tray assembly of modular design and shall contain all electrical components of the ballast. It shall have a polarized, quick disconnect, mate and lock power input plug. It shall be field interchangeable without requiring the luminaire to be removed. The ballast shall be specifically designed for the lamp type specified and at the voltage specified. Ballast shall be constant wattage autotransformer, high power factor type, with starting current less than operating current.
h. The socket shall be mogul porcelain enclosed and shall have a spring-loaded, centre contact. It shall be properly positioned to allow correct location of the lamp in the reflector assembly. It shall be specifically designed to withstand the high voltage impulse needed to start the lamp.
i. Reflector assembly shall be construction of high purity, reflective aluminium material, and shall be designed to provide optimum photometric results in conjunction with the fixtures and the light sources for which they are designed. Fixtures must be available with a minimum of four different reflector assemblies to provide various photometry performances.
j. Glare shields will be available.
k. All painted parts shall be coated with powder coat thermoset polyester enamel, formulated to provide no appreciable fading, blistering, or peeling within five (5) years. Colour shall be as specified in the lighting schedule.

A4.4 SUBMITTALS

Shop drawings submittals shall include, but not be limited to, the following:

a. Cut sheets on all lighting fixtures with all accessories and details clearly indicated.
b. Cut sheets and complete technical data on ballasts, lamps, lens, poles, etc.
c. Photometric performance data.
d. Computer generated illumination calculations in the latest DIAlux format and files (.ies) to the engineer for approval.
e. Additional information as required.

A4.5 INSTALLATION

a. All lighting fixtures shall be furnished complete with mounting accessories to suit the specific service and installation intended. The Electrical Contractor shall verify the required fixture ceiling/trim coordination prior to light fixture orders.
b. Fixtures shown on the fixture schedule to be recessed shall be complete with plaster frames, mounting yokes, rod hangers, etc., and/or any other accessories required to fit the fixture to the ceiling construction.
c. However, where ceiling system cannot maintain said support, provide supplemental steel support members connected to the building structure capable of carrying the weight of the fixture plus 100kg at each support without sagging. Provide the necessary supports for hangers located between structural members. Securely fasten the luminaire to the ceiling framing members. In plaster ceilings, provide threaded hanger rods secured to the main ceiling suspension structure and supplementary horizontal steel members as required, and to the luminaire housing, using two nuts at each end of rod.
d. Connect each ceiling-recessed luminaire into the conduit system by means of flexible cabtyre cable with plug top not more than 3m or less than 1.2m in length routed from an above-ceiling outlet point.
e. Provide alignment clips on all pendant or ceiling mounted luminaries used in continuous rows.
f. Chain-suspended lighting fixtures shall be connected to the outlet box mounted directly above the fixture using flexible metallic conduit, and the flexible metallic conduit shall be strapped to the fixture chain.
g. Fixture supports shall be provided in all outlet boxes from which fixtures are suspended. Fixtures shall not be suspended by means of cover or canopy screws. Canopies shall completely cover the ceiling opening of all ceiling fixtures except lay-in fixtures in T-bar construction, and tramless fixtures.
h. Where surface mounted lighting fixtures (i.e., exit lights, etc.) are installed on lay-in panels in T-bar ceiling construction, the outlet boxes shall be rigidly supported to the ceiling system using metal channels spanning perpendicular across the T-bars and securely attached to each side of the outlet box.
i. Connect each fixture housing to the equipment grounding conductor by means of a crimped spade-type terminal connector secured to the housing with a self-tapping screw.
j. All fixtures shall be clean at the time of acceptance of the Work and shall be properly aimed or adjustable as required. No extra will be permitted for cleaning, aiming or adjustable fixtures to meet the requirements of the Engineer at the time of acceptance of the Work.
k. All lamps used during construction and prior to final inspection, shall be replaced prior to final acceptance of the building by the Owner.
l. The locations indicated for outlet boxes of lighting fixtures are diagrammatic. Outlets shall be located as required to coincide with suspension hangers where they occur and with structural an architectural element of the building and shall be located in accordance with the Architectural Reflected Ceiling Plan (RCP).

A4.6 MOUNTING AND POSITIONING OF LUMINAIRES

f. 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 about the ceiling pattern.
g. The layout of the luminaires as indicated on the drawings must be adhered to as far as possible and must be confirmed with the Engineer or representative.
h. Earth conductors must be drawn in with the circuit wiring and connected to the earthing terminal of all luminaires as well as other luminaires exposed to the weather in accordance with the “Wiring Code”.
i. Luminaires are to be screwed directly to outlet boxes in concrete slabs. Against board ceilings the luminaires shall be secured to the brandering or joists by means of two 40mm x No. 8 round head screws.

A4.7 LUMINAIRE IDENTIFICATION

a. Lighting outlets are numbered on the drawings.

b. The numbering of the outlets defines the circuitry and control required. Each luminaire shall be furnished with the wattage and colour as specified or as implied by the catalogue number of the luminaires specified.
c. The luminaire shall bear the SANS 60598-2-3 and SANS 60598-2-5 safety mark or equivalent international rating. The luminaire shall have a Ta rating not less than = 40ºC. The luminaire shall be manufactured by an ISO 9002 accredited company. The luminaires company shall be an ISO Marked Bearing Company or International Equivalent.

A4.8 GENERAL

The electrical subcontractor shall only commence with the installation of light fittings after the paintwork in the vicinity of the fitting is complete and dry. Care shall be taken to ensure that ceiling boards and paintwork is not damaged during the installation of light fittings. The type of light fittings to be used are indicated and specified on both the relevant drawings as well as in the lighting schedule.

A. Positions of light fittings

The mounting positions of light fittings are indicated on the relevant drawings and shall be verified on site.

B. Mounting heights of light switches

Light switches shall be installed 1,4 metres above finished floor level unless specified to the contrary.

C. Mounting of light fittings
a. Surface mounted fittings shall be screwed to the ceiling by means of at least two 4 mm diameter electroplated self-tapping screws.
b. On concrete, plastered and brick surfaces good quality plastic expansion plugs shall be used and on suspended and soft ceilings a solid timber backing strip of at least 40 x 40 mm timber shall be supplied and installed between supports and the screws fixed to these backing strips.
c. Surface mounted fittings will be rigidly mounted to ensure close contact with the ceiling over the entire length of the fitting.
d. On concrete slabs the fittings shall be mounted by means of two screws into the ceiling conduit box as well as two round headed 4 mm x 30 mm electroplated self-tapping screws and plastic expansion plugs, one at either end.
e. On suspended ceilings the fittings shall be similarly mounted but timber backing strips of at least 40 x 40 x 450 mm shall be placed in position on top of the ceiling board and the end screws secured to these strips to spread the load.

A5. STREET AND AREA LIGHTING

A5.1 QUALITY ASSURANCE

A5.1.1 CODES AND STANDARDS

The Street and area lighting fixtures shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards. The latest issue of:

a. SANS 10225: The design and construction of lighting masts
b. SANS 15607: Specification and qualification of welding procedures for metallic materials – General rules
c. SANS 15609: Specification and qualification of welding procedures for metallic materials - Welding procedure specification Part 1: Arc welding
d. SANS 62: Steel pipes Part 1: Pipes suitable for threading and of nominal size not exceeding 150 mm.
e. SANS 62: Steel pipes Part 2: Screwed pieces and pipe fittings of nominal size not exceeding 150 mm.
f. SANS 657: Steel tubes for non-pressure purposes Part 1: Sections for scaffolding, general engineering, and structural applications
g. SANS 121/ISO 1461: Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods
h. SANS 10098-1: Public lighting Part 1: The lighting of public thoroughfares.
i. SANS 10098-2: Public lighting Part 2: The lighting of certain specific areas of streets and highways
j. ARP 035: Guidelines for the installation and maintenance of street lighting
k. SANS 60598-1: Luminaires Part 1: General requirements and tests
l. SANS 60598-2-3: Luminaires Part 2-3: Particular requirements - Luminaires for road and street lighting
m. SANS 1088: Luminaire entries and spigots

A5.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

a. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
b. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A5.1.3 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A5.2 SECURITY LIGHTING/AREA LIGHTING

a. Security lighting to be manufactured to SANS specification and suitable for use as per SANS 10098.
b. The luminaires shall be delivered completely assembled with housing, ballast, photoelectric control unit, lighting management system and protector lens. Luminaires shall be Class 1 of IEC 60598-1 and be of the totally enclosed type. The luminaire output shall be provided as nominal flux at Tq of 35 ^{0}C.
c. The luminaires shall have minimum rating of IP 65 in accordance with SANS 60529 for both the light and ballast compartments, when normally mounted as per SANS 475.

d. A Security lighting Management system is to be incorporated as part as the security lighting installation. Contractors and suppliers are to ensure that the security lighting supplied is fully compatible with the security lighting management system supplied. The lights should be able to be controlled locally and remotely from a remote computer.

A5.3 CONSTRUCTION OF LUMINAIRES

a. The housing shall be robustly constructed, weatherproof, hail proof, insects proof, corrosion proof, ultraviolet light resistant and vandal resistant. Luminaires shall be suitable for operation at an ambient temperature, Ta, of 35^{o}C. Fixing devices, junctions, lips and the like shall be designed to shed water. Pockets and ledges in which condensation may accumulate shall be avoided.
b. The luminaires shall be supplied with a built-in PECU capable of performing a minimum of 8 000 switching operations under full load and shall be located in a position where it is least likely to be affected by luminaire heat.
c. LED luminaires shall contain a heat sink with no fans, pumps or liquids, and the design of the heat sink shall prevent the accumulation of dirt and nesting of insects or ants, thus ensuring effective heat dissipation.
d. The luminaires shall be constructed from light weight durable materials which for all parts shall be compatible and failure or deterioration shall not occur due to electrolytic action or by differential thermal expansion. Where glass reinforced polyester (GRP) is used it shall comply with the requirements of SANS 141 for Type F laminate products. Luminaires manufactured from polymeric material shall be ultraviolet stabilized. Luminaires shall have successfully passed the accelerated ageing test specified in SANS 60598.
e. Luminaires with aluminium housings shall be of grade LM 6 (EN1706 AC-44100) (or higher) aluminium alloy and shall comply with BS 1490. Bidders offering aluminium housings shall submit a metallurgical report from an independent metallurgist confirming the grade of aluminium for all the luminaires offered. The client reserves the right to submit luminaires for metallurgical testing when necessary.
f. Powder coated luminaires shall be light grey or white in colour. A powder coating that cracks because of corrosion of the aluminium base shall be considered a failure under warranty.
g. Ferrous components shall be hot dip galvanised and shall withstand the test specified in the current edition of SANS 121 for heavy duty application.
h. Small components (such as toggle clips, bolts, screws, nuts, washers) shall be manufactured of stainless steel (grade 304 or better).
i. Due attention shall be paid to the accessibility of parts and to other requirements necessary for efficient maintenance and cleaning, where required. If screws are used to secure covers, they shall be held captive when opened.
j. The ballast or driver shall be mounted internally and be replaceable with the aid of commonly available hand tools.
k. The LED module or array shall be designed in such a way that the failure of one LED shall not cause additional LEDs to switch-off.

A5.4 PROTECTOR LENS

a. The protector shall be resistant to heat and shall not discolour after prolonged exposure to the atmosphere or artificial light. Protectors manufactured from high-impact acrylic shall be ultra-violet stabilized. Bidders shall submit certified data regarding degradation of the material and depreciation of light transmission under working conditions, namely temperature and ultra-violet irradiation. Polycarbonate protectors are not acceptable. High-impact glass is the preferred material for the protector lens.
b. A protector, when fitted, shall form a seal preventing the entry of moisture, dust and insects into the lamp housing. A one-piece gasket shall be used for this purpose. The material of the gasket shall be a silicon sponge material and shall not deteriorate or suffer permanent deformation during the life of the luminaire. The gaskets shall not deteriorate due to light, heat or compression to which they will be exposed in practice and shall be screened against radiation from the light source.

c. The gasket shall be fitted into a groove in the housing and shall be kept in place by a tongue provided on the diffuser, thus ensuring the integrity of the IP65 rating. Further, the gaskets shall not work loose during maintenance of the luminaire.

A5.5 POWER SUPPLY OR DRIVER REQUIREMENTS

a. LED module(s) drivers shall be housed fully within the body of the luminaire and be suitable for operation with the specified rating of luminaire.
b. The output frequency of the drivers shall be 100 Hz or greater, to avoid visible flicker.
c. The harmonic distortion levels of the LED module driver(s) shall comply with the limits given in SANS 61000-3-2.
d. The LED module driver(s) shall operate at a power factor of 0,85 or greater, and the harmonic distortion levels shall be limited to not cause interference on the electrical network.
e. The power supply or driver compartment (containing the LED module driver) shall be sealed by a hinged non-corrosive, light-weight cover and shall be accessible from underneath. No components shall be mounted onto this cover. The cover shall be secured onto the fitting such that the provisions of clause 8.2 of IEC 60598 are met. Screws or bolts, if used, shall be held captive once loosened. Control gear shall be mounted on a removable gear-tray for ease of maintenance and not on the access door.
f. The power supply or driver compartment shall be so designed that there is sufficient space to permit repairs, replacement of components and reassembly without difficultly and without the removal of the luminaire from its mounting.

A5.6 EARTHING

a. The luminaire shall be earthed in accordance with Clause 13 of the Electrical Machinery Regulations of the OHS ACT (Act 85 of 1993).
b. Metal parts of luminaires which may become alive in the event of an insulation failure, and which are not accessible when the luminaire is mounted but liable to come into contact with the supporting surface shall be permanently and reliably connected to an earthing terminal and shall withstand the test specified in IEC 60598-2-3.
c. Protection against electric shock shall be maintained for all methods and positions of installation in normal use. Protection shall also be maintained after removal of all parts which can be removed by hand, except those parts of lamp holders specified in SANS 60238.
d. Earthing terminals shall comply with sub-clause 7.2 of IEC 60598-1. All parts of an earth terminal shall be made of brass or other corrosion resistant metal and the contact surfaces shall be bare metal and not painted or varnished surfaces.
e. All earth connections shall be affected by means of suitable lugs appropriately made to avoid all possibility of electrolytic corrosion.
f. An earth connection shall be provided in all instances, even if the luminaire is fully insulated and even if all conductive parts, which could become alive in the event of an insulation fault, are not accessible. This is to facilitate future wiring should the luminaire be replaced by a unit which requires an earth connection.

A5.7 PHOTO-ELECTRIC CONTROL UNIT (PECU)

a. The luminaires or Street lighting kiosk as per drawings shall be supplied with a PECU capable of performing a minimum of 8 000 switching operations under full load and shall be located in a position where it is least likely to be affected by luminaire light.
b. The switch on photometric level of the PECU shall be at 25 lux ± 10%.
c. The switch off photometric level of the PECU shall be at 15 lux ±10%.
d. The PECU shall be designed to fail to the “off” state of the switch.
e. The degree of protection provided to any part of a PECU which is open to the environment shall be at least IP 65 in accordance with SANS 60529.
f. All materials used in the manufacture of the PECU shall be UV stabilized in such a way that damage due to solar radiation will not cause the photometric performance of the PECU to deteriorate beyond the specified limits within a period of at least 10 years.
g. The changeover switch shall be capable of switching 10 Amps alternating current at 230volts.

h. The unit shall comprise a photocell, thermal actuator, and change-over switch. The cover of the unit shall be manufactured from a tough, durable material providing protection against tampering. The cover shall have good weathering properties. It shall be ultraviolet resistant and shall not deteriorate when exposed to sunlight for prolonged periods.
i. The operation level shall be factory pre-set for "ON" and "OFF" at a light level as indicated. Voltage variations shall not materially affect the operational levels.
j. A time delay of not less than 15 seconds shall be provided to prevent the unit from functioning due to lightning or other short period changes in illumination.
k. The unit shall be effectively safeguarded against voltage surges by means of a suitable surge protector which shall preferably form an integral part of the unit.
l. The unit shall be of the two-part, base and daylight switch type and shall be supplied complete.

A5.8 WIRING

a. The internal wiring of the luminaires shall be flexible and suitably insulated to withstand the voltage and the temperature encountered in service. Wiring colours shall be live-brown (or red), neutral-blue (or black) and earth-green/yellow.
b. Wiring to the Light / LED module compartment shall be suitably grommeted to prevent the ingress of insects into the light / LED module compartment.
c. The supply terminals shall accept 4mm^2 wires and be easily accessible. No part of the cover shall damage the supply wires when closed.

A5.9 LUMINAIRE MARKINGS

a. Each luminaire shall be distinctly marked with black writing on a white background using 25 mm high lettering on the outside of the control gear compartment, such that it is clearly visible from the ground, with the following information:
   - Rated wattage of luminaire *and lamp type* in accordance with the description specified in Schedule A, e.g., 50 W *LED*: and
   - The name of supplier followed by the luminaire model, e.g., *SUPPLIER X, LUMINAIRE MODEL NAME*.
b. Each luminaire shall bear the name or trademark of the manufacturer and the date of manufacture.
c. Luminaires delivered without the specified markings shall be rejected.

A5.10 LUMINAIRE PACKAGING

Each luminaire shall be delivered completely assembled ready for use and shall be individually packed in suitable containers such as cardboard boxes. The luminaires may be packed two per box. The containers shall be marked with appropriate description and stock code of the luminaire contained within.

A5.11 LUMINAIRE DOCUMENTATION

Full technical and descriptive details, relating to all the items offered shall be submitted so the offer can be fully evaluated. This shall include:

a. Actual design data and results, and encrypted luminaire data files in an electronic format.
b. Name of luminaire.
c. The method of manufacture of the Luminaire.
d. The dimension & weight of the Luminaire.
e. The self-cleaning properties of the Luminaire.
f. The cooling mechanism of the Luminaire to adequately dissipate heat.
g. Country of design, manufacture, and assembly.
h. Standards to which the luminaire conforms to (National & International).
i. Specify life span of LED Module driver(s) or Power Supply.

A5.12 LUMINAIRE SPARES

a. Bidders shall state their recommendations regarding the stocking of spare parts, which will be ordered at the discretion of the client and shall indicate whether such spare parts are available ex local stocks.
b. Any spare apparatus shall be subject to the same specification, tests and conditions as similar material supplied under the main contract.

A5.13 LUMINAIRE TEST REPORTS

a. Failure to provide test reports of the following tests called for may result in the rejection of the Bid:
    - Type test according to IEC 60598-1:2004 and IEC 60598-2-3:2003.
    - IP rating test reports for all items offered in accordance with SANS 60529.
b. A separate ambient temperature (Ta rating) test report shall be provided, in accordance with SANS 475.
c. The test reports shall be issued by SANS or IEC accredited test authority.
d. Bidders offering luminaires with aluminium housings shall submit a metallurgical report confirming the grade of aluminium.
e. Certified data from a recognised test authority regarding degradation of the material and depreciation of light transmission under working conditions, i.e., temperature and ultra-violet irradiation for the following:
    - material of the body.
    - material of the bowl.
    - material of the reflector.

The performance test reports which include the following:

- Photometric requirements.
- Static wind force test.
- External and internal wiring.
- Protection against electric shock.
- Thermal tests.
- Power factor.
- Resistance to corrosion.
- Insulation resistance and electric strength.
- Resistance to heat, fire, and tracking; and
- Accelerated ageing tests.

f. An encrypted luminaire data file for each luminaire offered in an electronic format suitable for use with the DIAlux Lighting Design Software package. The encrypted data file shall be produced by an accredited independent laboratory. This data file shall be supplied on a CD or flash drive with each bid.
g. Failure to submit such information may preclude further consideration of the bid.

A5.14 MATERIAL TESTING

Luminaires offered may be subjected to an accelerated aging test to evaluate the design and quality of materials used.

A5.15 TECHNICAL SPECIFICATION FOR STEEL SURITY LIGHTING POLES

A5.15.1 GENERAL

A. Scope

This specification details the manufacture, supply, delivery, off-loading and stacking of vertical security lighting poles as specified below and in the Bill of Quantities as depicted on drawings.

B. System and service conditions

The Security lighting poles shall be for outdoor use in the area of installation and shall be suitable for conditions as set out in Section 0002: Design Criteria.

C. Design Data
   a. The steel tubes shall comply fully with SANS 657: Part 1 except were amended herein. All items shall be manufactured from new materials.
   b. The steel security lighting poles shall be designed to support two luminaire of unit mass of approximately 24.2 kg.
   c. The steel security lighting poles shall be manufactured of grade 300W steel or equivalent, in accordance with SANS 657 with a minimum yield stress of 300 MPa and a minimum tensile strength of 450 MPA.
   d. The steel security lighting poles shall be capable of withstanding a fluctuating wind load in accordance with the requirements of SANS 10225.
   e. The maximum horizontal deflection at the spigot end, when subjected to two thirds of the design loading, shall not exceed 0,025 of the developed length above ground.
   f. The maximum vertical deflection at the spigot end, when subjected to the mass of the luminaries shall not exceed 1,5 % of the total length of the pole.
   g. Tenders must be accompanied by full technical details including comprehensive strength calculations certified by a qualified professional structural engineer.
   h. Design wind speed: Terrain Category 2 with wind speed of 144km/ hour

D. Security lighting poles
   a. The steel security lighting poles shall have minimum wall thicknesses as indicated on the drawings.
   b. Protection sleeves shall be fully seal welded onto the steel security lighting poles. The dimensions of the protection sleeves shall be 600 mm long mild steel with a thickness of at least 3,5 mm and shall extend 300 mm above and below ground level.
   c. Base plates, as per drawings shall be fitted to all steel security lighting poles.
   d. A fuse box opening 300 mm long, 95 mm wide shall be provided 1000- 3000 mm above the ground line as indicated on the drawings. All edges are to be free from burrs and protrusions. The pole dimensions shown shall be increased to provide the required modulus of section or, alternatively, interior reinforcing shall be provided, should either of these requirements be necessary. A M6 stainless steel set screw (for earthing purposes) shall be fitted adjacent to the stud which is used to fasten the cover plate for the fuse box opening.
   e. Alternative shapes of fuse - box openings may be considered but drawings showing full details of the proposed alternative arrangements shall be submitted with tender for approval.

E. Cover plate for fuse box opening.
   a. A curved mild steel cover plate of the same wall thickness as the steel pole shall be fitted to cover the fuse box opening. The cover plate shall be permanently attached to the pole by a fixing mechanism e.g., chain which shall be welded onto both the cover plate and pole. The plate shall be secured in the closed position by means of a M10 - 25 mm galvanized or stainless-steel stud welded to the pole, and a unique heptagonal (seven-sided) M10 stainless steel or brass nut. Once the cover is secured to the pole the nut shall not protrude beyond the diameter of the pole, and it shall only be possible to remove the nut with the aid of a tube spanner. The tenderer shall submit a fully detailed working drawing of any alternative cover and fixing mechanism offered, e.g., for cover plates of UV stabilised, impact resistant plastic. Due to the prevalence of removal and theft of cover plates by vandals within the area of supply, preference will be given to designs whereby the cover plate sits flush with the exterior surface in order to prevent external leverage by means of tools and other implements.
   b. The cover plate shall fit against the steel streetlight pole to give a flush exterior appearance.
   c. A one-piece silicon gasket (approximately 2 mm thick) shall be provided for sealing the cover plate to the pole.

F. Cable access

For all steel security lighting poles, two 100 mm _ 65 mm slot shall be cut opposite one another at 90^{o} to the fuse-box opening. The slots shall be well radiused and free of burrs.

G. Alternative Designs
   a. Alternative designs of steel security lighting poles may be considered for acceptance provided that the poles are supplied in one piece.

b. For the alternative design, the tenderer shall submit with its tender, fully dimensioned drawings, and design calculations. These designs and calculations shall have been carried out by a qualified professional structural engineer. Documentary proof of compliance with this requirement will be required. It shall be required that the fuse box opening, cover plates, cable entries, protection sleeves, fins, spigots and joints be in accordance with the drawings submitted.

H. Welding

All welding shall be continuous and in compliance with SANS 15607/SANS 15609. All welds shall be dressed where necessary. No welded pieces (pipe reducers) shall be inserted in the poles. All joints shall be bevelled prior to welding and shall present a symmetrical appearance after welding.

I. Protection against Corrosion

a. Before galvanizing, all weld slag shall be removed from each pole by shot- or sandblasting and a visual inspection shall be carried out to ensure the efficiency of this operation. All items shall be hot dip galvanized in accordance with SANS ISO 121/ISO 1461.
b. No plugging at the ends of the poles during galvanizing shall be acceptable. The process used, shall comply completely with the requirements of SANS 121/ISO 1461 and the thickness of galvanizing shall comply with the thickness laid down in that standard for the various diameters. Manufacturers shall produce certificates to the satisfaction of the Engineer with Methods and Standards showing that the specified thickness of galvanizing has been attained.

A5.15.2 MARKING

a. The steel security lighting pole shall be clearly stamped, 50 mm below the fuse box cover plate, with 12 mm number and letter punches with the following:
   - the Contract number,
   - the manufacturer's name, and
   - the pole size.
b. The lettering and numbers shall be clearly visible after hot-dip galvanizing.
c. Alternative methods of marking poles may be considered provided that a full description of the marking process shall be submitted with the tender documents.

A5.15.3 INSPECTION

In addition to the requirements listed below, all poles shall comply with the test requirements of SANS 0225.

A5.15.4 PRIORITY OF WRITTEN SPECIFICATION

In the event of any disagreement between the written specification and the drawings, the written specification will take priority over the drawing(s).

A5.16 CONCRETE ENCASEMENT OF SERVICES

a. Should the drawings or Bill of Quantities specify concrete encasement of services, the following is to be adhered to with regards to in-situ 20MPa Concrete Encasement of low voltage cables, sleeves for Low Voltage, ICT services and other future services.
b. The unit of measure shall be the length of concrete encasement constructed and finished.
c. The concrete encasement shall be 250mm wide x 400mm deep for service sleeves and 300mm wide x 200mm deep for cables alone.
d. All LV and intermediate voltage cables shall be totally encased in concrete and enforced using bonding agent and chicken wire mesh.
e. Encasements shall be done in one-meter sections. Service sleeves are laid into position as per construction drawings as well as shuttering installed to obtain a class F1 surface finish. The concrete encasement will be constructed of standard 20MPa concrete with 19mm grade crush stone size.

f. Furthermore, cube tests shall be performed on the concrete and results submitted to the Engineer.
g. One set of cubes shall be submitted to the engineer for independent testing.

A5.17 SUBMITTALS

Shop drawings submittals shall include, but not be limited to, the following:

a. Cut sheets on all lighting fixtures with all accessories and details clearly indicated.
b. Cut sheets and complete technical data on ballasts, lamps, lens, poles, etc.
c. Photometric performance data.
d. Detailed information of the pole dimensions
e. Test reports and certificates of thickness of galvanising
f. Additional information as required.

A5.18 INSTALLATION

Mounting and installation of luminaires for security light to be in accordance with the manufacturer's recommendations. Due to the mounting height of the luminaires

A5.19 MOUNTING

a. Security arms are inclined at 60^0 to the horizontal. If the luminaire offered is designed to be installed at 0^0 it shall have a mechanism to allow adjustment back to 0^0. The luminaire shall be clearly marked with angles of inclination, and full details of how to adjust the angle of inclination shall be supplied. The angle of inclination must be clearly stated as this affects design data.
b. Luminaire entries shall be of a material that is inherently corrosion resistant and compatible with the galvanised mild steel supporting spigot to such a degree that deterioration by electrolytic action will not occur.
c. Spigot entries shall be designed to fit easily over the bracket pipe and shall be truly parallel to the fitting axis and shall comply with Table 1 of SANS 1088:1990 as follows:
   - For Type 2 luminaires (side entry), the inside diameter of the spigot entry shall be 50 mm to 55 mm.
d. The luminaire shall be secured on its spigot by at least two stainless steel M10 hexagonal-head screws as specified in ISO 4762. The construction of the housing shall be such that cracking cannot occur during the process of fixing the luminaire to the pole or bracket.

A5.20 GENERAL

a. The electrical subcontractor shall only commence with the installation of light poles or masts after the surrounding final civil finish level has been established or completed. The type of light fittings to be used are indicated and specified on both the relevant drawings as well as in the lighting schedule.
b. Positions of light fittings
   - The mounting positions of light fittings are indicated on the relevant drawings and shall be verified on site.

A5.21 GUARANTEE

a. All luminaires offered shall have a minimum guarantee period of five years. The scope of this guarantee includes the LED module drivers, luminaire housing, LED module(s), brackets, photoelectric control unit receptacle, protector lens. If luminaires are found to have failed within this period because of poor manufacturing processes and/or poor materials it shall be replaced free of charge by the manufacturer.
b. Luminaires bearing a date of manufacture exceeding four months prior to the date of delivery shall not be accepted.

A6. CIRCUIT WIRING AND OUTLET POINTS

A6.1 QUALITY ASSURANCE

A6.1.1 CODES AND STANDARDS

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

a. The latest issue of SANS 60614 and SANS 61035, parts 1 and 2: Metallic conduit and accessories
b. The latest issue of SANS 950: Non-metallic conduit and accessories
c. The latest issue of SANS 1507: Electric cables with extruded solid dielectric insulation for fixed installations.

A6.2 CONDUCTORS

A. General
   a. All wiring shall, unless expressly stated otherwise in the detail specification, comprise of PVC insulated, stranded copper conductors and bare stranded copper or green PVC insulated, stranded earth continuity conductors. The conductors shall comprise of high conductivity annealed stranded copper conductors and shall be insulated with general purpose PVC, of the 600/1000 grade. All conductors used for the wiring of the electrical installation shall comply with SANS 1507.
   b. Conductors shall be from new stocks and shall be delivered to site with unbroken seals.

B. The following PVC insulated unarmoured cables with a bare earth conductor are considered:
   a. PVC insulated flat multicore cable with a bare earth conductor.
   b. PVC insulated round multicore cable with a bare earth conductor and with metal stiffening.

C. Wiring Terminals
   a. Terminal bodies and screws shall be constructed from non-corrosive metal, enclosed in fire resistant, moulded plastic insulating bodies. No part of the terminal body or fastening screws shall project beyond the insulating material which shall afford suitable protection against accidental contact by personnel and against short circuits or tracking.
   b. The terminal block and its associated mounting rail shall be constructed in such a manner as to ensure a firm and positive fastening of the terminal block to the rail. Terminal blocks shall be held in position by means of standard end clamps. It shall furthermore be possible to extend the terminal block by adding additional terminal blocks within the terminal sequence without having to disconnect or dismantle the terminal strip.
   c. It shall be possible to intermix terminals of various sizes, for different conductor sizes, whilst utilising the same mounting rail. Where smaller terminal blocks occur adjacent to larger terminal blocks, suitable shielding barriers shall be inserted to conceal the terminals that might otherwise be exposed.
   d. The terminal bodies and clamping screws shall be so constructed as to ensure that conductors are not needed or severed when the clamping screws are tightened. Screws shall not come into direct contact with the conductors. Each terminal block shall have provision for clip-in numbering or labelling strips to be installed, together with protective, clear caps over the sheets.

A6.3 INSTALLATION

A. General

The electrical subcontractor shall ensure that the wiring of the electrical installation for the building or other structure is carried out in accordance with SANS 10142.

B. Wireways

All unarmoured conductors shall be installed in conduits, trunking or power skirting and such conductors shall under no circumstances be exposed.

C. Circuits

The circuits for the complete electrical installation are indicated on the relevant drawings. The following are the maximum number of points normally connected to each type of circuit unless otherwise indicated on the drawings:

a. Light points per circuit = 8
b. Socket outlets per circuit =6
c. Air conditioner points per circuit = 2
d. Stoves, Geyser etc = 1

Conductors supplying circuits which are fed from different switchboards shall not be installed in the same wireway. The wiring of one circuit only will be allowed in a 20 mm diameter conduit, except for the wiring from switch boards to fabricated sheet metal boxes located close to switchboards, in which case more than one circuit will be allowed. For larger conduit sizes the requirements of SANS 10142 shall be met.

D. Looping and joints

A loop-in wiring system where conductors are looped from outlet to outlet shall be employed. Joints in conductors shall be avoided as far as possible but where it becomes unavoidable, joints will be accepted in cable channels only and not in conduits. Joints shall be soldered or shall alternatively consist of approved ferruling properly covered with the correct size heat-shrink sleeves. The use of PVC insulation tape is not acceptable.

E. Grouping of conductors

In cases where the conductors of more than one circuit are installed in the same wireway, the conductors of each separate circuit, including the circuit earth continuity conductor, shall be grouped at intervals of at least one (1) metre using plastic cable ties. The conductors of different circuits shall however remain separate to ensure that any given circuit may be withdrawn from the wireway. Conductors entering distribution boards or control boards shall be grouped and bound by means of plastic cable bands. The use of PVC insulation tape for grouping conductors will not be accepted.

F. Pulling-through of conductors

The electrical subcontractor shall take utmost care whilst pulling conductors through conduit to ensure that the conductors are not kinked, twisted or strained in any manner. Care shall furthermore be taken to ensure that conductors do not meet materials or surfaces that may damage or otherwise adversely affect the insulation and durability of the conductor.

G. Conductor colours

The colours of conductor PVC insulation shall comply with SANS 10142.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 the wiring of two-way and intermediate switches shall preferably differ from the colour of phase conductors.

H. Earth continuity conductors

a. Bare copper earth continuity conductors or green PVC insulated stranded copper earth continuity conductors, as specified in the detail specification, shall be used throughout the installation.
b. When earth continuity conductors are looped between earth terminals of equipment, the looped conductor ends shall be twisted together and then ferruled or soldered to ensure that a positive earth continuity is maintained when the conductors are removed from any earth terminal.
c. Where bare copper earth wires are specified for circuits installed in power skirting and floor ducting, the electrical subcontractor shall provide a suitable length of PVC sleeving over the bare earth conductor where it passes behind or is connected to power outlets to ensure that such an earth conductor does not meet any live parts.

I. Wiring inside vertical wireways

Conductors installed in vertical wireways shall be secured at intervals not exceeding 5m to support the weight of the conductors. Approved clamps shall be supplied and installed in suitable draw-boxes for this purpose.

J. Conductor sizes

The conductor size for each circuit type is specified in the detail specification. In the event that a conductor size is not specified in the detail specification, the following minimum conductor sizes shall be used:

Circuit	Minimum Conductor (Size)	
	Phase (mm^2)	Earth (mm^2)
Lighting	2,5	2,5
Socket outlet	2,5	2,5
Stove	6.0	6.0
Air-conditioner	4.0	4.0
Geyser	6.0	6.0

K. Single pole switches

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

L. Three phase outlets
   a. With the exception of three phase outlets, wirings to circuits connected to different phases shall not normally be present at lighting, switch or socket outlet boxes. Where this is unavoidable, barriers shall be provided between terminals or connections of the various phases and the box shall be suitably labelled internally and externally to indicate the presence of three phase voltages.
   b. A separate neutral conductor shall be installed together with each three-phase circuit to outlets intended for equipment connection by means of isolators or sockets, irrespective of whether the particular equipment normally requires a neutral or not.

M. Connections
   a. The insulation of conductors shall only be removed over the portion of the conductors that enter the terminals of switches, socket-outlets, or other equipment. When more than one conductor enters a terminal, the strands shall be securely twisted together.
   b. Under no circumstances shall any of the strands be removed to enable easier insertion of the conductors into terminals.
   c. No more than two conductors shall be permitted to be fastened to any one terminal. The electrical contractor shall take care to ensure that the copper strands are not kicked during the removal of the insulation. PVC insulated conductors shall not be used for the direct connection to equipment where the temperature exceeds 75°C, such as stoves, geysers, electric water heaters and high-power LED lamps. Silicon coated or other approved conductors shall be used in such cases.

N. Terminals

Terminals shall be sized and current rated to match the conductors that are connected to them.

A6.4 POWER OUTLETS

A. General

The electrical contractors shall only commence with the installation of power outlets in the conduit outlets allowed therefore of the plasterer and painter have completed their work in the vicinity of the outlet.

B. Socket outlets with switches

a. All socket outlets with switches shall be of the standard 16A 3-pin pattern, white in colour. Emergency socket outlets shall be red, with the flattened earth pin on top. UPS outlets shall be blue, with the flattened earth pin on the right.
b. Units for flush mounting shall be suitable for 100 x 100 x 50 mm deep flush wall box. Surface mounted patterns shall be housed in heavy pressed steel boxes. Shutters shall be provided. All socket outlets with switches shall be continuously rated at 16A and shall be suitable for operation on a 250V, 50 Hz, a.c. system.
c. All socket outlets with switches shall fully comply with SANS 164 as amended. Covers shall have bevelled edges which overlap the box.

C. Isolators
a. Moulded case isolators shall be of the double pole ON-LOAD type.
b. Toggles shall be interlocked with the covers. All isolators shall comply with SANS 60947. To distinguish the switches from circuit breakers the operating handles of isolators shall have a distinctive colour and were called for in the "particular specification" the switch shall be clearly and indelibly labelled "ISOLATOR".

A6.5 INSTALLATION

A. General

Socket outlets and power outlets shall be installed in the positions as indicated on the drawings.

B. Socket outlets

Unless otherwise specified socket outlets shall be installed at the following heights above finished floor level, measured to the underside of the outlet:

Outlet Point	Location	Height (from finished floor level to underside of outlet)
Socket Outlet	General applications	300mm
Socket Outlet	Kitchens	1200mm
Geyser isolator	Within 1m of geyser	500mm
Heaters, fans &air conditioners	Within 1m of unit	1500mm

C. Connections to geysers

Each geyser shall be connected to a separate circuit with a separate earth conductor. The conduit from the distribution board shall terminate in a 100 x 100 x 50 mm outlet box within 1 metre of the geyser. A suitably rated double pole isolator shall be installed in the outlet box. A flexible conduit shall be installed between the isolator and the geyser.

D. Connections to heaters, fans and air conditioners

a. A suitably rated double pole isolator shall be supplied and installed within 1 metre of heaters, fans, and air conditioners. Where the equipment is out of reach the isolator shall be installed 1,5 metres above floor level. Flexible cords of sufficient rating may be used for the final connection to the equipment.
b. Where control units are to be installed the units shall be installed 1,5 metres above floor level.

A6.6 LIGHT SWITCHES

A. Flush mounted switches

a. Flush mounted switches shall comply with SANS 60947 and shall bear the SABS mark. All flush mounted switches shall be suitable for mounting in 100 x 50 x 50 mm galvanised steel wall boxes unless otherwise specified in the detail specification.
b. The switch mechanism shall be of the tumbler operated micro-gap type with silent operation and shall be rated for 16 A at 250 V and 50 Hz.
c. Switches shall have protected terminals for safe wiring. Multi-lever switches shall be constructed to
d.
e.
f.
g.
h. enable individual defective switches to be removed and replace without having to remove the remaining switches.
i. The mounting holes provided on the yoke strap shall be slotted to allow for easy alignment. A brass earthing terminal shall furthermore be provided on the yoke to ensure the positive earthing of the switch assembly.

B. Switches with pilot light indication
   a. Flush mounted switches with pilot light indication shall comply with the relevant SANS specification and shall bear the SABS mark.
   b. Switches with pilot light indication shall be suitable for mounting in 100 x 50 x 50 mm galvanised steel wall boxes. The switch shall be rated at 16 A at 250 V and 50 Hz. A red neon indication lamp shall form an integral part of the switch level and shall light-up when the switch is in the on position.

C. Cover plates for switches
   a. Cover plates for flush mounted switches shall have levelled edges which overlap the wall box in order to conceal all wall imperfections and shall conform to SANS 60947.
   b. Cover plates shall be finished in ivory coloured baked enamel and shall bear the identical manufacturing batch number.

D. Surface mounted switches
   a. Surface mounted switches shall comply with SANS 60947 and shall bear the SABS mark. Surface mounted switches shall consist of single or multiple switches, not exceeding four, and shall be mounted in a pressed steel box of heavy-duty construction.
   b. The switch mechanism shall be of the tumbler operated micro-gap type with silent operation and shall be rated for 16 A at 250 V and 50 Hz.
   c. A brass earthing terminal shall furthermore be provided on the switch construction to ensure the positive earthing of the switch assembly and enclosure.
   d. The covers of surface mounted switches shall have toggle protectors.

E. Watertight Switches

Watertight switches shall consist of 10A switches on porcelain bases in cast iron or aluminium alloy housing. Contacts must be of heavy-duty brass construction and a quick acting spring mechanism shall be fitted. A rigid operating knob shall be clearly marked to indicate the "ON" and "OFF" positions. Conduit entry shall be provided through a tapped hole. The complete unit shall be watertight.

A6.7 TELEPHONE AND DATA OUTLETS

a. Telephone and data outlets in walls shall comprise of 100 mm x 100 mm x 50 mm deep wall boxes which shall be flush mounted in the wall, in the position shown on the relevant drawing, with the underside 300 mm above the finished floor level. The wall box shall be fitted with a blank cover plate. All outlet boxes shall align up neatly with adjacent socket outlet wall boxes. Telephone and data outlets in floors fitted with floor ducting shall be of the same type as the floor outlets for power socket outlets and shall normally be provided in the same outlet box.
b. Telephone and data outlets in power skirting shall be provided in the positions shown on the relevant drawing and the electrical subcontractor need only provide a separate short length cover plate at these positions. The cover plate for the fixing of the telephone and data outlet shall not exceed 250 mm in length and shall be secured in such a manner that adjacent cover plate sections may be removed without disturbing the telephone outlet.

A7. DUCTS AND POWER SKIRTING

A7.1 QUALITY ASSURANCE

A7.1.1 CODES AND STANDARDS

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

a. SANS 61084: Cable trunking and ducting systems for electrical installations

A7.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

a. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
b. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A7.1.3 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A7.2 POWER TRUNKING

a. 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.

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

A7.3 UNDERFLOOR DUCTING

This section covers two or three compartment underfloor ducting in buildings.

a. The ducting and associated accessories shall be manufactured from 2 mm thick sheet steel. The sheet steel shall either be galvanised prior to the manufacturing of the ducting or shall be epoxy powder coated after manufacture. The three-compartment ducting shall be subdivided into three approximately equal compartments, of which the centre compartment shall be used for electrical power distribution with the outer two compartments for other services.
b. Outlets shall be provided on a modular basis in the ducting for the installation of pedestal or recessed outlets. The openings shall have removable flush cover plates and shall have tapped holes for the installation of the pedestal or recessed outlets.
c. The underfloor ducting shall be complete with flush cross-over, T-junction and right-angle bend draw boxes. The junction boxes shall be complete with cross-over of services and removal cover plates secured by means of countersunk screws.

d. Pedestals suitable for two or three services as specified shall be manufactured from die-cast aluminium or pressed steel. The pedestals shall be epoxy coated of an approved colour after the manufacturing hereof.
e. The underfloor ducting with accessories shall be installed strictly in accordance with the manufacturer's instructions. The ducting shall be fixed to the floor by approved means.

f. Up-bends shall be supplied and installed wherever the ducting is terminated at distribution boards, telephone distribution boards or behind power skirting.
g. The power circuit wiring shall be installed in the centre compartment of the ducting. Sufficient slack shall be left in the form of a loop at each outlet in the ducting in the area to be served by the ducting. Galvanised draw wires shall be installed in the other compartments to enable cables to be drawn in by others. The entire installation shall be effectively earthed and bonded together.

A7.4 POWER SKIRTING

This section covers the supply and installing of two or three compartment power skirting.

a. The power skirting and covers shall be manufactured from 1 mm thick sheet steel or aluminium and shall be manufactured in modular lengths. The length of the skirting shall not exceed 2,5 metres and, unless otherwise specified in the detail specification, the covers shall be supplied in 1 metre lengths.
b. The covers shall either snap on or shall be fixed by means of toggle or swivel nuts. Each modular cover shall be punched and prepared for the installation of a standard three pin socket outlet. The punched holes shall be blanked off with easily removable blanking plates, painted the same colour as the power skirting. Suitable brackets shall be supplied for the fixing of the socket outlet to the channel.
c. All internal and external bends and off sets shall be factory made.
d. The power skirting and cover shall be epoxy powder coated of an approved colour after the manufacturing thereof.
e. Conduits for the circuit wiring to the power skirting shall be installed in the floor-slabs and chased into the walls to terminate in flush conduit boxes behind the power skirting at the heights
f. of the compartments for the telephone, power and other service compartments.
g. The wiring shall pass through large diameter holes, suitably bushed, cut in the rear of the power skirting.
h. Where power skirting is interrupted by doorways bridging conduits shall be installed for each of the service compartments.

A7.5 WIREWAY TRUNKING

A. General

This section covers the supply and installation of wireway trunking and accessories in buildings.

B. Materials

The covers of the wireway trunking shall be secured to the framework by at least four points per section. Covers shall be so designed that they can be easily removed after installation of the trunking. Sections of the trunking which pass through walls and floors shall have separate covers. Fire barriers of non-flammable, non-conducting material shall form an integral part of each section. The fire barriers shall be so placed as to prevent the spreading of fire from one floor to another.

C. Installation
   a. Trunking shall be of the size and type as specified in the detail specification. The electrical contractor shall ensure that the trunking is installed in accordance with the routes indicated on the relevant drawings.
   b. However, should the electrical contractor discover that the indicated route is not practically possible, or for some other reason the route clashes with other services, he shall immediately contact the engineer for clarification in this regard.

D. Ceiling space
   a. Trunking for use as wireways shall be installed as specified on the drawings. When installed in open ceiling spaces, trunking shall be mounted against the wall to allow space for mechanical and other services. The trunking shall be installed along the full length of the open ceiling space. Individual conduits shall be extended from the trunking to switch and socket outlet boxes, light points, distribution boards, etc.
   b. The trunking shall be installed in one straight length and all joints shall be both electrically and mechanically continuous. The trunking shall only be installed where there is a minimum

clearance of 750 mm as measured between the top of the final trunking installation and the underside of the roof sheeting. The trunking shall be securely fixed to every roof truss or member by means of round headed screws or approved truss clamps.

c. Both incoming and outgoing conduits shall be bonded to clean surfaces, both internally and externally, by means of two locknuts and a female brass bush. A solid brass bushnut installed from inside the trunking may also be used. Conduits which are extended from the trunking to outlets and power points shall be installed along roof members. Suitable timber or other supports shall be provided for free standing conduits extended from the trunking.

E. Suspending or fixing trunking against walls

a. The electrical contractor shall provide all the necessary hangers, supports, brackets and fixing hardware for the securing of the trunking installation.

b. Trunking up to and including 76 mm x 76 mm shall be supported at regular maximum spacings of 600 mm and larger channels at regular maximum spacings of 1 m. Trunking runs shall be carefully planned to prevent clashes with other services and to ensure that all covers can be easily removed after completion of the installation. Purpose made clamps and hangers shall be provided as required. Where however it is not possible to support the trunking at the specified spacings, such trunking sections shall be supported in a sound manner and to the approval of the engineer.

F. Cast in concrete.

a. Where trunking is to be cast into concrete, the insert type of trunking shall be used. Spacer blocks shall be used where required to prevent the trunking from being deformed during the casting of the concrete.

b. The trunking shall be filled with polystyrene or other suitable fillers, prior to casting, to prevent the ingress of concrete. The trunking shall furthermore be securely fixed in position to the shuttering.

G. Conduit connections

Conduit connections shall be bonded to clean surfaces, both internally and externally, by means of either two locknuts and a female brass bush or by means of a solid brass nut inserted from the inside of the trunking. Conduit connections may be made by means of a conduit box if the trunking is wide enough to allow a hole to be punched through the back or side thereof. All holes through which conductors pass shall be fitted with bushes, grommets or shall be aligned with PVC strip grommet.

H. Joints and bends

a. Two adjoining lengths of trunking shall be aligned and shall be securely joined by means of fishplates fixed by means of mushroom bolts, washers, and nuts. Alternatively, connection pieces that are pop-rivetted to both adjoining sections may be used. All adjoining lengths of trunking shall be rectangular and shall burr tightly. Special care shall be taken to ensure that the covers fit tightly across the joints.

b. Where the trunking passes through an expansion joint in the structure, suitable expansion joints shall be provided in the trunking by means of fishplates which are to be pop-rivetted or screwed to the trunking on one side of the expansion joint, without obstruction in the trunking on the opposite side of the expansion joint.

c. Bends and T-joints shall be constructed to ensure compliance with the minimum allowable bending radii as specified in SANS 10142, in the case of PVC insulated cables and conductors.

d. All burrs and sharp edges shall be removed from the cut edges of the trunking and the inside edges shall be lined with a suitable rubberised or plastic compound to prevent laceration of the conductor insulation during installation.

I. Circuits

a. The conductors for each individual circuit, including the earth continuity conductor for that circuit, shall be grouped together at regular spacings not exceeding 500 mm by means of PVC cable ties or straps.

b. Each circuit to be installed inside the trunking shall be individually laid to avoid unnecessary tangling of the grouped conductor. The utilized cross-sectional area of the trunking shall not normally exceed 50% of the total cross section of the specified trunking.

J. Earthing

A separate earth continuity conductor of size as specified in the detail specification shall be installed from the main earth bar or terminal to the trunking where it shall be terminated to ensure a proper

earthing of the trunking. The earth conductor shall be equipped with a crimped or soldered lug and shall be bolted to the wall of the trunking by means of a 6 mm Ø brass bolt, washers, and nut.

K. Cover plates

Cover plates shall be installed over the full length of the installed trunking. Flush mounted trunking shall be provided with overlapping metal cover plates with plastic edge trim to cover irregularities in the wall recess. Where required and when specified, in the detail specification, cover plates shall be attached to the trunking by means of screws at suitable intervals to prevent warping.

L. Vermin-proofing

After installation all trunkings shall be suitably vermin proofed. Any holes present in the trunking shall be sealed by means of screwed metal plugs or else with metal strips which are tube-bolted or pop-rivetted to the trunking. No timber or other temporary form of plug shall be accepted. Cover plates shall be installed over the full length of the trunking.

A8. LV CABLES

A8.1 QUALITY ASSURANCE

A8.1.1 CODES AND STANDARDS

Cables supplied and installed shall comply with the following Acts and regulations:

a. The latest issue of SANS 10142-1: “Code of Practice for the Wiring of Premises-Part 1: Low Voltage Installations”.
b. The Occupational Health and Safety Act, 1993 (Act 85 of 1993) as amended.
c. The Local Government Ordinance 1939 (Ordinance 17 of 1939) as amended and the municipal by-laws and any special requirements of the local supply authority.
d. The Fire Brigade Services Act 1993, Act 99 of 1987 as amend.
e. The National Building Regulations and Building Standards Act 1977 (Act 103 of 1977) as emended.
f. The Post Office Act 1958 (Act 44 of 1958) as amended.
g. The Electricity Act 1984 (Act 41 of 1984) as amended.
h. The Regulations of the local Gas Board where applicable.

A8.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

a. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
b. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A8.1.3 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A8.2 SUBMITTALS

Shop drawing submittals shall include, but not be limited to, the following:

a. The Contractor shall submit to the Engineer for review, a list of the proposed manufacturers of cables, cable lugs, cable connectors, and termination fittings listed herein. The Contractor may install cable, cable lugs, cable connectors, joints and termination fittings furnished by any manufacturer listed on the approved submittal.
b. Cut sheets on all conductors with manufacturers name, ratings and capacities, insulation characteristics, and available colours, clearly listed.
c. Cut sheets indicating all cable lugs, termination fittings, joints and cable connectors.
d. Cut sheets indicating types of conductor identification bands.
e. Additional information as required in the specification.

A8.3 INSTALLATION - GENERAL

a. All cables laid directly in the ground shall be laid at a depth such that the vertical distance from the top of the cable to the finished ground surface is not less than the values given below:

Cables in open ground or under pedestrian paved areas	MV Cables	LV cables
Residential sites	800mm	450mm

Industrial sites	1000mm	500mm
Road Crossings	1100mm	1100mm
Railway crossings	1500mm	1500mm

b. Cables shall not be laid in the ground if any corrosive agent is found in the ground.
c. Before cable laying is commenced, all cable trenches shall be drained, the bottoms graded and compacted, and all loose stones and similar debris removed.
d. Cable trench width for one or two cables shall be a maximum of 550mm. The width shall be increased as more cables are installed allowing for at least two cable diameters spacing for each cable added.

A8.4 HANDLING OF CABLE DRUMS ON SITE

a. It is recommended that a correctly designed spreader must be used to load and unload the drums with a crane.
b. Every drum must be mounted on jacks or on a cable-drum trailer with a horizontal supporting beam of suitable size and strength to handle the width and weight of the drum. The drum may not be allowed to rotate freely when the cable is rolled off. (Free rotation causes the cable to twist and loosen the windings, which can cause the inside armouring/insulation of the cable to be stretched). The cable must enter the trench from the top of the reel. All cables end including that left on the drum or in a trench must be sealed to prevent the penetration of moisture into the cable. The free cable end on the drum must be fastened to the side of the drum.

A8.5 CABLE LAYING

a. Cable rollers shall be used at all times to run out cables. Rollers shall be spaced so that the length of cable will be totally suspended during the laying operation.
b. Where cables have to be drawn through pipes or ducts, a suitable cable sock shall be used and care shall be exercised to avoid abrasion, elongation or distortion of any kind.
c. Where cables have to be drawn around corners, well lubricated securely fixed skid plates shall be used.
d. Cables shall be pulled into trenches etc, by hand or approved whinch system only.

A8.6 SPACING OF CABLES

a. Cables installed in a common trench shall be laid parallel to each other spaced as follows: (LV: up to 1000V; MV: 1000V to 11000V)

LV/LV : 2 x cable diameters

LV/MV : 300mm minimum

b. Where MV and LV cables have to be installed in the same trench, the MV cable shall be laid on the one side of the trench at a depth as specified and the covered with soil. The LV cable shall be then laid on the other side of the trench at the depth specified. Cables shall not be buried on top of each other unless layers are specified. The minimum spacing between layers shall be 200mm.
c. Cables for telephones, communication systems and other low voltage systems (less than 50V) shall be seperated from power cables by at least 1000mm. All control or pilot cables shall be laid at least 300mm from power cables.

A8.7 INSTALLATION IN BUILDINGS

a. Particular attention shall be paid to the application of grouping factors in respect of current rating and the appropriate spacing of cables shall be allowed.

b. Cables for services above 650 volts shall be run separately from all other cables with a minimum clearance of 2300mm. cables for service below 100 volts including sound and telephone systems shall also be segregated from all other cables.
c. All cables shall be adequately supported throughout their length as specified by the Wiring Regulations or, where not specified as recommended by the cable manufacturers. No joints shall be allowed in cables of less than 300m length, unless as specified or specifically approved.
d. Cable run indoors shall be supported on cable trays or cable rack, secured thereto by heavy duty plastic strapping. The cables shall be fixed at intervals not greater than those stipulated in SANS 10142 and shall be spaced sufficiently to avoid de-rating in terms of SANS 10142 – 1. Cables shall be individually fixed so that anyone may be removed from a group without disturbing the others.
e. Every run of cable shall be a single length without joints. Save that where a run exceeds the general drum length of where the length of a run is increased after the cable is delivered on site, a through box will be permitted. Such through boxes shall be so placed as to afford easy access for maintenance and repair; when they are required in underground cable runs the contractor shall provide special cable markers to locate them.
f. All cable tails shall be provided with either cable lugs or ferrules as may be appropriate. At each sealing end straps-on cable markers shall be fixed, showing clearly and indelibly the number and size of cable cores and the destination of the cable.

A8.8 CABLES IN CONCRETE TRENCHES

In concrete trenches, cables shall be laid side by side on the bottom of the trench without cross-overs. When necessary to maintain spacing factors, cables shall be fixed to the sides of the trench using cleats as specified for installation above floor level.

A8.9 CABLES IN DUCTS

The total cross sectional area of all cables installed in a duct shall not exceed 50% of the internal cross sectional area of the duct. After installation of the cables, duct stoppers shall be fitted to each end of each duct run and at the entry to the building to effectivly seal the duct from ingress of vermin, etc.

A8.10 CABLE ROUTES

a. Cables shall follow the routes shown on the drawings; the routes shall only be varied with the written permission of the Engineer. Where no routes are defined on the drawings the contractor may select routes to his reasonable preference but shall obtain written approval of them before installing the cables.
b. The contractor shall, before trenching commences, familiarizes him with the routes and site conditions and the procedure and order of doing the work shall be planned in conjunction with the general construction program for other services and building requirements.
c. The contractor shall acquaint himself with the position of all the existing services such as storm water pipes, water mains, sewer mains, gas pipes, telephone cables, etc. before any excavations are commenced. For this purpose, he shall approach the Engineer's representative, the local municipal authority and any other authority which may be involved, in writing.
d. 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.
e. The removal of obstructions along the cable routes shall be subject to the approval of the Engineer.

A8.11 CABLE JOINTS

a. Cable joints shall be carried out strictly in accordance with the manufacturer's instruction and by personnel competent in jointing the cables involved.
b. No joints in cable runs will be allowed unless a cable run exceeds the maximum length available on a cable drum (normally 300m)
c. The joint shall not impair the characteristics of the cable.
d. Joints shall be fully water and airtight and shall be free of voids and air pockets.
e. The crossing of cores in joints shall not be permitted under any circumstances.
f. The contractor shall notify the Engineer timeously of the day on which jointing is to be carried out in order that the inspection may be arranged if so required. Any cable joint not inspected by the Engineer because of insufficient notice being given shall be opened for inspection and redone at the discretion of the Engineer and at the cost of the contractor.

A8.11.1 CONNECTION OF CABLE CORES

a. When cutting away insulation from cable cores to fit into lugs, care shall be taken that no strands are left exposed. Under no circumstances may any of the conductor strands be nicked or cut away to fit into lugs
b. Contact surfaces shall be thoroughly cleaned and smoothed and fixing bolts shall match the hole size of the lug.
c. Suitable lugs shall be crimped to cable core ends using mechanical or pneumatic tolls designed for the purpose.
d. Cables that are connected to clamp type terminals where that clamping screws are not in direct contact with the conductor, need not be lugged but the correct terminal size shall be used.
e. Ferrules shall be used where cable cores are connected directly to equipment with screws against the conductor strands.

A8.12 TRENCHING

a. The contractor shall, before trenching commences, familiarise himself with the routes and site conditions. The procedure and order of doing the work shall be co-ordinated with the general construction programme.

b. Trenching shall be programmed in advance and the approved program shall not be departed from except with the consent of the Engineer.

c. 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.

d. The contractor shall take all the necessary precautions and provide the necessary barriers, warning signs and/or lights to ensure that the public and/or employees on site are not endangered.

e. The contractor shall ensure that the excavations will not endanger existing structures, roads, railways, other site constructions or other property.

f. Trenches shall connect the points shown on the drawings in a straight line. The Engineer beforehand shall approve any deviations due to obstructions or existing services.

g. Trenches shall be as straight as possible and shall be excavated to a depth as indicated in this specification.

h. The excavated material shall be placed adjacent to each trench in such a manner as to prevent nuisance, interference or damage to adjacent drains, gateways, trenches, water furrows, other works, properties or traffic. Where this is not possible the excavated materials shall be removed from site and returned for back filling on completion of cable lying.

i. In the event of damage to other services or structures during trenching operations the contractor shall immediately notify the Engineer and institute repairs.

j. Prior to cable laying the trench shall be inspected thoroughly and all objects likely to cause damage to the cables either during or after lying shall be removed.

k. Where ground conditions are likely to reduce maximum current carrying capacities of cables or where the cables are likely to be subjected to chemical or other damage or electrolytic action, the Engineer shall be notified before installing the cables. The Engineer will advise on the course of action to be taken.

l. Extreme care shall be taken not to disturb surveyor's pegs. These pegs shall not be covered with excavated material. If the surveyor's pegs are disturbed, a person qualified to do so shall replace them.

m. The contractor shall ensure that the excavations will not endanger existing building structures, roads, railways, or other site construction or other property before excavating.
n. The contractor shall take all the necessary precautions and provide the necessary warning signs, barricades, shoring and/or lights to ensure that the public and /or personnel on site are not endangered.
o. Trenching crossing roads, footpaths or access ways shall not be left uncovered. If cables cannot be laid immediately, the contractor shall install sleeves or temporary “bridges” or cover plates, of sufficient strength to accommodate the traffic concerned.
p. The bottom of the trench shall be smooth and free of any sharp dips or rises which may cause tensile forces in the cable during backfilling.
q. The nature of the soil can be encountered is classified as follows:
    - **Soft Soil**: Shall mean ground that can be removed by pick and shovel and includes hand pickable soil that can be loosened by hand pick and includes hard shale, compact gravel stone and rocks up to 0.003 cubic meters in volume.
    - **Soft rock**: Shall mean rock that can only be excavated by machine excavation and includes granite, quarzitic sandstone, slate, and rock of similar or greater hardness, solid shale, and boulders over 0.03 cubic meter in volume.
    - **Hard Rock**: Shall mean rock that can only be excavated by explosives.
r. Should blasting be necessary, the contractor shall obtain all necessary authorities from the relevant departments and Local Authorities. The contractor shall take full responsibility and observe all conditions and regulations set forth by the above Authorities.
s. The necessary insurance cover must be obtained to cover possible damage and losses.
t. Blasting shall be subject to the approval of the Engineer.

A8.13 CABLE SLEEVES

a. Where cables cross under roads, railway tracks, other service areas, etc and where cables enter buildings, the cables shall be installed in heavy duty uPVC pipes. The sleeves shall be heavy duty class 34 uPVC sleeving with a wall thickness of not less than 1,5mm thick and a smooth finish inside. Roads and railway crossings shall be done at right angles.
b. Sleeves shall be a minimum diameter as specified and shall extend at least 1,0m beyond the road edge or kerb on either side of the crossing.
c. After installation of cables, the ends of all sleeves shall be sealed with a non-hardening watertight compound. All sleeves intended for future use shall likewise be sealed.
d. Where sleeves have to be built into structures by others, the Contractor shall supply the sleeves and ensure that they are installed correctly.

A8.14 CABLE INSTALLATION AND BACK FILLING

a. The Contractor is responsible to ensure that the cable is installed at the depths specified, Cable’s depths indicated from finished ground level (FGL) must be installed accordingly. It is the Contractors responsibility to ensure that cable depths are measured from a finished final ground level. The contractor will be responsible to excavate and re-install the cable if this depth if not found to be correct.
b. Before the cable is laid into the trench, the bottom of the trench shall be filled across the full width with a 50mm layer of suitable sifted soil and levelled off. After cable laying, a further layer of bedding shall be provided to extend 50mm above the cables.
c. If there is no suitable soil available on site, the contractor shall import fill and make all the necessary arrangements to do so. The cost of importing soil for bedding purpose shall be included in the rates for excavations.

d. The bedding under joints shall be fully consolidated to prevent subsiding.
e. The contractor shall not commence with the back filling of trenches before the Engineer has inspected the cable installation. Should the Contractor fail to give timeous notification, the trenches shall be re-opened at the Contractor's cost. Such an inspection shall not be unreasonably delayed.
f. Cables (1000V to 11000V) shall be provided with a yellow-coloured plastic marking tape installed 400mm above the cable. The tape shall be marked with red skull and crossbones with the words "Electric Cable". This marking tape shall be installed over the entire length of the cable.
g. The maximum accepted diameter of stones present in the back fill material is 75mm.
h. The backfill shall be compacted in 150mm layers and sufficient allowance shall be made for final settlement. The contractor shall maintain the refilled trench at his expense for the duration of the contract. The surface shall be made good to the same density and to match the surrounding areas on completion.
i. In the case of roadways or paved areas, the excavations shall be consolidated to the original density of the surrounding material and the surface finish reinstated.

A8.15 CABLE MARKERS

a. Cable markers shall consist of concrete blocks dimensioned as follows:
b. 300mm high, 150mm x 150mm and 250mm x 250mm at the bottom.
c. A stainless-steel plate for labelling shall be cast into the tops of the blocks in such a manner that they cannot be prised loose. The wording as follows as well as arrows indicating cable direction shall be clearly stamped on the plates.
   - For MV and LV cable routes: "ELECTRICAL CABLES"
   - For joint positions: "ELECTRIC CABLE JOINT"
d. Cable markers shall be installed on the surface along all the underground routes and shall project 50mm above finished ground level. If the projected markers could be a hazard to pedestrians or other traffic, they shall be installed flush with the surface.
e. Cable markers shall be installed at all change in direction, at the beginning and the end of cable runs (i.e., where a cable enters a substation or building), above all joints, above cable pipe entries and exits and at intervals not exceeding 50m along the cable route. The position of cable markers shall be indicated on the "as built" drawings.

A8.16 TESTING - GENERAL

a. LV cables shall be tested by means of a suitable megger at 1kV and the insulation resistance shall be tabulated and certified.
b. The contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The cost of testing shall have been included in the tender price.
c. The contractor shall notify the Engineer and if applicable the Supply Authority timeously so that their representative may witness the tests.
d. On completion of the tests on any cable, the contractor shall without delay submit three (3) copies of the certified test results to the Engineer.
e. The contractor shall provide all the testing equipment as required for the respective tests.

A9. SWITCHBOARDS AND DISTRIBUTION BOARDS

A9.1 QUALITY ASSURANCE

A9.1.1 CODES AND STANDARDS

Cables supplied and installed shall comply with the following Acts and regulations:

a. The latest issue of SANS 556: “Low-voltage switchgear Part 1: Circuit-breakers
b. The latest issue of SANS 1765: “Low-voltage switchgear and control gear assemblies (distribution boards) with a rated short-circuit withstand strength up to and including 10 kA”.
c. The latest issue of SANS 60439: 1-5: “Low-voltage switchgear and control gear assemblies”,
d. The latest issue of SANS 60947: 1-8: “Low-voltage switchgear and control gear”,
e. The latest issue of SANS 1973: “Low-voltage switchgear and control gear ASSEMBLIES Part 1-8”,
f. The latest issue of NRS 003: “Metal-clad switchgear - For rated a.c. voltages above 1 kV and up to and including 24 kV Part 2: Standardized panels
g. Codes and standards as per Section 002: Design Criteria.

A9.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

a. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
b. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A9.1.3 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A9.2 DISTRIBUTION SWITCHBOARDS

Distribution switchboards shall have construction with group mounted circuit protective devices and include the following:

- Switchboard
- Circuit Protective Devices

A. General
   a. Switchboards shall consist of the required number of vertical sections bolted together to form one metal enclosed rigid switchboard for circuit protective devices and busbar work. Front and side plates shall be screw removable.
   b. Switchboards shall be designed as freestanding switchgear with front only access or otherwise noted on the drawings. This switchgear shall be designed with group mounted devices and isolated busbars, expandable for future sections by the addition of simple splice plates on the horizontal busbar. An air space of at least 50mm or a minimum 3mm thickness insulating barrier shall be provided between end of bus bar and end panel. Switchboard shall be front, and rear aligned to a common depth. Switchboard shall be of indoor switchboard construction.
   c. The switchboard shall include all protective devices and equipment as shown with necessary interconnections, instrumentation, and control wiring. Small wiring, necessary fuse blocks, and terminal blocks within the switchboard shall be furnished. All groups of control wires leaving, and switchboard shall be furnished with terminal blocks with suitable numbering strips. All wiring within switchboard enclosure shall utilize insulated copper conductors.

B. Enclosure Construction

a. Switchboard framework shall be fabricated on a preformed steel base, or base assembly, consisting of a minimum of 1.6mm corrosion resistant mild steel and commercial channel welded or bolted together to rigidly support the entire shipping unit for moving on rollers and floor mounting. The framework shall be formed of gauge mild steel, rigidly welded and bolted together to support all cover plates, busbars, and component devices during shipment and installation.
b. Each switchboard section shall have an open bottom and individually removable top plates for installation and termination of cables and conduit. Top and bottom conduit areas shall be clearly shown and dimensioned on the shop drawings. All closure plates shall be formed up on all sides, screw removable and small enough for easy handling by one man.
c. All steel surfaces shall be chemically cleaned and treated to provide a bond between paint and metal surfaces to prevent moisture entrance and rust formation under the paint film. The paint finish shall be two (2) coats of Gray enamel over a rust-inhibiting phosphate primer.
d. Baked enamel finish is acceptable if applied to properly prepared surface.

C. Assembly, Wiring and Controls
a. The switchboard shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchboard will be tested for operation under simulated service conditions to assure the accuracy of the wiring and the functioning of all equipment. The main circuits shall be given a dielectric test of 2200 Volts for one minute between live parts and ground and between opposite polarities.
b. The wiring and controls shall be given a dielectric test of 1500 Volts for one minute between live parts and ground. A certified test report shall be available to the engineer for approval.

D. Busbars
a. The switchboard busbars shall be 98% conductivity copper with bolted joint connections and of sufficient cross-sectional area to continuously conduct rated full load current with a maximum temperature rise of 65^{o}C above an ambient temperature of 40^{o}C. The switchboard shall have a full size, full length isolated neutral bus and a full-length copper earth bar.
b. The bus bars shall be rigidly braced to comply with the integrated equipment rating of the switchgear. The minimum interrupting current rating shall not be less than 65,000 AMPS symmetrical. The main horizontal bus bars between sections shall be located on the back of the switchboard to permit maximum available conduit area. Busbar supports shall be non-carbonizing, non-tracking insulators arranged to provide short circuit bracing as specified. All bolted joint hardware shall be equipped with lock washers and torqued to the Manufacturer's recommended settings. Bolted joint connection surfaces for copper busbars shall be silver plated.
c. Torque settings shall be provided for use during installation.
d. Busbars shall be arranged A-B-C, left-to-right, top-to-bottom, and front-to-rear, throughout. A ground busbar shall be secured to each vertical section structure and extend the entire length of the switchboard.
e. Where "space" is shown on one-line drawings, space shall be provided for installation of future switches, sized as shown.
f. Distribution feeder conductors shall be terminated on the "load side" of switchboard devices with hydraulically applied, high conductivity, compression lugs approved for the purpose. Where conductor connections are required to the main bus, they shall be made with copper bodied compression connectors.

E. Integrated Equipment Rating

Each switchboard, as a complete unit, shall be given a single integrated equipment rating by the manufacturer. The integrated equipment short-circuit rating shall certify that all equipment can withstand the stresses of a fault equal to that shown on the drawings, in RMS symmetrical amperes. Such ratings shall have been established by actual tests by the manufacturer, in equipment of similar construction as that of the project switchboard. This test data shall be available and furnished, if requested, with or before the submittal of shop drawings.

F. Electronic Power Monitoring System
a. Each switchboard shall be provided with an electronic circuit monitoring system.
b. The Circuit Monitor shall accept inputs from industry standard instrument transformers. The current and voltage signals shall be digitally sampled at a rate high enough to provide accurate RMS sensing and valid data for wave form analysis beyond the 30th harmonic based on a fundamental frequency of the 50 Hz. All set-up parameters required by the Circuit Monitor shall

be stored in non-volatile memory (no backup battery) and retained in event of a control power interruption. The instantaneous values and the time and date for the highest peak of all demand readings shall also be maintained in non-volatile memory.

c. The Circuit Monitor shall have capability to perform the following readings:
   - Current per Phase RMS (±1%).
   - Three Phase Average RMS Current (±1%).
   - Apparent RMS Current (±1%).
   - Phase-to-Phase and Phase-to-Neutral Voltage (±1%).
   - Three Phase and per Phase Power Factor (±2%).
   - Three Phase Real and Reactive Power (±2%).
   - Three Phase KVA (±2%).
   - Frequency (±0.5%).
   - Temperature (±2-1/2oC.).
   - Average Demand Current per Phase (±2%).
   - Peak Demand Current per Phase (±2%).
   - Average Real Power Demand (±2%).
   - Predicted Real Power Demand (±2%).
   - Peak Real Power Demand (±2%).
   - Accumulated energy (±2%).
   - Accumulated reactive energy (±2%).
d. The Circuit Monitor waveform capture capability shall, upon user command, capture and store, in non-volatile memory, three phase voltage and current samples consisting of 256 data points each.
   The data points shall represent at least three cycles of each current or voltage waveform. The samples shall be evenly gathered from each voltage and current phase input such that the original power signals with proper magnitude and phase relationships may be reconstructed. It shall be possible to recreate the original power signal from the stored data with sufficient accuracy such that steady-state power harmonic analysis will provide valid information on harmonic content up to the 30th harmonic.
e. All data and calculated values stored in the Circuit Monitor shall be accessible to external devices by means of a built-in RS485/RS422 serial communications port. It shall be possible to connect from one communication port to another such that up to 16 Circuit Monitors may be connected to form a continuous string extending up to 1000m. These strings shall form individual data transfer networks that comply with the RS485 multi-drop communications standards.
   Communication rates for each circuit monitor shall be adjustable up to 19,200 Baud.
f. Circuit Monitors shall be installed by the switchboard manufacturer. All control power, CT, PT, and communications components shall be factory wired and harnessed within the switchboard line-up. The Circuit Monitor shall be mounted on the front panel of the main switchboard incoming line compartment.

A9.3 SUBMITTALS

Shop drawing submittals shall include, but not be limited to, the following:

a. Switchboard shop drawings with all busbar and switch ratings, capacities, characteristics, features and associated accessories clearly indicated.
b. The minimum setting of the earth fault devices and the recommended setting for normal building operation.
c. Sufficient information to show that switchboard overcurrent protection devices have been fully coordinated with load side overcurrent protection devices and the Supply Authorities primary overcurrent protection. This shall include time/current curves and trip settings.
d. Equipment room layout showing switchboards, panel boards, motor control centres, etc., with required clearances as specified in the SANS codes.

A9.4 INSTALLATION

a. Install switchboard where shown, in accordance with the manufacturer's written instructions and recognized industry practices to ensure that the switchboards comply with the requirements and serve the intended purposes.
b. Install switchboard on a nominal 100 mm high reinforced concrete housekeeping pad. The housekeeping pad shall extend 80 mm beyond the housing of the switchboard unless shown otherwise. The entire assembled switchboard shall be anchored to continuous 40 mm x 150 mm channels for the full length.
c. The channels shall be embedded in the concrete housekeeping pad. Bolt studs shall be at least 10 mm in diameter and located not more than 750 mm apart centre to centre. The mounting channels shall be continuous single-piece structural channels and shall be levelled when embedded in the concrete housekeeping pads. The channel and bolt studs shall be furnished and installed by the Electrical Contractor.

A9.5 EQUIPMENT OF SWITCHBOARDS AND DISTRIBUTION KIOSKS

a. The fault-breaking capacity of each breaker shall be certified by IEC test to be not less than the prospective fault levels marked on the wiring schedules. When used as main L.T. switches protecting transformers, they shall be submitted to the Supply Authority for trip testing.
b. Moulded case circuit-breakers shall comply with IEC 157-1 or SANS 156:2007 as amended, shall be of fixed or draw-out execution as set out in the Project Specification. It shall have fault-breaking capacities certified by I.E.C. test to be equal to or greater than the prospective fault levels marked on the wiring schedules. Wherever possible, circuit breakers shall bear the SABS mark.
c. Miniature circuit-breakers shall comply with SANS 156:2007 as amended and shall bear the SABS mark. The fault-breaking capacity of miniature circuit breakers shall be certified by SABS test to be not less than the values set out in the wiring schedules.
d. Current-limiting circuit breakers, suitably certified, are acceptable in all cases.
e. In general circuit-breaker overload trip systems of the thermal or hydraulic-magnetic types are equally acceptable. In cases where high ambient temperatures or widely varying extremes of ambient temperature are expected hydraulic-magnetic devices shall be preferred: alternatively, thermal devices with ambient temperature compensation may be offered. Where circuit breakers must sustain motor-starting currents and the like, circuit breakers shall be hydraulic-magnetic with appropriate tripping characteristics. Where described in the Project Specification as being for short-circuit protection only, the circuit breakers shall be supplied without overload trip devices.
f. Switches shall comply with the requirements of SANS 60947 as amended and shall be capable of safely making onto fault currents of the magnitudes shown on the wiring schedules. Main switches of distribution boards shall additionally comply with the requirements of SANS 60947 applicable to switch-disconnectors. The main switches shall be rated for uninterrupted duty. Other switches shall be rated for 8-hour duty - the utilization category shall in all cases be AC22. All switches and switch-disconnectors shall bear the SABS mark.
g. Contactors shall comply with SANS 60947 and shall be rated to perform not less than 1 000 000 operations at the current ratings and duties quoted on the wiring schedules. They shall be so fixed as to ensure adequate coil ventilation. Contactors shall comply with the detailed requirements set out later in this Specification.
h. The internal wiring of switchboards shall be done with colour-coded PVC-insulated stranded conductors and shall include all phase, neutral, earth and control wires between equipment and to terminal blocks. Wiring channels shall be made spacious enough to permit the easy passage of all circuit wiring with adequate spacing between different circuits to promote ventilation. All the wires of each circuit or sub-circuit shall be braided together with approved strapping and shall be so arranged as to permit any individual circuit to be examined or renewed without disturbing any other circuits. Stranded conductors shall be terminated in crimped lugs of ferrules; manual crimping shall be done with makers' special tools which will not release until the full crimping pressure has been achieved; the ends of conductors from 50mm² cross-sectional areas upwards shall be crimped by hydraulic machine.

A9.6 SPARE SPACE

All distribution boards shall be of adequate size to accommodate specified equipment and a minimum of 30% spare capacity shall be allowed for future equipment unless specifically stated in the detail specification.

A9.7 LABELS AND LEGENDS

a. All labels shall be of plastic "sandwich board" material, the legends being engraved through the front plastic layer to the contrasting inner layer.
b. The lettering of legends shall not be less than 6mm high in sans-serif capitals; white lettering on black ground or black lettering on white ground shall be selected as necessary to ensure maximum legibility and contrast with the switchboard finish. All labels shall be secured by at least two bolts or rivets per label and shall be accurately level and central over their subjects.

A9.8 BUSBARS

Bus bars shall be of copper or aluminium and shall comply with SANS 1195 as amended. Copper bus bars shall be tinned after fabrication; the current ratings shall be those assigned by the Copper Development Association. Multiple bars shall be arranged with air gaps between the sections, equal to the section thickness. Insulating busbar supports shall be provided at intervals related to the prospective short-circuit fault currents. COLOUR FINISH

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

a. Normal supply : Light Orange, colour B26 of SANS 1091.
b. Standby power : Signal Red, colour A11 of SANS 1091.
c. UPS supply: Light Blue, colour of SANS 1091.

Note: Refer to the DB schematic for details. The DB manufacture to supply three (3) x sets of drawings for approval prior to manufacture.

A9.9 RECESSED AND SEMI-RECESSED DISTRIBUTION BOARDS

A. Distribution boards shall consist of the following parts:

The bonding tray shall be constructed from 1,60 mm corrosion resistant mild sheet steel. Bracing gussets with cam-shaped slots shall be welded on the four corners. Knockouts shall be provided in the upper and lower sides of the distribution boards. Expanded metal shall be spot-welded to the back of all bonding trays for 102,5 mm thick walls.

B. Architrave frame
   a. The architrave frame shall be constructed from 1,20 mm sheet steel with square edges.
   b. The architrave frame shall form 25 mm border around bonding tray and shall be fixed to the tray in such a manner as to allow for adjustment for the inequalities in wall the finish.
   c. A minimum of 75 mm shall be allowed between the inside of the architrave frame and the equipment.
   d. Distribution board numbers consisting of white engraved lettering on a black background shall be fixed to the top of the architrave frame.
C. Doors
   a. Doors shall be constructed from 1,20 mm sheet steel, reinforced to ensure rigidity.
   b. Doors shall be mounted flush in architrave frames. Door catches shall be constructed of chromium-plated brass and shall be mounted flush in the door. Built-in locks shall be provided when specified in the distribution board schedule.
D. Chassis

The chassis shall be fixed to the architrave frame. The chassis shall be reinforced, with the necessary provision for fixing of the switchgear. A distance of 75 mm shall be allowed between rows of equipment.

E. Panels

Panels shall be rigidly constructed from 1,6 mm sheet steel with machine-cut openings for flush mounted equipment. Panels shall be fixed to the architrave frame on studs with chromium plated hexagon dome headed nuts, or captive fasteners such that a clearance of 40 mm is maintained between panels and doors. Chromium-plated handles shall be supplied to facilitate removal of panels.

F. Busbars
   a. Busbars shall be of tinned HDHC solid copper with adequate cross-section and shall only be supplied if called for in the Schedules. Busbars are to be mounted on suitable isolators and shall be drilled and tapped.
   b. Each distribution board shall be supplied with copper neutral and earth bars. Adequate terminals shall be provided.
   c. Each busbar must be supplied with one larger terminal for the feeder cable.

G. Wiring
   a. Wiring shall be by means of PVC insulated conductors with sizes to suit the relevant switchgear. The ends of wires shall be provided with suitable lugs, firmly crimped, or soldered for connection to busbars.
   b. Wiring shall, where possible, be carried out in front of the chassis and shall be neatly bound in horizontal and vertical rows by means of approved plastic cable ties. Wiring shall be kept free of any current carrying parts.
   c. Ends of wires which are connected to the clamps of miniature circuit breakers, shall be turned together firmly before insertion into terminals.

H. Finish

Welding joints and steelwork shall be ground smooth and free from blemishes.

Metal components of the framework, panels, and chassis shall be painted in accordance with the procedure detailed below. Baked enamel or electrostatically applied powder coating may be used.

   a. Surface preparation.

Prior to painting, all metal parts shall be thoroughly cleaned of rust, mill scale, grease, and foreign matter to a continuous metallic finish. Sand or shot blasting, or acid pickling and washing may be employed for this purpose.

   b. Baked enamel finish.

Immediately after cleaning all surfaces shall be covered by a rust inhibiting, tough, unbroken metal phosphate film and then thoroughly dried to SANS 10064. Within forty-eight (48) hours after phosphating, a passivating layer consisting of a high-quality zinc chromate primer shall be applied, followed by two (2) coats of high-quality baked enamel to SANS 2808 Codes. The minimum paint thickness after baking shall be 0,6 mm. The paint shall have a shock resistance of 25 kg-cm on 0,9 mm soft steel plate and a scratch resistance of 2 kg.

   c. Powder coated finish.

Immediately after cleaning the metal parts shall be pre-heated and then covered by a micro structured paint powder applied electrostatically. The paint shall be baked on and shall harden within 10 minutes at a temperature of 190^{o}C. The minimum paint thickness after baking shall be 0,05 m and the paint cover shall have a shock resistance of 25 kg-cm on 0,9 mm soft steel plate and a scratch resistance of 2 kg.

A9.10 SURFACE MOUNTED DISTRIBUTION BOARDS

Surface mounted distribution boards shall comply with SANS 60456 and shall be similar to the specification for flush mounted boards, except that the architrave frames and bonding trays are not required. In this case a box shall be supplied manufactured from 1,60 mm corrosion resistant sheet steel with knockouts at the top and bottom for conduit entry. The board shall have a 25 mm wide frame around the flush mounted door, if required.

A9.11 TRAINING

Installation of the switchgear shall require no special tools. Product training shall be made available at the purchaser's facility if required.

A10. LOW VOLTAGE DISTRIBUTION CUBICLES (KIOSKS)

A10.1 QUALITY ASSURANCE

A10.1.1 CODES AND STANDARDS

Cables supplied and installed shall comply with the following Acts and regulations:

h. The latest issue of SANS 556: “Low-voltage switchgear Part 1: Circuit-breakers
i. The latest issue of SANS 1765: “Low-voltage switchgear and control gear assemblies (distribution boards) with a rated short-circuit withstand strength up to and including 10 kA”.
j. The latest issue of SANS 60439: 1-5: “Low-voltage switchgear and control gear assemblies”,
k. The latest issue of SANS 60947: 1-8: “Low-voltage switchgear and control gear”,
l. The latest issue of SANS 1973: “Low-voltage switchgear and control gear ASSEMBLIES Part 1-8”,
m. The latest issue of NRS 003: “Metal-clad switchgear - For rated a.c. voltages above 1 kV and up to and including 24 kV Part 2: Standardized panels
n. Codes and standards as per Section 002: Design Criteria.

A10.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

c. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
d. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A10.1.3 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A10.2 DISTRIBUTION KIOSKS

A10.2.1 GENERAL

This specification covers the manufacture of distribution kiosks for general reticulation and distribution systems in normal environmental conditions for three-phase, four-wire, 400/231V, 50 Hz systems.

A10.2.2 SIZE

Kiosks shall be of ample size to accommodate the specified equipment and provide space for future requirements as specified.

A10.2.3 MOISTURE AND VERMIN

3.1 Kiosks shall be weatherproof. To prevent the ingress of water onto live equipment, the door entry surrounds shall have a channel shape, at least 12mm deep, to accommodate the door edge.

3.2 The roof shall be constructed with an overhang above non continuous panelling and shall be provided with a drip-edge.

A10.2.4 VENTILATION

4.1 Two ventilation grilles or slots, approximately 150 x 125mm, vermin proofed, and insect proofed by means of 1,5mm brass mesh or perforated steel plate spot-welded on the inside, shall be provided on the top and bottom of both side panels.

4.1 The construction of the grilles shall prevent the ingress of rain or water.

A10.2.5 FIBREGLASS CANOPIES

Application

Where specified and for all kiosks to be installed within 50km of the coast and in corrosive industrial atmospheres, the canopy and doors shall be manufactured of fibreglass.

Construction

5.2.1 The laminate shall be constructed to SANS 141.

5.2.2 An outer isophthalic resin gelcoat with a minimum thickness of 0,4mm and ultraviolet absorption properties to prevent degradation of the surface from exposure to the sun shall be provided.

5.2.3 The gelcoat shall be backed by multiple layers of chopped strand mat glass rendering not less than 1,2kg/m^2. The strength shall be increased to 1,3 kg/m^2 on kiosks with panelling larger than 500 x 500mm.

5.2.4 The fibreglass shall be thoroughly impregnated with polyester resin. The resin should preferably be clear.

5.2.5 The resin to fibreglass ratio shall not be less than 2,5 :1 and not more than 3,0 :1.

5.2.6 Air entrapped between the glass mat layers shall be thoroughly worked out. The laminate must be free of air bubbles and voids.

5.2.7 All edges shall be reinforced with an additional 700 g/m^2 of fibreglass.

5.2.8 All large surfaces, wider than 300mm, shall be reinforced or panelled to improve stiffness and rigidity.

5.2.9 A resin coat shall be applied to the inside of the kiosk to cover the fibre pattern.

5.2.10 Brass or steel backing plates shall be laminated into the fibreglass at hinge points, locking mechanism catch support areas, door restraint fixing points and all other points which will be subjected to mechanical stresses.

5.2.11 Doors shall be adequately braced, reinforced, ribbed or double laminated with an air gap between the two layers of laminate to ensure rigidity.

5.2.12 The fibreglass canopy shall be fixed to the internal equipment support frame with bolts accessible through the door only.

Finish and Colour of Fibreglass Kiosks

5.3.1 The outside surface of the kiosk shall nave a glossy, smooth finish to ensure good weathering. To obtain this the manufacturer shall ensure that the mould is smooth, free of voids, hairline cracks, pores or other defects.

5.3.2 Compound rubbing or sanding of the outside surface will not be permitted.

5.3.3 Pigments shall be added to the outer gelcoat to obtain a matching colour to SANS 1091 "AVOCADO GREEN" colour C12 or "LIGHT STONE", colour C37.

5.3.4 Fibreglass kiosks shall not be painted.

A10.2.6 SHEET STEEL CANOPIES

6.1 Where specified the canopy and doors shall be manufactured of either mild steel as 3Cr12 stainless steel to the following requirements:

6.1.1 A metal framework shall be manufactured from solid angle iron, channel iron or 2,5mm minimum folded sheet steel.

6.1.2 Joints shall be non-continuously butt welded. Welds shall be ground smooth and the joint wiped with plumber's metal in order to provide a smooth finish.

6.1.3 Side panels, doors and the roof shall be manufactured from 2mm minimum sheet steel. The panels shall have upturned edges which are recessed in the frame or which fit over lips on the frame. The side panels may be either bolted or welded to the frame or form part of the folded metal frame.

6.1.4 The roof of the cubicle shall be removable and shall be fitted by means of bolts which shall be accessible from inside the cubicle only.

6.1.5 All panels and doors shall be suitably braced and stiffened to ensure rigidity and to prevent warping.

6.1.6 The steel canopy and framework shall be fixed to the base frame by four M16 high tensile steel bolts.

Finish and Colour of Sheet Steel Kiosks

6.2.1 Metal components of the framework, panels and doors shall be painted in accordance with the Department's "STANDARD PAINTING SPECIFICATION", Section C39.

6.2.2. The colour shall be "AVOCADO GREEN", colour C12 or "LIGHT STONE", colour C37 of SANS 1091. A tin of matching touch-up paint (not smaller than 500ml) shall be provided with each consignment.

A10.2.7 CAST IRON KIOSKS

7.1. Where specified the cubicle panels and doors shall be manufactured from cast iron to the following requirements:

7.1.1 A metal framework shall be manufactured from solid angle iron or channel iron.

7.1.2 Cast iron panels shall be bolted to the framework and shall be replaceable with standard cast iron panels.

7.1.3 The panels shall be bolted to the frame from the inside of the cubicle. Bolts or nuts on the outside of the cubicle are not acceptable.

7.1.4 The roof of the cubicle shall be one casting and shall be bolted in position from inside the cubicle.

7.1.5 The minimum thickness of the cast iron panels and doors shall be 6mm

7.1.6 All cast iron panels and doors shall be fettled prior to painting.

Finish and Colour of Cast Iron Kiosk:

7.2.1 Metal components of the framework, panels and doors shall be painted in accordance with the Department's "STANDARD PAINTING SPECIFICATION". Section C39.

7.2.2 The colour shall be "AVOCADO GREEN". colour C12 or "LIGHT STONE", colour C37 of SANS 1091. A tin of matching touch-up paint (not smaller than 500ml) shall be provided with each consignment.

A10.2.8 DOORS

8.1 Doors shall be fitted to the front and to the rear of each cubicle. The doors shall provide free access to equipment which has to be operated and shall provide a full view of all meters. Cubicles wider than 700mm shall be provided with double doors.

8.2 Doors shall have well returning edges to fit into the channel of the door entry surrounds. Refer to par. 3.1 and 6.1.3.

8.3 Doors shall swivel through 135.

8.4 Brass hinges shall be used to hang the doors. The hinges shall be bolted to the canopy with brass bolts and nuts. Bolt heads or nuts shall not protrude beyond the outer surface of the kiosk. Nylon, aluminium or piano hinges are not acceptable.

8.5 Doors shall be fitted with lever locks with a 135° movement. The locking mechanism shall have a catch on the rear which catches behind the frame or door entry surround. The locking mechanism as well as the catch support area shall be backed with brass or galvanised steel plates. The locking mechanism shall be lockable by padlocks. Padlocks will be provided by the Department.

8.6 The locking mechanism shall be made of brass or stainless steel.

8.7 Door restraints shall be provided. Cloth or canvas straps are not acceptable. The fixing points of the restraint at both the door and canopy shall be reinforced.

8.8 At least three hinges shall be supplied on steel doors higher than 12mm.

8.9 Doors shall be fitted with neoprene or equivalent seals.

8.10 Metal doors shall be earth bonded to the frame by means of a copper braided strap, tooth washers, bolts and nuts.

A10.2.9 EQUIPMENT SUPPORT FRAME

9.1 A free standing, angle iron or similar type rigid support framework shall be provided.

9.2 The frame shall be bolted down on the base by four M16 high tensile steel bolts. The holding-down bolts shall be accessible from the inside of the cubicle only. The frame of sheet steel canopies may be bolted to the canopy framework.

9.3 A galvanised steel cable gland plate shall be bolted to the bottom of the frame across the full width of the cubicle to cover the cable entry opening in the base.

9.4 The gland plate shall be suitably punched to accept the number and size of cables specified.

9.5 All steelwork shall be hot dip galvanised in accordance with SANS 32&121.

9.6 A panel of resin bound synthetic wood or other suitable dielectric material shall be provided for the mounting of all equipment and busbars. Impregnated hardboard, other treated or untreated wood products are not acceptable.

9.7 Alternatively, all equipment and busbars shall be flush mounted within a purpose-made sheet metal frame enclosed by a machine punched removable front panel through which the operating handles of the equipment protrude. Care shall be exercised that the rear studs of circuit-breakers are properly insulated from the steel chassis. Miniature circuit-breakers may be installed in clip-in trays mounted on the frame.

A10.2.10 CONCRETE BASES AND BASE FRAMES

10.1 To ensure stability of the kiosk after installation, it shall be mounted on a base frame which, in turn, shall be bolted to a concrete base cast into the bottom of the cable trench.

10.2 The base frame shall be constructed of angle iron, at least 50 x 4mm thick and shall be of welded construction hot-dip galvanised and coated with epoxy resin tar.

10.3 The vertical height of the box frame shall be at least 900mm and the construction shall be such as to provide a rigid support for the kiosk.

10.4 The base frame shall protrude to a maximum height of 200mm above ground level. Provision shall be made for the protection and concealing of the cables entering the kiosk and to prevent access of animals and vermin.

10.5 The base frame shall be secured by at least four M16 bolts to the support frame of the kiosk and four M16 anchor bolts and nuts to the concrete base. The bolts, nuts and washers shall be galvanised and supplied with the kiosk.

10.6 All galvanising shall be to SANS 32&121.

10.7 The kiosk manufacturer shall supply a detailed drawing of the base frame and the concrete base required.

10.8 Alternative designs and materials for the base (or root) of the kiosk will be considered but full details must be submitted for approval by the Department.

A10.2.11 BUSBARS

See Section C15 for details.

A10.2.12 MOUNTING OF EQUIPMENT

13.1 The mounting of equipment shall comply with SANS 1765 where applicable. Equipment shall be fixed to the support panel with bolts, nuts, washers and spring washers or self-locking nuts with washers. Self-tapping screws are not acceptable.

13.2 Equipment shall be arranged and grouped in a logical fashion.

13.3 All equipment shall be flush mounted behind panels with only circuit-breaker and isolator toggles and meter faces protruding. The front panels shall be secured in position by 6mm studs and hexagonal chromed brass dome nuts and washers or hank nuts fasteners. Self-tapping or similar screws are not acceptable.

13.4 Blanking plates shall be fitted over slots intended for future equipment. These plates shall be fixed so that fixing holes do not need to be drilled through the front panel.

A10.2.13 ACCESS

All equipment, busbars and wiring shall be completely accessible with the door open and the back door and front panel removed. In the case of fibreglass kiosks, the complete canopy shall be removable.

A10.2.14 LABELLING

15.1 All equipment shall be fully labelled, and accurate descriptions shall be given in both official languages.

15.2 Engraved brass shall be used for labels. The labels shall be riveted to the kiosks.

15.3 The following labels shall be supplied as a minimum requirement:

15.3.1 Number and allocation of kiosk, e.g., LVK 1

(Lettering: At least 10mm high. Label on the outside in a prominent position).

15.3.2 Designation of circuit i.e., circuit-breaker, isolator, meter, etc. e.g.:

LVK 5

L1(1-16)

(Lettering: At least 5mm high. One label installed directly below each item of equipment pertaining to the circuit shall be provided).

15.3.3 The main switch shall be marked in accordance with the regulations.

15.3.4 The function and circuits of all other equipment shall be clearly identified. Flush mounted equipment within the front panel shall be identified by labels fixed to the front panel. The labels for all equipment installed behind panels shall be fixed to the support panel close to the equipment.

15.3.5 The labels shall be secured by means of rivets. Self-tapping screws are not acceptable. Labels shall not be glued to their mounting positions. Sufficient rivets shall be provided to prevent labels from warping.

15.3.6 All label designations shall be confirmed with the Department before manufactured.

A10.2.15 NOTICES

At least one with the words "DANGER/INGOZI/GEVAAR" shall be mounted outside on the front of the kiosk. This notice shall be riveted to the steel or cast-iron door so that it cannot easily be removed. Brass rivets shall be used. The notice shall be laminated into the fibreglass door in the case of fibreglass kiosks.

A10.3 SUBMITTALS

Shop drawing submittals shall include, but not be limited to, the following:

e. Kiosks shop drawings with all busbar and switch ratings, capacities, characteristics, features and associated accessories clearly indicated.
f. The minimum setting of the earth fault devices and the recommended setting for normal building operation.
g. Sufficient information to show that switchboard overcurrent protection devices have been fully coordinated with load side overcurrent protection devices and the Supply Authorities primary overcurrent protection. This shall include time/current curves and trip settings.
h. Equipment room layout showing switchboards, panel boards, motor control centres, etc., with required clearances as specified in the SANS codes.

A10.4 INSTALLATION

d. Install Kiosks where shown, in accordance with the manufacturer's written instructions and recognized industry practices to ensure that the switchboards comply with the requirements and serve the intended purposes.
e. Install Kiosk on a nominal 100 mm high reinforced concrete housekeeping pad. The housekeeping pad shall extend 80 mm beyond the housing of the switchboard unless shown otherwise. The entire assembled switchboard shall be anchored to continuous 40 mm x 150 mm channels for the full length.
f. The channels shall be embedded in the concrete housekeeping pad. Bolt studs shall be at least 10 mm in diameter and located not more than 750 mm apart centre to centre. The mounting channels shall be continuous single-piece structural channels and shall be levelled when embedded in the concrete housekeeping pads. The channel and bolt studs shall be furnished and installed by the Electrical Contractor.

A10.5 SPARE SPACE

All distribution boards shall be of adequate size to accommodate specified equipment and a minimum of 30% spare capacity shall be allowed for future equipment unless specifically stated in the detail specification.

A10.6 TRAINING

Installation of the switchgear shall require no special tools. Product training shall be made available at the manufacturer facility if required.

A11. CONDUIT AND OUTLET BOXES

A11.1 QUALITY ASSURANCE

A11.1.1 CODES AND STANDARDS

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

a. The latest issue of SANS 60614 and SANS 61035, parts 1 and 2: Metallic conduit and accessories
b. The latest issue of SANS 950: Non-metallic conduit and accessories

A11.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

a. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
b. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A11.1.3 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A11.2 CONDUIT AND ACCESSORIES

a. 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 the particular specification.
b. Electrical and ICT distribution within buildings shall be as follows:
   - Cable trays – in open areas and accessible ceilings
   - Cable Baskets – in accessible ceilings
   - PVC Conduits – in accessible ceilings and hidden conduits
   - Galvanised steel conduits – exposed and surface mounted
c. 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.
d. 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.
e. Bushes used for metallic conduit shall be provided in addition to locknuts at all points where the conduit terminates at switchboards, switchboxes, draw-boxes, etc.
f. Draw-boxes are to be provided in accordance with the “Wiring Code” and wherever necessary to facilitate easy wiring.
g. 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 the particular specification or indicated on the drawings.
h. Only one manufactured type of conduit and conduit accessories will be permitted throughout the installation.
i. 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.
j. Under no circumstances will conduit having a wall thickness of less than 1,6mm be allowed in screeding laid on top of concrete slabs.

k. Bending and setting of conduits 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 Engineers 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.
l. 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.
m. All conduit and accessories used in areas within 50 km of the coast shall be galvanised to SANS specifications.
n. 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 Employer to any claim submitted by the Contractor, which may result from a lack of knowledge in regard to the supply authority's requirements.

A11.3 SCREWED METALLIC CONDUIT AND ACCESSORIES

a. Screwed metallic conduits shall comply with SANS 60614 and shall bear the SABS mark. Screwed metallic conduits shall comprise of a heavy gauge, welded or solid drawn, black enamelled or hot-dipped galvanised, screwed steel tube.
b. Galvanised conduits shall be hot dipped on both the inside and outside thereof, in accordance with SANS 121.
c. All conduit ends shall be reamed and threaded on both sides and shall be delivered to site with a steel coupling fitted at one end and a plastic screw on cap on the opposite end.
d. All screwed metallic conduit accessories shall be of malleable cast iron or pressed steel with brass bushes and all accessories shall be in accordance with SANS 60614 Part II. No alloy or pressure cast metal accessories or zinc base alloy fittings will be accepted.
e. All accessories whether galvanised or black enamelled shall be supplied with brass screws.
f. Locknuts are to be of the narrow, hexagonal type. Ring type lock nuts shall not be accepted except when used in round grouping boxes.
g. Bushnuts and male or female conduit bushes shall be manufactured from solid brass. Brassed alloy bushnuts and bushes shall not be accepted.
h. In general, screwed steel conduit shall be used in the wiring of buildings. The installation shall conform to requirements of SANS 10142. All joints in conduit tubing shall be red leaded to prevent rust. Galvanised conduit and accessories shall be used in the following circumstances and normally be electro-galvanised or cadmium plated:
    - In damp areas
    - In areas exposed to the weather
    - For all installations within 50 km of the coast. (These conduits and accessories shall be hot dip galvanised to SANS 121).
    - In plenum chambers containing humidifying equipment.
    - For surface mounted conduit installations in kitchens and boiler rooms.
    - In screed resting directly on soil.
    - For connection points to future installations.
    - For underground conduit containing earthing conductors.
    - In buildings where animals are housed such as cattle, sheep, dogs, etc.
i. Screwed conduits shall be terminated by means of a brass female bush and two lock nuts in pressed steel switchboards and distribution boxes, cable ducts, power skirting, etc. The conduit end shall only project far enough through the hole to accommodate the bush and locknut.
j. A female bush and two lock nuts shall be used to terminate conduits at draw boxes and outlet boxes without spouts should there be sufficient room in the box. Where there is insufficient room, a coupling, brass male bush and locknut may be used with sufficient allowance for the reduction of the internal diameter by the male bush. Mechanical and electrical continuity shall be maintained throughout the conduit installation. The resistance of a completed joint shall not exceed 0,2 ohm. Under no circumstances shall conduit be relied upon for earth continuity

A11.4 PLAIN-END METALLIC CONDUIT AND ACCESSORIES

a. As an alternative to threaded metallic conduit, plain-end or unthreaded metallic conduit and accessories may be used. Plain-end conduit shall be manufactured from mild steel having a minimum wall thickness of 0,9 mm and shall comply with SANS 60614. Bending and setting of plain-end conduit shall be undertaken using the correct bending apparatus as recommended by the manufacturer of the conduit.
b. Galvanised conduits shall be hot dipped on both the internal and external surfaces, in
c. accordance with SANS 121. All plain-end metallic conduit accessories shall be of malleable cast iron or pressed steel and shall comply to SANS 60614.
d. Where specified plain-end conduit shall be installed. The following shall apply:
e. Bending and setting of plain-end conduit shall be done with special benders and apparatus manufactured for this purpose. Damaged conduit resulting from the use of incorrect bending apparatus shall be completely removed and rectified at the electrical contractor's expense.

A11.5 PVC CONDUIT AND ACCESSORIES

a. PVC conduit shall comply with SANS 950 and shall bear the SABS mark. PVC conduit shall be constructed from rigid PVC and shall be supplied in standard 4 metre lengths. PVC conduit shall be white in colour and shall be non-inflammable. The minimum softening temperature shall be at 75°C.
b. All PVC conduit accessories shall be fully in accordance with SANS 950 and shall bear the SABS mark.
c. Where specified for a particular service, PVC conduit shall be installed.
d. All PVC conduits shall be installed in accordance with SANS 950. Insulated heat-resistant boxes shall be used for outlets of totally enclosed luminaires and other fittings where excessive temperatures are likely to occur. Luminaires and other fittings shall not be supported by PVC conduit of conduit boxes.
e. These fittings shall be secured to the surrounding structure in an acceptable way.

A11.6 FLEXIBLE CONDUIT

a. Flexible steel conduit and adaptors shall comply with BS 731, part 1 where applicable. Flexible steel conduit shall be of a galvanised steel construction which is not required to be waterproof but shall be vermin proof and suitable for protection of cables against mechanical damage. In moist or damp areas flexible steel conduit shall be of the plastic sheathed galvanised steel type. Flexible polypropylene tubing shall only be fastened to PVC conduit installations.
b. In installations where the equipment has to be moved frequently to enable adjustment during normal operation, for the connection of motors or any other vibrating equipment, for the connection of thermostats and sensors on equipment, for stove connection and where otherwise required, flexible conduit shall be used for the final connection to the equipment.
c. Flexible conduit shall 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 2 m of the junction and if the flexible conduit can easily be rewired.
d. Flexible conduit shall consist of metal reinforced plastic conduit or PVC covered metal conduit with an internal diameter of at least 15 mm, unless approved to the contrary. In false ceiling voids, flexible conduit of galvanised steel constructions may be used. Connectors for coupling to the flexible conduit shall be of the gland or screw-in type, manufactured from either brass or mild steel plated with zinc or cadmium.

A11.7 EARTH CLAMPS

Earth clamps shall comprise of copper strips having a minimum thickness of 1 mm and shall not be less than 12 mm wide. Earth clamps shall be provided complete with a 25 mm x 4 mm brass bolt, washer and nut and shall be constructed so that the clip can be firmly attached to the conduit without the need for any additional packing.

A11.8 FLUSH MOUNTED STEEL WALL BOXES

Flush mounted steel wall boxes shall be manufactured from heavy gauge sheet steel and shall be galvanised. All wall boxes shall comply with SANS 1085. The boxes shall be provided with the necessary mounting lugs to suite the units for which the box is intended. Mounting highs shall be drilled and tapped at 82,5 mm centres suitable for fastening either flush mounted switch or socket outlet units. All fastening screws shall be provided with the box. Single gang wall boxes shall be approximately 500 mm wide by 100 mm long by 50 mm deep, with one knock-out at each end and at the back, and with two knockouts on each side thereof. Double gang wall boxes shall be approximately 100 mm wide by 100 mm long by50 mm deep, with two knockouts on each end and with at least two knockouts on the back, and on each side. All knockouts are to be suitable for marking-off 20 mm diameter conduits.

A11.9 FLUSH MOUNTED PVC WALL BOXES

a. Flush mounted PVC wall boxes shall be manufactured from rigid PVC and shall be white in colour. All PVC wall boxes shall comply with SANS 950. The boxes shall be provided with the necessary mounting lugs to suite the units for which the box is intended. Mounting lugs shall be drilled at 82,5mm centres and shall be provided with no 6 screw threads.
b. The boxes shall be of approximately the same physical dimensions as those specified for steel wall boxes and shall have 20 mm knockouts. Facilities shall be provided for the fixing of earth terminals to the box.

A11.10 ROUND GROUP-TYPE STEEL BOXES

a. The boxes shall be manufactured in accordance with SANS 1085 where applicable. The boxes shall be of the long spout pattern and shall be constructed from either store enamelled jet black or galvanised steel, or from malleable cast iron. The two cover fixing holes shall be diagonally opposite each other and shall be drilled and tapped at 50 mm centres. The internal dimensions shall be approximately 60 mm in diameter by 60 mm deep for use in concrete work. Shallower boxes shall be used in open roof spaces.
b. Threaded spouts shall be suitable for 20 mm diameter conduit. Round box covers shall be constructed from pressed enamelled or galvanised steel and shall be seared by using brass screws.

A11.11 ROUND GROUP-TYPE PVC BOXES.

The boxes shall be similar in shape to those specified for steel boxes and shall have spouts which are to be reinforced with webs. The cover screw pillars shall be provided with tapped brass inserts and provision shall be made for a brass earthing terminal adjacent to one or both of the pillars. PVC round box covers shall be of PVC and shall be secured by means of 2 cadmium plated or brass screws at 50 mm centres. The boxes shall be fully in accordance with SANS 950.

A11.12 DRAW WIRES

All draw wires for unused conduits shall comprise of galvanised steel wire having a minimum diameter of 2 mm.

A11.13 INSTALLATION REQUIREMENTS

All accessories such as boxes for socket outlets, switches, lights, etc shall be accurately positioned. It is the responsibility of the electrical 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 electrical contractor to determine the correct final floor, ceiling, and roof levels in conjunction with the principal 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's representative and shall be indicated on the "as built" drawings. Galvanised steel draw wires shall be installed in all unwired conduit, e.g., conduits for future extensions, telephone installations and other services. The edge of flush mounted outlet boxes shall not be deeper than 10

mm from the final surface. Spacer springs shall be used under screws where necessary. Oversize cover plates shall be provided on all flush mounted round conduit boxes, where required. Surface mounted boxes shall be provided with standard size cover plate.

A11.14 INSTALLATION IN CONCRETE

a. In order not to delay building operations, the electrical subcontractor shall ensure that all conduits and accessories which are to be cast in concrete are placed in position in good time. The electrical contractor or his representative shall be in attendance when the concrete is cast. Draw boxes, expansion joints and round ceiling boxes shall be installed where required and shall be finished to match the finished slab and wall surfaces. Ceiling draw boxes shall be of the deep type. 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. Elbows for conduits of 32 mm diameter and smaller and sharp bends will not be allowed in concrete slabs.
b. 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. 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.
c. 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 where off-shutter finishes are required. Where fibre glass shuttering is used by the builder, the equipment shall be fixed to the steel only and no holes shall be drilled or made in shuttering. All draw boxes and outlet boxes shall be plugged with wet paper before they are secured to the shuttering.
d. As far as possible, conduits shall not be installed across expansion joints. Where this is unavoidable a conduit expansion joint shall be provided. The expansion joint shall consist of two draw boxes with an interlinking flexible conduit connection. 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 to 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. The circuit conduit passing through the sleeve shall be terminated 40 mm inside the draw box and in the case of metallic conduit, the conduit end shall be fitted with a brass bush.
e. The gap between the sleeve and the conduit at the joint shall be sealed with a suitable and approved sealing compound, to prevent the ingress of wet cement. In the case of metallic conduit, an earth clip shall be fitted to the conduit projection inside the draw box and the conduit bonded to the box by means of 2,5 mm2 bare copper earth wire and a brass bolt and nut. The other end of the circuit conduit shall be secured to the draw box by means of lock nuts and a brass bush in the case of screwed metallic conduit or a standard bushed adaptor for other conduit types. In addition to an earth wire which may be specified for the circuit, a 2,5 mm2 bare copper wire shall be provided between the first conduit box on either side of the joint in the case of metallic conduit. 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. Suitable steel cover plates shall be screwed to draw boxes installed along the expansion joint. The cover plates shall be installed before the ceiling is painted. 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. The installation of conduits in floor screed shall be kept to a minimum. Where conduits are installed in screed, the top of the conduit shall be at least 20 mm below the surface of the screed. Where the screed is laid directly on the ground, galvanised conduits shall be used. 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 m. The electrical contractor shall ensure that conduits are not visible above the screed where the conduits leave the screed. All draw boxes, conduits, etc, which are installed in concrete shall be cleaned with compressed air and provided with draw wires two days after removal of the shuttering.
f. Errors that occurred during the installation of the conduits, or any lost draw boxes, or blocked conduits shall be immediately reported to the engineer and confirmed in writing in order that an

alternative route can be planned and approved by the engineer before the additional concrete is cast. Where it is necessary to cut or drill holes in the concrete structure, prior permission shall be obtained from the engineer in writing.

A11.15 INSTALLATION IN BRICKWORK

Recessed conduits and accessories installed in brickwork shall be built in. In order not to delay building operations the electrical contractor shall ensure that all conduits and accessories which are to be built-in are placed in position in good time. Any conduits, draw boxes, outlet boxes etc, which have been damaged, lost or omitted shall immediately be reported to the engineer by telephone and confirmed in writing.

A11.16 CHASING AND BUILDER'S WORK

a. Except where otherwise specified the builder or principal contractor shall be responsible for building in of conduits, outlet boxes, switchboard trays, bonding trays, and other wall outlet boxes. The electrical contractor shall notify the builder of his requirements and the responsibility lies with the electrical contractor to ensure that all builder's work is clearly indicated or marked where necessary and provided in accordance with his requirements.
b. Electrical materials to be built in must be supplied, placed, and fixed in position by the electrical contractor when required to do so by the builder or principal contractor. The electrical contractor shall also ensure that these materials are installed in the correct positions.
c. Unless specifically stated to the contrary in the detail specification all flush mounted conduits, accessories, switchboard trays, bonding trays etc, shall be built-in and no chasing shall be allowed.

A11.17 MOUNTING HEIGHT OF DB'S, SWITCHES AND SOCKET OUTLETS

a. Except where stated otherwise, mounting heights shall be as follows:
   - Distribution boards: top frame 2000 mm above finished floor level
   - Switches: underside 1400 mm above finished floor level
   - Socket outlets: underside 300 mm above finished floor level
   - Telephone outlets: underside 300 mm above finished floor level
   - Power skirting: underside 100 mm above finished floor level
b. All distribution boards, switches and socket outlets shall be of the flush mounted type except were stated otherwise.

A11.18 POSITION OF OUTLETS, EQUIPMENT AND CONDUIT

Position of light outlets indicated on the plans are approximate. The exact positions of light outlets shall be determined with due regard to ceiling squares, brandering and patterns. Where any doubt arises as to the correct location of outlets, the engineer and/or architect shall be consulted. The positions of other outlets, equipment and conduit are also approximate. The exact positions shall be determined on site in consultation with the engineer and/or architect.

A11.19 CONDUIT IN ROOF SPACES

a. 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 or conduit clips nailed to the roof timbers.

b. 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.

c. 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.

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

e. All conduits shall be installed horizontally or vertically as determined by the route. The electrical contractor shall take all measures to ensure a neat installation. Conduits shall be firmly secured by means of saddles and screws and in accordance with SANS 10142. Conduits shall be secured within 150 mm before and after each 90o bend. Only approved plugging materials such as fibre plugs or plastic plugs, etc, and round head brass screws shall be used when fixing saddles, switches, plugs etc, to walls. Wood plugs are not acceptable nor should plugs be installed in joints in brick walls.

A11.20 SURFACE MOUNTED CONDUIT

a. Wherever possible, the conduit installation is to be concealed in the building work; however, where unavoidable or otherwise specified under the particular specification, conduit installed on the surface must be plumbed or levelled and only straight lengths shall be used.
b. The use of inspection bends is to be avoided and instead the conduit shall be set uniformly, and inspection coupling used where necessary.
c. No threads will be permitted to show when the conduit installation is complete, except where running couplings have been employed.
d. Running couplings are only to be used where unavoidable and shall be fitted with a sliced coupling as a lock nut.
e. Conduit is to be run on approved spaced saddles rigidly secured to the walls.
f. 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.
g. 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.
h. Where several conduits are installed side by side, they shall be evenly spaced and grouped under one purpose-made saddle.
i. Distribution boards, draw-boxes, industrial switches and socket outlets etc., shall be neatly recessed into the surface to avoid double sets.
j. In situations where there are no ceilings the conduits are to be run along the wall plates and the beams.
k. Painting of surface conduit shall match the colour of the adjacent wall finishes.
l. 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.

A11.21 FLEXIBLE CONNECTIONS FOR CONNECTING UP OF STOVES, MACHINES, ETC.

a. 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 Employer's site electrical representative.

b. 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.

c. Aluminium and zinc alloy connectors will not be acceptable.

A11.22 WIRING

a. Except where otherwise specified in the specification, wiring shall be carried out in conduit throughout. Only one circuit per conduit will be permitted.
b. 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.

c. Unless otherwise specified in the 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.
d. 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 the 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”.
e. The loop-in system shall be followed throughout, and no joints of any description will be permitted.
f. The wiring shall be done in PVC insulated 600/1000 V grade cable to SANS 60227.
g. 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.

A11.23 SWITCHES AND SOCKET OUTLETS

a. All switches and switch-socket outlet combination units shall conform to the Employer Quality Specifications, which form part of this specification.
b. No other than 16 A 3 pin sockets are to be used unless other special purpose types are distinctly specified or shown on the drawings.
c. 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.
d. All switches, isolators and socket outlets shall be Lumex or Crabtree with plastic covers.

A12. OUTDOOR STAND-BY / EMERGENCY GENERATOR SET

A12.1 SCOPE

A. General

The specification is intended to cover the complete installation and commissioning of the generator plant. 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.

For the purposes of this document the following applies:

- Generator Contractor shall be referred to as the Generator Contractor or simply Contractor.
- The masculine includes the feminine.
- The singular includes the plural.

B. Types

Included in this Outdoor Generator Specification

Supply, delivery, installation and commissioning of the complete outdoor emergency generator inside an IP65 canopy/container set on a concrete plinth as specified in this document.

The successful tenderer shall supply, deliver and install a complete single enclosed diesel driven standby generator set in a position that will be determined on site. The machine shall be totally enclosed in a 3CR12 stainless steel housing powder coated or within 50km from the coast with grade 316 steel housing powder coated. The exhaust shall be manufactured from stainless steel.

The housing is to be provided on galvanized 3CR12 stainless steel skids so that the generator set can be transported to site and placed in position on a concrete plinth, casted by the successful tenderer. The skids must be of sufficient height to allow for the passage of storm water under the set.

The types of Diesel Generators include, but are not limited to, the following:

a. Indoor 400-volt, Emergency Diesel Generator located in a generator room within a building. Size as indicated in the generator schedule.
b. Outdoor 400-volt, Emergency Diesel Generator located in a fully rated outdoor enclosure. Size as indicated in the generator schedule.

C. The specification scope covers the supply delivery, installation, and commissioning of the following:
a. Emergency Standby Diesel Generator
b. Switchboard panel
c. Change-over panel
d. Sound attenuation Enclosure

A12.2 QUALITY ASSURANCE

A12.2.1 STANDARDS AND CODES

The supply, delivery and installation of diesel generating sets shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards. The latest issue of the SANS codes will be applicable:

a. SANS 8528: Part 1-12: Reciprocating internal combustion engine driven alternating current generating sets.
b. SANS 10142-1: The wiring of premises: Low Voltage Installations
c. SANS 60034: Rotating electrical Machines
d. SANS IEC 60947: Low Voltage Switchgear
e. OHSACT: Occupational Health and Safety Act.
f. Department of Public Works Quality Specification Parts A, B and C.
g. Local municipality by-laws for generator installations. (To be obtained from local municipality)

A12.2.2 COMPLIANCE WITH REGULATIONS

a. The installation shall be erected and tested in accordance with the following Acts and regulations: The Occupational Health and Safety Act, 1993 (Act 85 of 1993) as amended,
b. The Local Government Ordinance 1939 (Ordinance 17 of 1939) as amended and the municipal by-laws and any special requirements of the local supply authority,
c. The Fire Brigade services Act 1987 (Act 99 of 1987) as amended,
d. The National Building Regulations and Building Standards Act 1977 (Act 103 of 1977) as emended,
e. The Electricity Act 1984 (Act 41 of 1984) as amended.
f. The environmental Act and regulations

A12.2.3 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

a. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
b. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A12.2.4 CONTRACTORS

The Contractor shall familiarise himself with the requirements of the other professional disciplines and shall examine the plans and specifications covering each of these sections.

The generator space, noise and vibration requirements shall be carefully checked with other professional disciplines to ensure that the equipment can be installed in the proper sequence in the space allotted.

Contractor must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A12.3 EQUIPMENT REQUIREMENTS

A12.3.1 ENGINE

A. General
   a. The engine must comply with the requirements as laid down in SANS/ISO 8528 and must be of the atomised injection, compression ignition type, running at a speed not exceeding 1500 r.p.m. The engine must be amply rated for the required electrical output of the set, when running under the site conditions. The starting period for either manual or automatic switching-on until the taking over by the generating set, in one step of a load equal to the specified site electrical output, shall not exceed 15 seconds. This must be guaranteed by the Tenderer.
   b. Turbo-charged engines will only be accepted if the Tenderer submits a written guarantee that the engine can deliver full load within the specified starting period.
   c. Curves furnished by the engine makers, showing the output of the engine offered against the speed, for both intermittent and continuous operation as well a fuel consumption curves when the engine is used for electric generation, must be submitted with the Tender.

B. Rating
   a. The set shall be capable of delivering the specified output continuously under the site Conditions, without overheating. The engine shall be capable of delivering an output of 110% of the specified output for one hour in any period of 12 hours consecutive running in accordance with SANS 8528.
C. De-Rating

a. The engine must be de-rated for the site conditions as set out in the Technical Specification, Section 3 of this document.
b. The de-rating of the engine for site conditions shall be strictly in accordance with SANS/ISO 8528 as amended to date. Any other methods of de-rating must have the approval of the Engineer and must be motivated in detail. Such de-rating must be guaranteed in writing and proved by the successful Tenderer at the site test.

D. Starting and Stopping

a. The engine shall be fitted with an electric starter motor and be easily started from cold, without the use of any special ignition devices under summer as well as winter conditions.
b. Tenderers must state what arrangements are provided to ensure easy starting in cold weather. Full details of this equipment must be submitted. In the case of water-cooled engines, any electrical heaters shall be thermostatically controlled. The electrical circuit for such heaters shall be taken from the control panel and must be protected by a suitable circuit breaker.

E. Starter Battery

The set must be supplied with a fully charged lead-acid type battery, complete with necessary electrolyte. The battery must have sufficient capacity to provide the starting torque stipulated by the engine makers. The battery capacity shall not be less than 120 Ah and shall be capable of providing three consecutive start attempts from cold and thereafter a fourth attempt under manual control of not less than 20 seconds duration each. The battery must be of the heavy duty “low maintenance” type, house in a suitable battery box.

E. Cooling

a. The engine may be either of the air of water-cooled type. In the case of water-cooling, a built-on heavy duty, tropical type pressurised radiator must be fitted. Only stand-by sets that are water cooled shall have electric heaters.
b. For either method of cooling, protection must be provided against running at excessive temperatures. The operation of this protective device must give a visual and audible indication on the switchboard on the switchboard. Water-cooled engines shall in addition be fitted with a low water cut-out switch, installed in the radiator, to switch the set off in the event of a loss of coolant. The protection shall operate in the same way as the other cut-outs (e.g., low oil pressure). The air shall be supplied from the cooling fan cowling/radiator face to air outlet louvers in the enclosure.

A. Lubrication

Lubrication of the main bearings and other important moving parts shall be by forced feed system. An automatic low oil pressure cut-out must be fitted, operating the stop solenoid on the engine and giving a visible and audible indication on the switchboard.

B. Fuel Pump

The fuel injection equipment is suitable for operation with the commercial brands of diesel fuel normally available in South Africa.

C. Fuel Tank

a. The fuel tank shall be an integral part of the base frame of the generator set. The tank shall have sufficient capacity for standby sets to run the engine on full load for a period of 24 hours.
b. The filtration system must be able to handle diesel fuel of “high” and of “low” sulphur content for an indefinite period. The suction line of the system must be connected to the lowest part of the storage system / tank. The return line must be connected in the top section of the storage system / tank in such a position and in such a way that the flow of fuel within the storage system / tank between the fuel return point and the fuel suction point will induce scouring of the bottom of the system / tank to effectively capture sediment and water in the to be filtered fuel.
c. The filtration unit must filter the diesel fuel, removing suspended particles of effective diameters down to 5 microns. In addition, it must separate all water from the fuel and the fuel storage system and automatically dispose of / dump such water into an open, removable receptacle for disposal at the installation or in a suitable position outside the building. Separation of the fuel and water must be sufficiently effective that the discharged water will meet the standard required for it to be disposed of into a municipal drain and sewer system.

d. The filter and water separator unit must draw its power from the DC batteries used to power the relevant generator set. The circulating pump shall be provided with a controller programmed to switch the pump through not more than three complete on and off cycles of equal time (i.e., 50% on; 50% off), per hour, with a deviation of not more than 10 % ±. The pump must be capable of a duty cycle of not less than 60% running time. The flow rate through the circulating pump must be between 1 L/min and 1.25 L /min.
e. The filter cartridge of the filter and water separator unit must be replaceable, and, in normal operational conditions, not require replacement within periods shorter than three months. The replacement units must be readily available.
f. The filtration & separator system may be mounted against the wall of the plant room or on the inside of a container, which may house the installation as may be specified elsewhere in this document.
g. The tank shall be fitted with a suitable filter, a full height gauge glass, “low fuel level” alarm, giving an audible and visible signal on the switchboard as well as a low-low fuel level cut-out.
h. An electrically operated pump with sufficient length of oil resistant hose to reach 2m beyond the door of the canopy/container, shall be supplied, for each set for filling the fuel tank/s from 200 litre drums.
i. The interconnection fuel piping shall consist of copper tubes and the connection to vibrating components shall be in flexible tubing with armoured covering.
j. The contractor shall allow for the supply and installation of a fuel shut off fusible link in the container. The fusible link shall shut off the fuel at a temperature of 130 degrees in an event of a fire in the self-contain enclosure. The fusible link shall be mounted above the engine and coupled to the shut off valve by means of a 2mm stainless steel cable. The cable shall be installed to the shut off valve without any possibility of kinking the cable which may cause malfunctioning of the protection device.

D. Governor
a. The speed of the engine shall be controlled by a governor in accordance with ECM of SANS/ISO 8528 if not otherwise specified in the specific requirements.
b. The permanent speed variation between no load and full load shall not exceed 4,5% of the normal engine speed and the temporary speed variation shall not exceed 10% External facilities must be provided on the engine, to adjust the normal speed setting by ± 5% at all loads zero and rated load.

E. Flywheel
a. A suitable flywheel must be fitted, so that lights fed from the set will be free from any visible flicker.
b. The cyclic irregularity of the set must be within the limit laid down in SANS/ISO 8528.

F. Exhaust Silencer
a. It is essential to keep the noise level as low as possible. An effective exhaust silencing system of the residential type must be provided and shall be capable of providing 20 to 30 decibels of suppression.
b. The exhaust pipe shall be installed in such a way that the expulsed exhaust fumes will not cause discomfort to the public. The exhaust pipe must be flexibly connected to the engine to take up vibrations transmitted from the engine, which may cause breakage. The exhaust piping and silencer shall be lagged and then cladded in stainless steel sheet to reduce the heat and noise transmission in the generator enclosure and shall be protected against the ingress of driving rain at 45° to the horizontal. The exhaust pipe must extend 0,5m above the canopy.
c. The exhaust system shall consist of 3CR12 steel for inland areas (greater than 50km from the coast) or Grade 304 stainless steel in coastal areas.

G. Accessories

The engine must be supplied complete with all accessories, air and oil filters, 3 instruction manuals, spare parts lists, the first fill of all lubricating oils, fuel, etc.

H. Exhaust emissions

The exhaust emissions shall comply with US Tier III/EU stage III standards

A12.3.2 ALTERNATOR

A. General
   a. The alternator shall be of the self-excited brushless type, with enclosed ventilated drip-proof housing and must be capable of supplying the specified output continuously with a temperature rise not exceeding the limits laid down in SANS 60034-1 for rotor and stator windings.
   b. The alternator shall be capable of delivering an output of 110% of the specified output, for one hour in any period of 12 hours consecutive running.
   c. Both windings must be fully impregnated for tropical climate and must have an oil resisting finishing varnish.

B. Regulation

The alternator must preferably be self-regulated without the utilisation of solid-state elements. The inherent voltage regulation must not exceed plus or minus 5% of the nominal voltage specified, at all loads with the power factor between unity and 0,9 lagging and within the driving speed variations of 4,5% between no-load and full load.

C. Performance

The excitation system shall be designed to promote rapid voltage recovery following the sudden application of the load. The voltage shall recover to within 5% of the steady state within 300 milli-seconds following the application of full load and the transient voltage dip shall not exceed 18%.

D. Coupling

The engine and alternator must be directly coupled by means of a high-quality flexible coupling, ISO 9001:2000 approved and must be designed and manufactured to this quality system.

A12.4 SWITCHBOARD

A. General
   a. A switchboard must be supplied and installed to incorporate the equipment for the control and protection of the generating set and battery charging.
   b. The switchboard must conform the specification as set out in the following paragraphs.

B. Construction
   a. The switchboard shall be a totally enclosed, floor mounted unit, fabricated from steel panels, carried on and-substantial angle iron framework.
   b. The board shall be flush fronted and all equipment to be mounted behind the front plate, on suitable supports.
   c. All equipment, connections and terminals shall be easily accessible from the front. The front panels may be either hinged or removable and fixed with studs and chromium-plated cap nuts. Self-tapping screws shall not be used in the construction of the board
   d. All pushbuttons, pilot lights, control switches, instrument, and control fuses, shall be mounted on hinged panels with the control wires in flexible looms.
   e. The steelwork of the boards must be thoroughly de-rusted, primed with zinc chromate and finished with two coats of signal red quality enamel, or a baked powder epoxy coating.
   f. Suitably rated terminals must be provided for all main circuits and the control and protection circuits. Where cable lugs are sued, these shall be crimped onto the cable strands. Screw terminals shall be of the type to prevent spreading of cable strands. All terminals shall be clearly marked.
   g. For the control wiring, each wire shall be fitted with a cable or wire marker of approved type, and numbering of these markers must be shown on the wiring diagram on the switchboard. Control wiring shall be run in PVC trunking. The trunking shall be properly fixed to the switchboard steelwork. Adhesives shall not be acceptable for the fixing of trunking or looms.
   h. The modular generator set controller and protection equipment shall be mounted on a separate easily replaceable panel.
   i. All equipment on the switchboard, such as contactors, isolators, busbars, etc., shall have ample current carrying capacity to handle at least 110% of the alternator full load current.
   j. Access to the cubicle will be such that all components can be conveniently reached for testing and maintenance purposes.

k. The necessary bushes and a screen over the terminals will be provided where the power feeds enter and leave the cubicle.
l. The cubicle will be so constructed that the ac and dc components are screened from one another.
m. The automatic control and protection equipment shall be mounted on a separate easily replaceable small panel with printed circuits. The equipment shall mainly be the “solid state” type. After mounting the equipment on the panel, the rear of this panel shall be sealed with epoxy-resin. However, other proven control systems may also be considered, but must be described in detail.

C. Protection and Alarm Devices

a. All switchboards shall be equipped with protection and alarm devices as described below.
b. A circuit breaker and an adjustable current limiting protection relay must be installed for protection of the alternator. The protection relay shall be of the type with inverse time characteristics. The relay shall cause contactor to isolate the alternator and stop the engine.
c. Protection must be provided for overload, high engine temperature, low lubricating oil pressure, over speed, start-failure, and low water level.
d. Reset push buttons are required on the modular generator set controller and a visible signal are required and the engine must stop when any of the protective devices operate. In the case of manual operation of standby sets, it shall not be possible to restart the engine.
e. The indicators and re-set pushes must be marked in English, as follows.

“OVERLOAD”
“TEMPERATURE HIGH”
“OIL PRESSURE LOW”
“OVER-SPEED”
“START FAILURE”
“LOW WATER LEVEL”

f. In addition, two relays with reset pushes must be fitted giving and audible and visible signal when:
g. The fuel level in the service tank is low. The reset push of this relay must be marked “FUEL LOW”.
h. In addition, a low-low level sensor must be provided. At this level the engine must stop to prevent air entering the fuel system.
i. The battery charger failed. The reset push of this relay must be marked “CHARGER FAIL”.
j. This is also applicable to the engine driven generator/alternator.
k. All alarm conditions must operate an alarm siren. A pushbutton must be installed in the Siren circuit to stop the audible signal, but the fault indicating light on the control panel must remain lit until the fault has been rectified.
l. An on/off switch is not acceptable. After the siren has been stopped, it must be re-set automatically, ready for a further alarm.
m. The siren must be of the continuous duty and low consumption type. Both siren and protection circuits must operate from the battery.
n. Potential free contacts from the alarm relay must be brought down to terminals for remote indication of alarm conditions.
o. A test pushbutton must be provided to test all indicators lamps.

D. Modular Generator Set controller

a. The modular generator set controller shall be an electronic unit to match those of the other modular generator set controllers and of a high quality i.e., Levato, Deep Sea Electronics, Circom. It must be provided with IO and communication facilities.
b. The modular generator set controller will be supplied with all its functions and shall be mounted on a separate easily replaceable panel with plug in termination blocks for easy installation and replacement.

c. The modular generator set controller interface will be implemented with relays, contactors etc.
d. The modular generator set controller will have a mimic display of the alternator/mains/ change over contactors configuration with LED's showing the status of the mains, alternator and change over contractors.
e. Configuration software shall be supplied with the system. The software will be capable of the following:

Fault management (event log)

- Configuration management (software upgrades and function changes)
- Account management (energy management)
- Performance management (generator set point changes)
- Security management (passwords)

f. The modular generator set controller will have a standard RS 232/485 or Ethernet interface suitable for TCP I/P transport medium. All communication including configuration management will be done through this port. Equipment connected at each end of the RS 232 or Ethernet cable shall be adequately protected against transient over-voltages, lightning effects (particularly if the set and remote alarms are in separate buildings), switching surges, power system surges or mains and alternator borne noise/interference.
g. The controller will incorporate the following functions:

- Main's sensing
- Alternator output-voltage sensing
- Alternator over- frequency sensing
- Control of processor unit (self-diagnostics)
- Alarm/ Status indications
- Control selector and operation
- Phase rotation monitor

h. A 4- position control selector on the controller will be provided to facilitate the following modes of operation:

- OFF: Diesel/ alternator generator set switched off
- MANUAL: Mains bypassed: Diesel/ alternator will not take load
- AUTO: Diesel /alternator takes load on mains failure
- TEST: Diesel /alternator takes load on mains failure
- A standby failure alarm (SF) will be given on the controller and to the output alarms when "Not in Auto" is selected.

i. The modular generator set controller must monitor the following
j. When the voltage of the incoming mains varies by more than a pre-program value (default +- 10%) from the normal voltage on any phase, the controller will signal that the incoming mains will be disconnected, and the engine-starting sequence initiated.
k. When the frequency of the incoming mains varies by more than pre- program value (default +-5%) from the normal frequency, the controller will signal that the incoming mains will be disconnected, and the engine-starting sequence initiated.
l. Upon restoration of the incoming mains to the pre-program value (default +-10%) of the normal voltage on all phases, the monitor will signal that the load will be disconnected from the alternator and reconnected to the incoming mains.
m. If the alternator has been disconnected from the load and the incoming mains within the voltage limits of +- 10% on all phases, the controller will signal that the load will be reconnected to the incoming mains.
n. Should the incoming mains fail or not in the specified limits while the engine is running under control of the cooling-off timer, the control for the cooling –off timer in the controller will be cancelled and the load connected to the alternator.
o. When the output voltage of the alternator varies by more than the pre-program value (default value +- 10 %) on ANY phase, the controller will signal that the load will be disconnected from the alternator and the engine stopped.
p. A software over and under-frequency monitor will be provided in the controller if the frequency exceeds or drop below pre-programmed values. It will meet the requirements of class G2 governing. The monitor will not be influenced by harmonics.
q. Note: Software monitors will include adjustable overshoot and undershoot timers to be fully compatible with Class G2 governing.

r. All timers will be implemented in software.
s. Incoming supply failure timer
t. It is essential that incoming supply failures, occurring at short intervals, do not cause a series of starts and stops.
u. A timer adjustable from 1 s to 10 s required
v. The timer default value will be generator set to 3 s
w. The signal generated by the mains voltage monitor will start the timer. If the duration of the signal is less than the generator setting on the timer, the signal is suppressed to that the switching and starting sequence is initiated. However, if the duration of the signal is more than the generator setting on the timer, the signal will be transmitted to initiate the switching and starting sequence.
x. Incoming supply restoration timer
y. It is essential that incoming supply failures, occurring at short intervals, do not cause a series of starts and stops.
z. A timer adjustable from 1 s to 10 s required.
aa. The timer default value will be generator set to 3 s.
bb. The signal generated by the mains voltage monitor will start the timer. If the duration of the signal is less than 150 sec, the signal is suppressed, and the timer is regenerator set. However, if the duration of the signal is more than 150 sec, the signal will be transmitted to initiate the switching sequence.
cc. Alternator supply/ incoming supply change-over timer
dd. It is essential that the supply be disconnected from the load before the incoming supply is reconnected to the load. This will be software generator settable in the controller with a minimum of 5 seconds and maximum of 20 seconds.
ee. On receipt of the switching signal, the alternator supply will be disconnected from the load and timer started. After 5 sec, the incoming supply will be reconnected to the load.
ff. Engine cooling-off timer
gg. After the load has been transferred to the incoming supply the engine will run without load for a period to cool off and then stop.
hh. A timer, software adjustable in the controller from 5 to 10 min is required.
ii. Repeat- start control: A repeat- start control is required in the controller software adjustable so that in the event of the engine falling to start on the first start attempt, the starter motor will be released and repeat the start attempt.
jj. The repeat-start attempt will be repeated 3 times.
kk. The duration of each start attempt will be 6 sec with a period of 15 sec between successive start attempts.
ll. Should the engine fail to start after the third start attempt, the controller will transmit a signal for alarm purposes.
mm. In addition to the requirement for the switchboard instruments listed elsewhere in this document metering will also form part of the modular generator set controller and must be accessible on the software.
nn. The modular generator set controller shall display the following alarm/status indications:
- High engine temperature.
- Low Oil pressure
- High/low alternator output voltage
- Over and under speed (frequency)
- Low water level
- Emergency stop activated
- Mains fail
- Battery chargers fail
- Dummy load in operation (When provided)
- Unit not in Auto
- Engine running
- Low fuel alarm
- Engine start failure

oo. Conditions one to six above will stop the engine.

pp. The Contractor shall provide a remote alarm mimic panel and the associated control wiring for the set. The panel shall be installed in the duty/security room at the entrance to the building approximately 70m from the generator set position.

qq. The mimic panels must fit into furniture and blend with the design. Before manufacture, the Contractor shall submit and obtain the approval, from the Engineer, for the mimic panel.

rr. The remote alarm must have potential free relay contacts which shall indicate the following on each set:

1) Mains on/off
2) Alternator running
3) Common fault alarm
4) Buzzer which can only be reset at the generator panel
5) Fuel low

ss. The cable between the remote alarms is to be a signal cable with a screen and this option must be able to operate from a 12 / 24 V dc supply so that it can be powered from the generator set batteries.

tt. A facility to originate a fault message should a warning or shutdown fault occur.

uu. A facility to allow the mode of the control system to be changed to any of the four modes to allow the set to be run from a remote location.

vv. A facility to originate a call to the control cellular and to transfer a fault message should a warning or shutdown fault occur. The alarm conditions above from the controller will be extended to four relays with a make and break contact and terminal strip to allow for remote monitoring of the following alarms:

- Mains fail
- Standby run
- Standby fail
- Low Fuel

ww. A remote start facility must be supplied, software controllable in the controller.

xx. All events relating to the status of the generator set shall be logged with date and time in a non-volatile memory (which can retain information for a period of 6 months in the absence of power to the controller) and the user shall be able to contain a hard copy on site.

yy. The modular generator set controller system must be able to operate with a minimum DC supply voltage of 4 volts (without making use of either an internal or an external auxiliary battery) to allow cranking and starting under conditions of low battery capacity. Control cables between the set and the control panel shall be fitted with sockets for ease of undoing in the event the modular generator set controller has to be removed.

E. Manual Starting

Each switchboard shall be equipped with two pushbuttons marked “START” and “STOP” for manual starting and stopping of the set.

F. Battery Charging Equipment

Each switchboard shall be equipped with battery charging equipment.

a. The charger shall operate automatically in accordance with the state of the battery and shall generally consist of an air-cooled transformer, a full wave solid state rectifier, and the necessary automatic control equipment of the constant voltage system.
b. The charger must be fed from the mains. An engine driven alternator must be provided for charging the battery while the set is operational. Failure of this alternator must also activate the battery charger failure circuit.
c. The starter battery voltage will be software monitored by the modular generator set controller. The voltage will be digitally displayed.

G. Switchboard Instruments

Each generating set shall have a switchboard equipped as follows:

a. One flush square dial voltmeter, reading the alternator voltage, scaled as follows:
   - 0-300V for single phase generators.
   - 0-500V for three phase generators. In this case a six position and off selector switch must be installed for reading all phase and phase to neutral voltages.

b. A flush square dial combination maximum demand and instantaneous ampere meter for each phase, with resettable pointer suitably scaled 20% higher than the alternator rating. A red arc stripe above scale markings from 0-20A and a red radial line through the scale at full-load current, shall be provided. This instrument shall be supplied complete with the necessary current transformer.
c. One flush square dial vibrating type frequency meter, indicating the alternator frequency.
d. A six-digit running hour meter with digital counter, reading the number of hours the plant has been operating. The smallest figure on this meter must read 1/10 hour.
e. Fuses or m.c.b.'s for the potential voltage circuits of the meters.
f. One flush square dial ampere meter suitably scaled for the battery charging current.
g. One flush square dial voltmeter with a spring-loaded pushbutton or switch for the battery voltage.

H. Marking

All labels, markings or instructions on the switchgear shall be in both official languages.

I. Earthing
   a. An earth bar must be fitted in the switchboard, to which all non-current carrying metal parts shall be bonded.
   b. The neutral point of the alternator must be solidly connected this bar by means of a removable link labelled "EARTH". Suitable terminals must be provided on the earth bar for connection of up to three earth conductors, which will be supplied and installed by others.

J. Operation Selector Switch
   a. A four-position selector switch must be provided on the switchboard marked "AUTO", "MANUAL", "TEST" and "OFF".
   b. With the selector on "AUTO", the set shall automatically start and stop, according to the mains supply being available or not.
   c. With the selector on "TEST", it shall only be possible to start and stop the set with the pushbuttons, but the running set shall not be switched to the load.
   d. With the selector on "MANUAL", the set must take the load when started with the pushbutton, but it must not be possible to switch the set on to the mains, or the mains onto the running set.
   e. With the selector on "OFF", the set shall be completely disconnected from the automatic controls, for cleaning and maintenance of the engine.

A12.5 AUTOMATIC CHANGE-OVER SYSTEM

A. Automatic Change-over System
   a. A fully automatic change-over system will be supplied and installed with the main MCC panels. This unit will be provided to isolate the mains supply and connect the standby set to the outgoing feeder in case of a mains failure and reverse this procedure on return of the mains.
   b. The contactors for this system must be electrically and mechanically interlocked.

B. By-pass Switch and Main Isolator
   a. The switchboard shall be equipped with an on-load isolator to isolate the mains and a manually operated on-load 4 pole 4 position by-pass switch, which shall switch the connected loads as follows:
   b. NORMAL: will allow for the normal connection i.e., connects the incoming mains to the
   c. Automatic control gear or directly to the outgoing feeder.
   d. In the GEN BY-PASS position the switch will disconnect the automatic changeover control gear and will connect the municipal mains directly the essential supply busbar which will allow for the maintenance of either or both the generator and the automatic changeover equipment.
   e. MAINS BY-PASS switching position would allow the generator to be connected directly to the essential supply busbar. This is when there is a problem with the automatic changeover equipment and there is no municipal power available.
   f. The final position is an OFF position which will remove all power downstream of this switch.
   g. It is required that this by-pass switch and mains isolator be mounted away from the automatic control gear, in a separate compartment, either on the side or in the lower portion of the switchboard cubicle, and that the switches are operated from the front of the compartment.
   h. Contractor to note: The by-pass and mains isolator switch shall also break the main neutral.

C. Start Delay

Starting shall be automatic in event of a mains failure. A 0-15 second adjustable start delay timer shall be provided to prevent start-up on power trips or noticeably short interruptions.

D. Stop Delay

A stop delay with timer is required for the set, to keep the set on load for an adjustable period of one to sixty seconds after the return of the mains supply, before changing back to the supply. An additional timer shall keep the set running for a further adjustable cooling period of 5 to 10 minutes at no-load before stopping.

The Generator supplier will be required to liaise and co-ordinate with the panel manufacturer so that the system operates as recorded above.

A12.6 SOUND ATTENUATION

The soundproofing on canopy engine sets shall be such that the maximum noise level generated by the set under any load condition shall not exceed 65 dB measured in any direction at a distance of 5m from the centre of the set with the doors closed.

The supply and discharge air paths will require separate attenuators on soundproof sets.

A12.7 INSTALLATION

Except for the supply of the incoming mains cable and outgoing feeder cables, the tenderer must include for the complete installation and wiring of the plant in running order, including the connection of the incoming cable and outgoing feeder cables.

The connecting of the cable and control cabling to the generator and the control terminals in the LV board remains the responsibility of the tenderer.

A12.8 CONTROL SYSTEM

a. The unit to have a control panel with the following minimum indication and alarms:
   - Control Language, English
   - Warning - Low Battery Voltage
   - Warning - High Battery Voltage
   - Shutdown - Fail to Start
   - Shutdown - High AC voltage
   - Shutdown - Over/Under Voltage
   - Shutdown - Over/Under Speed
   - Warning & Shutdown – Engine temperature
   - Warning & Shutdown - Oil Pressure
   - Warning & Shutdown - Coolant Temperature
   - Warning & Shutdown – Fuel Level
   - Emergency Stop Switch – External
   - Display - Control LCD

b. The system to be able to communicate to a building management or SCADA system via a PLC via Ethernet.

A12.9 WARNING NOTICES

Notices, in English, must be installed on the outside of the steel enclosure.

a. The successful tenderer must consult the Occupational Health and Safety Act 83 of 1993 and get approval of the wording from the Department's representative, prior to ordering the notices.
b. The notice shall be made of a non-corrodible and non-deteriorating material, preferable plastic, and must read as follows:

DANGER: This engine will start without notice. Turn selector switch on control board to “OFF” before working on the plant.

c. An engraved label shall be installed next to the fuel cap that indicates the following:
Base Tank Capacity
Bulk Tank Capacity (if provided)
Full load litres per hour consumption

A12.10 CONSTRUCTION

a. The engine and alternator of the set shall be built together on a common frame, which must be mounted on a skid base on anti-vibration mountings. The set must be placed direct on the concrete of the generator room. A drip tray must be fitted under the engine. The tray must be large enough to catch a drip from any part of the engine.
b. The frame must be of the ‘DUPLEX’ type.

A12.11 OPERATION

a. The set is required to supply the lighting and power requirements in the case of a mains power failure.
b. The set shall be fully automatic i.e., it shall start when any one phase of the main supply fails or get switched and shall shut down when the normal supply is re-established. In addition, it shall be possible to manually start and stop the set by means of pushbuttons on the switchboard.
c. The automatic control shall make provision for three consecutive starting attempts. Thereafter the set must be switched off, and the start failure relay on the switchboard must give a visible and audible indication of the fault.
d. To prevent the alternator being electrically connected to the mains supply when the mains supply is on and vice versa, a safe and fail proof system of suitably interlocked contactors shall be supplied and fitted to the changeover switchboard.

A12.12 ELECTRICAL CHARACTERISTICS

Output and Voltage

After the de-rating factors for the engine and generator due to site conditions have been considered, the set must have a site output and voltage as follows:

No load voltage	:	400/230 Volt
Rating	:	Refer to SLD and Particular Specs
Power at 0,8 power factor	:	208kW
Frequency	:	50Hz
Fault Level	:	2kA

A12.13 TESTING CERTIFICATES AND INSPECTIONS

The following tests are to be carried out:

a. At the supplier’s premises, before the generating set will be delivered to site Representatives of the Department must be present during the test to satisfy themselves that the generating set complies with the specification and delivers the specified output. The test must be carried out in accordance with SANS 8528. The Representative/Agent must be timeously advised of the date for the test.
b. 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.

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

The total costs for these tests shall be included in the tendered amount.

In the event of the plant, equipment or installation not passing the test, the Representative/Agent shall be at liberty to deduct from the Contract amount all reasonable expenses incurred by the Employer and/or the Representative/Agent attending the test.

A12.14 DRAWING, OPERATING AND MAINTENANCE INSTRUCTIONS

The Contractor shall be responsible for the compilation of a complete set of Operating and Maintenance manuals.

This shall be done in accordance with Particular specifications – Operating and Maintenance manuals.

All information shall be recorded and reproduced in electronic format as well as supplying the Representative/Agent with three sets of hard copies.

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

a. Two copies of a fully detailed and dimensioned drawing of the recommended mounting plinth for the generator unit.
b. Two copies of a dimensioned outline drawing of the generator unit (Plan and elevations).
c. One paper copy and one electronic copy of the schematic wiring diagram of a typical generator unit, including change-over panel, switchboard, room attenuation and building requirements.

A12.15 ERECTION

Installation arrangement — Skid unit with base.

A12.16 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 Representative/Agent.
b. All work shall be executed in a first-class manner by qualified accredited tradesman.
c. The Contractor shall be fully responsible for his work and shall replace any of the work which may be damaged, lost or stolen. The Contractor shall protect the building and its contents against damage by him, his employees or sub-contractors and shall make good any damage thereto.
d. The Contractor shall indemnify the Employer of all liability for damages arising from injuries or disabilities to persons or damage to property occasioned by any act or omission of the Contractor or any of his sub-contractors, including any and all expenses, legal or otherwise, which may be incurred by the Employer or Representative/Agent in the defence of any claim, action or suit.
e. 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.

f. The Contractor shall thoroughly acquaint himself with the work involved and shall verify on site all measurements necessary for proper installation and commissioning 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.
g. The Contractor shall inspect and verify that the existing power feeder system is compatible with the equipment offered and any changes or upgrading of the electrical supply shall be brought to the attention of the Representative/Agent.
h. Material and equipment damaged in transit shall be replaced with undamaged material without additional cost to the Department.
i. 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.
j. All control equipment and serviceable items shall be installed and positioned such that they will be accessible and maintainable.
k. The Contractor shall make sure that all safety regulations and measures and environmental regulations are applied and enforced during the installation and guarantee period to ensure the safety of the public and the User Client.

A12.17 PRE-DELIVERY INFORMATION

Within four weeks of receipt of the purchase order, the tenderer shall submit for the engineer's review, comment, and approve the following:

- Finalised schematic diagram and dimension drawings
- Operating characteristics of the transformer and protective devices.
- Shipping/ transport details.

A13. UNINTERRUPTED POWER SUPPLY

A13.1 SCOPE

A. General

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.

B. Types

The types of UPS include, but are not limited to, the following:

a. Indoor 400-volt, 230-volt, Tower mount UPS located in Varies room within a building. Size as indicated in the UPS schedules.
b. Indoor 230-volt, Rack mount UPS located in sever room within a building. Size as indicated in the UPS schedules

C. The specification scope covers the supply delivery, installation, and commissioning of the following:

Supply, delivery, installation, and commissioning of the complete uninterrupted power supplies specified in this document. The rooms will be provided by other trades and the contractor shall ensure that the space allowed is sufficient for the installation of the UPS and that the ventilation of the intended

room is adequate. If any changes to the design must be made the contractor must inform the consulting engineer in writing.

A13.2 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.

A13.2.1 CODES AND STANDARDS

The supply, delivery and installation of diesel UPS sets shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards. The latest issue of the SANS codes will be applicable:

a. SANS 1474: UPS units.

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

c. The local Municipality by-laws and Regulations as well as the regulations of the local Supply Authority.
d. The local Fire regulations.
e. The Regulations of the Department of Posts and Telecommunications.
f. 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.

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

c. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
d. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A13.2.2 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A13.3 UNINTERRUPTED POWER SUPPLY (UPS)

A13.3.1 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.

A13.3.2 SYSTEM REQUIREMENTS

Refer to the Part B: Specifications for detailed requirements

A. 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 0,9 lagging.
e. Max starting current: 10 times full load current for not more than ½ a cycle with rectifier soft starting facility.

B. Output to Load

a. Rating : Refer to detail specification.
b. Output voltage : Refer to detail specification.
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%

C. Overall Performance

a. Efficiency (overall) : 90-95%

D. 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.
h. A self-monitoring system with digital readout by means of which all critical functions can be checked.

The system shall be capable of providing an uninterrupted supply to the load with the output characteristics as specified for a minimum period of **30 minutes** 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 0,9 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 the 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:

a. Input circuit breakers.
b. System busbars.
c. Rectifiers.
d. Batteries.
e. Inverters.
f. Electronic switches.
g. Bypass circuit.
h. Detour circuit.
i. Fuse protection.
j. Output circuit breakers.
k. Oscillator.
l. Power supply circuits to oscillator, alarms, controls, etc.
m. Battery isolator.

E. 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.

F. 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 consider 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.

For three phase units each of the three rectifier transformers shall have a different primary to secondary phase displacement to minimise the harmonics generated by the rectifiers.

G. 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.

H. 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.

I. Wards/office UPS installation

The rectifier shall be equipped with **2 independents** 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.

J. 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 batteries shall give satisfactory service for a minimum period of **3 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 ohms to 10000 ohms 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.

K. 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.

A13.4 CONSTRUCTION OF CUBICLES AND SWITCHBOARDS

A. General

a. All the converter equipment shall be housed in totally enclosed, free standing, floor mounted cubicles, designed to provide adequate ventilation for the equipment.
b. All cubicles shall be rigid with suitably braced doors providing front access.
c. All cubicles shall be vermin proof.
d. 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.
e. 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.

f. All electronic printed circuit cards shall be of a good quality and shall be easy and simple to interchange.
g. 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.
h. 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.
i. 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.
j. 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.

A13.5 INSTRUMENTATION AND CONTROLS

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 transistors and metal oxide varistors in power supplies and external communication lines. Standard electronic equipment not internally protected with transistors 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.

A13.6 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:

a. Normal
b. Main’s failure
c. Inverter failure
d. Shutdown imminent
e. Load on mains
f. Overload
g. 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 accept 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.

A13.7 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.

A13.8 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:

zz. All general arrangement drawings.
aaa. Detailed dimensioned drawings of all plant and equipment.
bbb. 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:

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

i. 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.

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

k. A detailed **schedule** of all wiring.

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

A13.9 INTRUCTION OF OPERATION 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.

A13.10 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.

A. Battery Tests

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

b. 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.

c. 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.

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

e. 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.

B. Oscillator Test

c. Frequency within tolerances at all loads.
d. Parallel redundancy.
e. Auto automatic synchronisation for connection of the synchronous motor/alternator to mains via the thyristor switch.
f. An electronic frequency counter shall be used to measure the frequency.

C. Rectifier Tests

i. Output voltage of rectifiers at no load and full load with batteries charged and not charged.
j. Current limit, both for mains failure and return to mains.
k. Switch off value mains input monitor.
l. Sequential switch on for return to mains.
m. Soft start circuits.

D. 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.

A13.11 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.

A13.12 SCHEMATIC DIAGRAM

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

A13.13 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.

A13.14 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.

A13.15 DISTRIBUTION WIRING

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

A. Mains power plug circuit
   d. 4 mm^2 PVC/copper in red and black conductors and
   e. 2,5mm^2 bare copper earth.

B. UPS Power Plug Circuit
   a. 4 mm^2 PVC/copper in blue and black and
   b. Green PVC insulated 2,5mm^2 earth wire
   c. The black neutral conductors must be clearly labelled at each end as follows: "UPS"

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

A14. ISOLATION TRANSFORMER

A14.1 SCOPE

A. General

Furnish and install Isolation Transformers as shown, scheduled, and specified.

B. The specification scope covers the supply delivery, installation, and commissioning of the following:

Supply, delivery, installation, and commissioning of the complete uninterrupted power supplies specified in this document. The rooms will be provided by other trades and the contractor shall ensure that the space allowed is sufficient for the installation of the Isolation Transformers and that the ventilation of the intended room is adequate. If any changes to the design must be made the contractor must inform the consulting engineer in writing.

A14.2 QUALITY ASSURANCE

A. Codes and Standards: The supply, delivery and installation of Distribution Transformers (315KVA) shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards. The latest issue of the SANS codes will be applicable:

a) SANS 780: Transformers

b) SANS 60076: Power Transformers Part 1-15

c) SANS 60137: Insulated bushing for alternating voltages above 1000 V.

d) SANS 60815: Guide for the selection of insulators in respect of polluted conditions.

e) SANS 121/ISO 1461: Hot dip galvanized coating on fabricated iron and steel articles.

f) NRS 054: Power Transformers

B. Manufacturers: If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

1. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
2. Products must carry the SABS mark or an international certification and approved for use in South Africa.
3. Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A14.3 ISOLATION TRANSFORMERS

A factory-assembled and tested free-standing unit that is suitable for use in an area accessible to the public, which comprises of a transformer that is suitable for connection to underground cables.

A14.3.1 GENERAL DESIGN PARTICULARS

The specification scope of dry type transformers. Naturally self-cooled, suitable for indoor installation.

The 1:1 transformer will be used for isolation and distribution purposes.

A14.3.2 TANK AND CONSTRUCTION

A. The tank shall be of the dry type and shall be so constructed to avoid the possibilities of any oil leaks or the ingress of any moisture.

B. The cooling fins shall be hot dip galvanised throughout. The interior of the tank shall be protected against corrosion in accordance with SANS 780. The exterior of the tank may not be hot dip galvanized but shall be thoroughly cleaned by shot blasting of all paint, dirt, grease, rust, mill scale, moisture and other contaminants to give a dry bright metallic surface and immediately thereafter shall be treated with zinc galv six primer coat prior to being painted.

C. The cable termination bushings shall be of the porcelain type and no other material shall be accepted. The terminations shall be covered with boots to prevent accidental contact. Both termination compartments to be fully enclosed and sealed.

D. Lifting hooks of adequate strength shall be fitted to the transformer and they shall be so constructed that no distortion shall take place when lifting the transformer complete with oil.

A14.3.3 ELECTRICAL CHARACTERISTICS

A. The transformer shall be of the “low loss” type and shall conform to the Vector group DDN 12. The no-load voltages shall be as required and off-load tap changing facilities in steps of 3%, thus –6%, -3%, 0%, 3%, 6% shall be provided by off-load tap changing switch through the tank. The switch shall be situated in a readily accessible position. The transformer shall be three phase 50 Hz and shall conform to SANS 780 as amended.

B. Power rating: The values of rated power specified are shown on the schedules.

C: Rated Current: The rated current shall correspond to the transformer power rating at rated voltage on the nominal tap position.

D. Maximum continuous current on any tapping: It may be assumed that the transformer will be operated such that the maximum continuous current in any winding on any tapping position will not exceed 1.05 times the rated current on the nominal tapping.

E: Emergency current: transformers shall have over loading capabilities in accordance with IEC 60354.These capabilities shall be verified by type testing at 1.5 pu and 1.3 pu current respectively in accordance with temperature rise tests.

F: Rated voltage on nominal tapping: The rated voltage of each winding of the transformer on the nominal tapping shall be: Unless otherwise specified, shall correspond to the system nominal voltage, Un.

I. Maximum temporary over voltage: The transformers shall be able to withstand the following over voltages without damage:

• 1.00 Urn for continuous;

• 1.05 Um for 5 min

• 1.25 Um for 5 s

• 1.5 Um for 1s

• 1.7 Urm for 0.25s

J: Network frequency: The transformer shall be designed for a rated frequency of 50Hz. If a under frequency had to occur the condition may be sustained for 30min and the over frequency could be sustained for 5 min.

K. Ability to withstand abnormal electrical conditions/loadings: Notwithstanding the over current limits tabulated in IEC 60076-5, the transformer with the standard minimum percentage impedances stated in schedule A, shall be capable of withstanding the thermal, mechanical and other effects of the following faults for 2 s duration per fault incident:

a) A three-phase bolted fault on any set of terminals. The expected occurrence of such faults is once every five years: 230V Primary terminals - 10KA
400V Primary terminals — 16KA

b) A line-to-ground fault on any terminal. The expected average occurrence is once every year.

The Engineer reserves the right to obtain all information regarding calculations and the philosophy of dealing with the short-circuit forces.

In the absence of such tests the manufacturer shall demonstrate with internationally accepted design calculations that the transformer meets the requirements for short-circuit strength.

L. Impedance and tolerances:

a) Main power windings

The leakage impedance of the transformer on any tapping, at 75 °C and 50 Hz, shall be in the permissible percentage impedance given in SANS Requirements.

All impedances shall be referred to the nominal impedance of the transformer. Therefore, the impedance on any tapping shall be the impedance in ohms as viewed from the higher voltage terminals, expressed as a percentage of U2n/M.

where:

Un is the nominal voltage of the higher voltage system in kV, and

M is the MVA rating of the HV winding of the transformer.

M. Standard tapping ranges to be considered for impedances: To be achieved by a no-load tapping switch. All comprising of 5 positions off load ±5%, +2.5%, 0%, -2.5%, -5% and complete with keyed alike padlocks.

N. Acoustic noise: The transformer shall be designed to meet the dBA noise level specified in schedule A to the SANS requirements.

O. Interchange-ability: All transformers of a specific rating and ratio ordered under the same contract shall be identical and interchangeable with one another at short notice. No alteration to control circuits shall be allowed or be necessary for this purpose. All parts of the transformer shall be made accurately to dimensions so that any corresponding parts will fit into place without the need for adjustments.

P. Bushings: The minimum creepage distance of bushings shall be as specified in table below.

1	**2**
IEC 60815 pollution level	Heavy to very heavy (Coastal applications)
Environment	Corrosive
Creepage distance	31 mm/ KV (porcelain or silicone rubber)

A14.3.4 POLE MOUNTED

A. Transformer shall be Pole mounted onsite fence(pending the approval of application the Supply Utility) . The cables will be installed via ducting into the Switch Gear Room

A14.3.5 GENERAL

1. Earthing

A. An earth stud shall be welded onto the transformer tank. All metal parts shall be solidly bonded to this earth point.

2. Labels and Plates

A. All labels shall be of an approved non-fading corrosion resistant material, preferably stainless steel, with black lettering on a white background and shall be fixed with stainless steel screws. Enamelled steel labels will not be accepted as experience has proved that this material corrodes completely within two years.

B. All labelling shall comply with the Occupational Health and Safety Act no 85 of 1993 as amended.

A14.3.6 DOCUMENTATION

A. An instruction manual shall be provided with necessary information for receiving, handling, storage, installation, operation, and maintenance.

B. Routine test certificates shall accompany each unit, with standard schematic drawings for the ring main unit.

C. Specification brochures for the type of switchgear offered must be provided.

A14.3.7 CABLE TERMINATIONS

A. The terminals on the primary side shall be suitable for the making off of PILC DSTA screened or belted cables from 10mm sq. to 16mm sq. The cable termination will be of the indoor heat shrink type.

B. The clearance between the terminals shall be specified. The minimum creepage distance between phase and earth shall be not less than 25mm per kilovolt of the highest r.m.s. phase-to-phase voltage, in compliance with NRS 031.

C. Cable boxes shall be provided on both the Primary and Secondary connection points.

A14.3.8 SUBMITTALS

DRAWING, OPERATING AND MAINTENANCE INSTRUCTIONS

(a) Two copies of a fully detailed and dimensioned drawing of the recommended mounting plinth for the Isolation Transformers;

(b) Two copies of a dimensioned outline drawing of the Isolation Transformers (Plan and 4 elevations);

A14.3.9 ERECTION

A. Installation arrangement — Skid base with rollers.

B. Erection shall include off-loading, lifting, handling, positioning on foundations prepared by the employer, oil filling and installation of the transformer, together with the provision of all materials and ancillary equipment necessary for completing the installation. All work to be in accordance with the relevant safety standards.

C. All equipment provided for erection shall be removed from site when erection is completed and the site cleaned of any debris and oil spillage

A14.3.10 TRANSPORT

A. It shall be the contractor's responsibility to make all arrangements for transport to the site with the appropriate authorities.

B. It shall be the contractor's responsibility to co-ordinate the arrangements for all stages of the transport of the transformer from the manufacturer's works to site.

C. The supply of oil is included in the contract and where transport weight limitations permit, the transformers shall be transported with sufficient oil to cover the core and windings during all transport and storage conditions. The tank shall be sealed for transport to prevent all breathing.

D. Every precaution shall be taken to ensure that the transformer arrives at site in a satisfactory condition so that, after proper oil processing and filling, the transformer can be put into service without the necessity for extensive drying out, provided that oil quality requirements are met.

E. Full details of the proposed method of transport shall be submitted for approval.

F. The costs of any necessary extensions and/or improvements to existing facilities for transporting to site and escort and permit fees shall be included in the contractor's prices.

G. Availability of lifting lugs and jacking pads: The lifting lugs and jacking pads shall be designed to lift the completely assembled transformer with oil.

A14.3.11 EARTHING AND FITTINGS

- Primary bushing 3
- Secondary bushing 3
- Earth terminal, approx. 300mm from transformer tank base on each end of each major side of the transformer tank.
- Rating and diagram plate

A14.3.12 MARKINGS

A. Transformers shall carry the SANS 780 certification mark.

A14.3.13 DIMENSIONS

A. The dimensions of the transformers will be to the measurements as specified.

A14.3.14 TESTS

A. General: Failure of a unit to pass any test listed in this section will constitute non-compliance with this specification.

B. Required tests: The following type tests shall be performed on each design and in accordance with SANS 60076 and SANS 780:1998:

1. Factory Tests: Manufacturers shall perform all routine factory tests and type tests. The test certificates shall be submitted to the Engineer for approval, prior to the dispatching of the transformer from the manufacturers premises to the Site.

2. The following routine tests shall be performed in accordance with SANS 60076 / IEC 60076 and SANS 780 on each transformer.

a) Measurement of winding resistance.

b) Measurement of voltage ratio and phase displacement.

c) Measurement of short-circuit impedance and load loss.

d) Measurement of no-load loss and current.

e) Separate source voltage test.

f) Induced over voltage test.

g) Measurement of paint thickness.

h) Test for effectiveness of sealing.

3. The following type tests shall be performed in accordance with SANS 60076 / IEC 60076 and SANS 780 on each transformer.

a) Temperature-rise test.

b) Impulse test (primary and secondary windings).

c) Tank stiffness test.

d) Demonstration of ability to withstand the dynamic effects of short-circuit and

short-time current.

e) Ratio and polarity test.

f) Load losses test.

4. Testing on site: The testing and checking procedures shall include the verification of:

- Megger — 500V on 400V and, 280V on 230V
- Pressure test
- Chemical check
- Phase rotation and displacement.
- Open circuit voltage.

The results of the above tests shall be documented, signed off as part of the quality process and included in the transformer manuals. All the tests to be witnessed by a representative of the electrical consulting team.

5. Witnessing of tests: The Engineer reserves the right to be present at any of the tests specified.

The contractor shall ascertain the sequence of tests required in each particular case and whether witnessing of tests is required, and, after completion of all works preliminary tests, shall then give the Engineer not less than 14 days notice of the firm date when the transformers and associated apparatus will be ready for the witnessing of testing. As many tests as possible shall be arranged to take place on the same day.

No transformer shall be dispatched from the manufacturer’s works without the Engineers approval of its testing and overall quality.

Any costs incurred by the contractor because of abortive or protracted visits by the Engineers representatives, due to poor organization on the part of the manufacturer or test failures, shall be for the contractor’s account,

The Engineer shall be notified as soon as possible of all test failures and corrective measures. This shall take the form of abbreviated reports that shall, upon request, be supported by more detailed reports.

6. Test certificates: Two copies of test certificates in English shall be supplied to the Engineer prior to the transformer being delivered to site.

A copy of the test certificate shall be incorporated into each maintenance/operating manual.

A14.3.15 PRE-DELIVERY INFORMATION

Within four weeks of receipt of the purchase order, the tenderer shall submit for the engineer's review, comment and approve the following:

1. Finalised schematic diagram and dimension drawings
2. Operating characteristics of the transformer and protective devices.
3. Shipping/ transport details.

A14.3.16 SPARE PARTS

A. Furnish a schedule of all recommended spare parts and replacement components in quantities to serve for a one (1) year period with individual prices for each item listed.

A14.4 SPECIFIC REQUIREMENTS FOR ISOLATION TRANSFORMER

1. 1 KVA, 230V IN, 230V OUT

Item	Description	Detail
1	Number required	6
2	Continuous maximum rating at rated voltage of transformer	1kVA
3	Indoor or Outdoor?	Indoor
4	Number of phases	1
5	Dry type or oil immersed?	Dry
6	Rated frequency Hz	50Hz

Item	Description	Detail
7	Normal “ON LOAD” phase-to-phase voltages for transformer :	Primary: 230 Volts Secondary: 230 Volts
8	System highest operating voltage for transformer:	280 Volts
9	Vector group of transformers	DDN 0
10	Type of cooling	Air
11	Tappings	Full capacity tappings provided in the winding and corresponding to 95%, 97,5%, 100%, 102,5% and 105% of the rated primary voltage
12	Cable boxes or outdoor bushings for line terminals of transformer:	Primary: air filled cable box Secondary: air filled cable box
13	Clamps required for bushings:	Primary: 1 x 10-16mm² 1-core Cu Secondary: 1 x 10-16mm² 1-core Cu
14	Pressure relief device required	N/A
15	Winding temperature indicator required?	N/A
16	Wheels required	Yes
17	Maximum door height	300 mm
18	Enclosure	IP23

2. 5 KVA, 230V IN, 230V OUT

Item	Description	Detail
1	Number required	5
2	Continuous maximum rating at rated voltage of transformer	5kVA
3	Indoor or Outdoor?	Indoor
4	Number of phases	1
5	Dry type or oil immersed?	Dry
6	Rated frequency Hz	50Hz

Item	Description	Detail
7	Normal “ON LOAD” phase-to-phase voltages for transformer :	Primary: 230 Volts Secondary: 230 Volts
8	System highest operating voltage for transformer:	280 Volts
9	Vector group of transformers	DDN 0
10	Type of cooling	Air
11	Tappings	Full capacity tappings provided in the winding and corresponding to 95%, 97,5%, 100%, 102,5% and 105% of the rated primary voltage
12	Cable boxes or outdoor bushings for line terminals of transformer:	Primary: air filled cable box Secondary: air filled cable box
13	Clamps required for bushings:	Primary: 1 x 10-16mm² 1-core Cu Secondary: 1 x 10-16mm² 1-core Cu
14	Pressure relief device required	N/A
15	Winding temperature indicator required?	N/A
16	Wheels required	Yes
17	Maximum door height	300 mm
18	Enclosure	IP23

3. 10 KVA, 400V IN, 400V OUT

Item	Description	Detail
1	Number required	4
2	Continuous maximum rating at rated voltage of transformer	10kVA
3	Indoor or Outdoor?	Indoor
4	Number of phases	3
5	Dry type or oil immersed?	Dry
6	Rated frequency Hz	50Hz

Item	Description	Detail
7	Normal “ON LOAD” phase-to-phase voltages for transformer :	Primary: 400 Volts Secondary: 400 Volts
8	System highest operating voltage for transformer:	480 Volts
9	Vector group of transformers	DDN 0
10	Type of cooling	Air
11	Tappings	Full capacity tappings provided in the winding and corresponding to 95%, 97,5%, 100%, 102,5% and 105% of the rated primary voltage
12	Cable boxes or outdoor bushings for line terminals of transformer:	Primary: air filled cable box Secondary: air filled cable box
13	Clamps required for bushings:	Primary: 1 x 10-16mm² 3-core Cu Secondary: 1 x 10-16mm² 3-core Cu
14	Pressure relief device required	N/A
15	Winding temperature indicator required?	N/A
16	Wheels required	Yes
17	Maximum door height	300 mm
18	Enclosure	IP23

A15. FIBRE OPTIC CABLES

A15.1 QUALITY ASSURANCE

A15.1.1 CODES AND STANDARDS

The supply, delivery and installation of mini subs shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards. The latest issue of the SANS codes will be applicable:

a. SANS 10340-1: Installation of telecommunication cables Part 1: Fibre optic cable in buildings
b. SANS 10340-2: Installation of telecommunication cables Part 2: Outdoor fibre optic cables
c. SANS 60331-25: Tests for electric cables under fire conditions -Circuit integrity Part 25: Procedures and requirements - Optical fibre cables
d. SANS 60332: Tests on electric and optical fibre cables under fire conditions Part 1-2
e. SANS 60793-1: Optical fibres Part 1: Measurement methods and test procedures
f. SANS 60793-2: Optical fibres Part 2: Product specifications
g. SANS 60794-1: Optical fibre cables Part 1: Generic specification
h. SANS 60794-2: Optical fibre cables Part 2: Indoor cables
i. SANS 60794-3: Optical fibre cables Part 3: Sectional specification - Outdoor cables
j. SANS 60794-5: Optical fibre cables Part 5: Sectional specification - Microduct cabling for installation by blowing.
k. SANS 60869-1: Fibre optic attenuators Part 1: Generic specification
l. SANS 60874-1: Connectors for optical fibres and cables Part 1
m. SANS 60874-14: Connectors for optical fibres and cables Part 14: Detail specification for fibre optic connector type SC
n. SANS 60874-19: Connectors for optical fibres and cables Part 19: Fibre optic adaptor (duplex) type SC for single-mode fibre connectors
o. SANS 61073-1: Mechanical splices and fusion splice protectors for optical fibres and cables Part 1: Generic specification
p. SANS 61280-1-3: Fibre optic communication subsystem basic test procedures Part 1-3: Test procedures for general communication subsystems - Central wavelength and spectral width measurement
q. SANS 61280-2: Fibre optic communication subsystem basic test procedures Part 2: Test procedures
r. SANS 61281-1: Fibre optic communication subsystems Part 1: Generic specification
s. SANS 61282: Fibre optic communication system design guides
t. SANS 61290: Optical fibre amplifiers
u. SANS 61300: Fibre optic interconnecting devices and passive components
v. SANS 61753: Fibre optic interconnecting devices and passive components performance standard
w. SANS 61754: Fibre optic connector interfaces
x. SANS 62221: Optical fibres - Measurement methods
y. NRS 088: Duct and direct-buried underground fibre-optic cable Part 1: Product specification

A15.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

a. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
b. Products must carry the SABS mark or an international certification and approved for use in South Africa.
c. Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A15.2 DESIGN CONSIDERATIONS OF OPTICAL FIBRE CABLE

A15.2.1 GENERAL FIBRE OPTIC CABLE SPECIFICATIONS

a. All fibres in the cable shall be usable and meet required specifications.
b. The life expectancy of the cable shall be 25 years for service in the specified environment.
c. The cable shall be designed for installation in underground conduit, wet or dry environments, including alternating wet and dry conditions.
d. All fibre optic cable run in conduits or duct banks shall be an accepted product of the SABS and meet the requirements of SANS.
e. Each optical fibre shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.
f. Each optical fibre shall be proof tested by the fibre manufacturer and test results provided prior to installation
g. The attenuation specification shall be a maximum value for each cabled fibre at 23 ± 5 °C on the original shipping reel.

A15.2.2 FIBRE OPTIC CABLE DISTRIBUTION

a. Single-mode fibre optic cable shall be installed as indicated on the drawings. Single-mode fibre optic cable shall be installed on the facility inside Data room (DR) cabinets and between the Data room and the Distribution Cabinet (DC).
b. Fibre optic cable shall serve as the backbone medium between the Data room (DR) and communication distribution cabinet (DC). The fibre cable shall be placed in a physical ring backbone topology. Backbone fibre cables shall consist of 24-strand single-mode fibre cabling, which shall be of outside plant design for outdoor applications and plenum design for indoor applications. All fibres shall be terminated, tested and certified, whether working or spare.
c. There will be no intermediate cross-connect, patching, consolidation point, or other termination of the fibre optic cable between the DR and the DC.
d. The fibre optic backbone will be configured in a physical ring topology.
e. The DR and each field communications distribution cabinet will have physically redundant entrances to facilitate the ring topology.
f. To facilitate future integrated (fibre direct) subsystem devices, single mode fibre optic backbone cable will be installed. The minimum cable size will be 24-strand cable.
g. Upon receiving the fibre cable shipment reels at the site, the Contractor shall conduct all necessary testing to verify and demonstrate to the Engineer that the shipped fibre cables are acceptable. All deficient or rejected fibre cabling equipment shall be rejected and returned back to the vendor for substitution.
h. Use of Multi-mode fibre cable and the associated equipment solutions shall be avoided and could only be permitted as an exception (due to lack of adequate substitute based on single-mode fibre solution) and only if approved by the Engineer.
i. BLOWN fibre in micro ducts is required for the inner ring and DIRECTLY buried CST fibre cables are to be installed along the fence perimeter.

A15.2.3 PRODUCT TECHNICAL SPECIFICATIONS

Fibre Cable Performance Specifications:

A. Single Mode Fibre 9/125

Optical Properties	
Attenuation at 1310 nm	0.35 dB/km
Attenuation at 1385 nm	0.32 dB/km

Attenuation at 1550 nm	0.25 dB/km
Cable Cut-Off Wavelength	< 1260 nm
Mode Field Diameter @ 1310 nm	9.2 +- 0.5mm
Zero Dispersion Wavelength	1300 – 1320 nm
Zero Dispersion Slope	< 0.092 ps/(nm2.kn)
Dispersion: 1285 nm | 1330 nm	3.5 ps/(nm.km)
Dispersion: 1525 nm | 1575 nm	19ps/(nm.km)
Geometric Characteristics	
Core Cladding Concentricity Error	0.8 mm
Core Non-Circularity	<6%
Cladding Diameter	125 +- 2 mm
Cladding Non-Circularity	1.5%
Coating Diameter	245 +- 10mm
Coating Concentricity	<10mm
Coating Non-Circularity	<5%

B. Multi-Mode Fibre Graded Index 50/125

Optical Properties	
Attenuation at 850nm	2.504 dB/km
Attenuation at 1300 nm	0.704 dB/km
Bandwidth at 850 nm	400 MHz.km
Bandwidth at 1300 nm	800 MHz.km
Geometric Properties	
Core Diameter	50 +- 3mm

Numerical Aperture	0.200 +- 0.015
Cladding Diameter	125 +- 2 mm
Core/Cladding Non Circularity	3.0 mm
Cladding Non Circularity	2%
Coating Diameter	245 +- 10mm
Coating Concentricity	< 15 mm
Coating Non-Circularity	< 5 mm

A15.2.4 PHYSICAL CABLE SPECIFICATIONS

Outdoor Optical Fibre Cable shall conform to the following specifications:

A. Micro Blown Fibre Optic cables – ITU-T G.652.D
   a. Cable Identification

Micro blow Single mode fibre optic cable G.652.D ITU-T G.652.D (9/125), 24 or 48 core

   b. Physical properties
      - UV resistant Polyethylene sheath (Black)
      - Glass reinforced plastic centre strength member (GRP)
      - Water-blocked cable core
      - Spare Space Fillers
      - Optical fibres
      - PBT loose tube Φ1.7mm (Thixotropic filled)

   c. Physical characteristics:

Fibre Count	Elements	Fibres per tube	Cladding Diameter	Core/Clad offset	Coating Diameter (coloured)	Coating /cladding Concentricity Error (max)
4	2	2	125.0 ± 0.7 µm	≤ 0.5 µm	254 ± 7 µm	12 µm
12	2	6				
24	4	6				
48	4	12				
72	6	12				

   d. Environmental and Mechanical

Item	Specification
Operating Temperature	-10° to + 70° C

Installation temperature	-10º to + 60º C
Storage Temperature	-10º to + 75º C
Proof test	100kpsi
Coating strip force	1.3 – 8.9 N
Fibre curl	≥4m
Dynamic Fatigue parameter	≥20
Macro-bending (100 turns @ 75mm mandrel)	0.05 db (1310/1550nm @ 50mm 0.05 db (1625nm @ 60 mm)
Macro-bending, max (1 turn @ 32mm mandrel)	0.05 db @ 1550nm
Temperature dependence -60ºC to + 85ºC	≤ 0.05 dB
Temperature Humidity Cycling -10ºC to + 85ºC up to 95% RH	≤ 0.05 dB
Water immersion 23+2ºC	≤ 0.05 dB
Heat aging 85 + 2ºC	≤ 0.05 dB

e. Optical Characteristics, Wavelength Specific

	1310-nm	**1385-nm**	**1550-nm**
Max. attenuation, loose tube cable	0.35 dB/km	0.32 dB/km	0.25 dB/km
Max. attenuation, tight buffer cable	0.50 dB/km	0.50 dB/km	0.50 dB/km
Mode Field diameter	9.2 ± 0.3 µm	9.6 ± 0.6 µm	10.4 ± 0.5 µm
Group Retractive Index	1.468	1.468	1.467
Dispersion, max.	3.2 ps/(nm-km) from 1285 to 1330 nm		18 ps/9nm-km)

f. Optical Characteristics, General

Point defects, max	0.10 dB
Cutoff wavelength	≤ 1260

Zero dispersion Wavelength	1302 – 1322 nm
Slope, max	0.090 ps/(km-nm-nm)
Polarization mode dispersion link design value	≤ 0.06ps/sqrt(km)

B. Corrugated Steel Tape (CST) Armoured Fibre Cable

a. Cable Identification

- Corrugated Steel Tape (CST) optic cable stranded loose tube with 12-fibre subunits, 24 or 48 cores.
- Polyethylene outer sheath.
- Plastic coated corrugated steel tape armour.
- Water blocking tape
- Polyethylene Inner sheath.
- Ripcord (2)
- Core Binder
- Water blocking tape
- Ripcord (1)
- Binder
- Gel filled buffer tubes.
- Colour coded fibres.
- Dielectric strength member.

b. Physical properties

- UV resistant Polyethylene sheath (Black)
- Glass reinforced plastic centre strength member (GRP)
- Water-blocked cable core
- Spare Space Fillers
- Optical fibres
- PBT loose tube Φ1.7mm (Thixotropic filled)

c. Physical specifications:

Fibre Count	Subunits	Outer diameter (mm)	Weight (kg/km)	Minimum Bend radius (cm)		Max. tensile load (Newtons)		Maximum vertical rise (m)
				Loaded	unloaded	Short Term	Long Term	
002 - 060	5	16.2	227	32.4	16.2	2700	800	361

d. Environmental and Mechanical

	Specification	Test Method*
Operating Temperature	-40º to + 70º C	FOTP -3
Installation temperature	-30º to + 60º C	N/A
Storage Temperature	-40º to + 75º C	N/A

Crush resistance	44 N/mm	FOTP -41
Impact resistance	To exceed requirements	FOTP -25
Flexing	25 cycles	FOTP -104
Twist bend	To exceed requirements	FOTP -85

*All testing to be as per international Fibre Optic Test Procedures (FOTP)

C. Indoor Optical Fibre LAN Cable

a. Cable Identification

Cable jacket – Black medium density polyethylene with co-extruded colour stripes

b. Physical properties

- PE outer jacket.
- Non-metallic flexible strength elements
- 6.0mm buffer tube
- Ripcord for jacket access (2).
- Gel filled loose tubes.
- Fibre binder threads
- 250micron fibres
- Colour coded fibres.

c. Physical specifications

Fibre Count	Bundles	Buffer Tube diameter (mm)	Jacket diameter (mm)	Weight (kg/km)	Minimum Bend radius (mm)		Max. tensile load (Newtons)		Maximum vertical rise (m)
					Loaded	unloaded	Short Term	Long Term	
002 - 024	2	4.0	10.1	94	20.2	10.1	2700	800	871
026 - 048	4	6.0	12.1	128	24.2	12.1	2700	800	639
050 - 096	8	8.0	14.1	164	28.2	14.1	2700	800	499

d. Environmental and Mechanical

	Specification	Test Method
Operating Temperature	-40º to + 70º C	FOTP -3
Installation temperature	-30º to + 60º C	N/A
Storage Temperature	-40º to + 75º C	N/A
Crush resistance	44 N/mm	FOTP -4

Impact resistance	To exceed requirements	FOTP -25
Flexing	25 cycles	FOTP -104
Twist bend	To exceed requirements	FOTP -85

*All testing to be as per international Fibre Optic Test Procedures (FOTP)

A15.3 SPLICE ENCLOSURES AND FIBRE TAILS

a. All products installed shall be branded indicating the manufacture's name and the product code.
b. Splice enclosures shall be 24 Way 19" Rack Mountable.
c. Mid couplers installed shall either be of the SC or SFF type. Polymer mid-coupler will not be allowed.
d. Only approved dome joints are to be used and shall consist of the following:
    - Shall be waterproof
    - O-ring seal
    - Heat shrinks for cables
    - Screw type bracket to seal lid.
    - Wall mount brackets
    - Splice organizer
    - Type 2 to 4way
    - Seal unused inlets with plugs
e. Fibre patch cables are to be factory assembled, terminated, and certified to the relevant standards.

A15.4 CABLE IDENTIFICATION

All cables shall be stamped with the following details:

- The name of the manufacturer.
- The type of cable.
- Length marking.
- Date of manufacture.

These markings shall be clearly marked on the cable sheath at intervals of not more than 1m throughout the whole length of cable.

A15.5 MAXIMUM DB LOSS

The following specify the SX and LX optical parameters, which meet IEEE 802.3z/d4.2:

- Multi-Mode - SX
- Average Launch Power (Min) = -9.5dbm
- Average Launch Power (Max) = -4dbm
- Receive Sensitivity =-17dbm
- Optical budget = 7.5dbm
- Single-Mode - LX power budget is the same for Multi-mode - LX
- Average Launch Power (Min) = -11.0dbm
- Average Launch Power (Max) = -3.0dbm
- Receive Sensitivity =-20dbm
- Optical budget = 9dbm

A15.6 INSTALLATION AND EXECUTION

A15.6.1 NETWORK PERFORMANCE

a. Switched 10/100 Ethernet are required at all end-node locations. Each connection must support both the 10BaseT and 100BaseT standards.
b. Core network connections must support Gigabit Ethernet, to provide the bandwidth required.
c. Despite the high bandwidth, it could be desirable - in certain situations - to prioritize (or block) certain traffic. The use of the available bandwidth should be controlled by prioritization

A15.6.2 RESILIENCY / REDUNDANCY

a. When reviewing core redundancy, the following areas should be considered:
   - Hardware redundancy
   - Fibre / path redundancy
   - Routing / protocol redundancy
b. Hardware redundancy can be achieved through the implementation of dual redundant Core switches linked via XRN technology and redundant power and fan unit modules.
c. Fibre redundancy can be achieved through multiple fibre runs between the distribution areas and the dual core switches. If one fibre path should be severed, or the ports connecting the primary fibre run should go faulty, the redundant path would dynamically take over and forward traffic.
d. Protocol redundancy typically refers to a standby L3 switch (router) that takes over the routing task for a particular network address should the primary L3 switch fail (VRRP – Virtual Router Redundancy Protocol). Switches in the core of a network using XRN technology will perform this protocol redundancy.

A15.6.3 INSTALLATION SPECIFICATIONS

a. Indoor backbone fibre optic cables shall have a minimum bend radius of 10 times the cable's outside diameter when under no load and 15 times the cable's outside diameter when being pulled. Outside equipment backbone optical fibre cables shall have minimum bend radius of 10 times the cable's diameter when under no load and 20 times the cable's outside diameter when being pulled.
b. Vertical optic Fibre Cables:
   - Use cable strain relieve at the top of each vertical rise and thereafter at 1m intervals. If for some reason, tight-buffer cable cannot be utilised, cables in riser shafts shall be looped at each floor.
   - Cable drums shall be supported with an axle on trestles.
c. During installation, the cable shall be laid out in a figure 8 method.
d. Twisting of cable is not allowed.
e. Do not leave any slack at intermediate manholes unless there shall be a joint introduced for future developments. Planning shall indicate this.
f. Fit slack Box/dome joint in manhole 100mm from manhole roof if possible or any other practical position.
g. Cable slack shall be a minimum 15 meters on both cables to enable splicing to take place outside of manhole inside the splicing vehicle.
h. Cable pulling must be carried out with a cable sock capable of transferring sufficient load to the cable strength member materials (zero slippage occurs) as per manufacturer recommendations.
i. The optic fibre cable shall be terminated in 19" rack mountable 24-way fibre splicing termination trays directly on mid-couplers or be spliced onto unjacketed pigtails connected to the mid-couplers.
j. The position of the splice tray in the cabinet shall be established before the installation commences.
k. The Splice tray shall house sufficient splice organizers.
l. All splices shall be protected with splice-protectors.
m. All cores in a cable shall be terminated at both ends.
n. Direct Termination or fusion splicing may be performed on the patch panel.
o. Always adhere to minimum bending radii when routing fibres in the termination drawers.
p. Unused slots shall be blanked off both in the front and back of the splice tray.

q. Fibre optic patch leads shall be duplex patch leads used for connection of the single-mode or multi-mode fibre optic cables to equipment. The length of a patch lead shall be as required.
r. The connectors to be fitted on the patch leads shall match the connectors on the equipment/ termination devices.
s. Cable slack at termination points shall be 5 meters and 15 meters at splicing manhole.

A15.6.4 FIBRE OPTIC COLOUR CODE

Fibre binder threads and fibres are identified with standard colour coding:

Tube / Strand No.	Strand / Tube Colour	Tube / Strand No.	Strand / Tube Colour	Tube / Strand No.	Strand / Tube Colour
1	Blue	5	Slate	9	Yellow
2	Orange	6	White	10	Violet
3	Green	7	Red	11	Rose
4	Brown	8	Black	12	Aqua

A15.6.5 MARKING SPECIFICATIONS

a. The marking method of the fibre optic cable shall be by means a Carrier Strip-on method. The cable shall be marked at each end of the cable as close as possible to a termination point and in each manhole/draw pit.
b. The identification shall be “4FO/123 1A:456 2B”, where:
   - 4FO – is the fibre count
   - 123 – is the building from
   - 1A – is the cabinet from
   - 456 – is the building to
   - 2B – is the cabinet to
c. Fibre warning tags shall be attached to the cable in the same positions as the cable identifier. The warning tag shall at least be printed with the following: “WARNING: Fibre Optic Laser Beam”. The tag shall be clearly visible.
d. Secure label and warning tag on fibre cable with cable ties.
e. Fibre splice trays shall be labelled in the following manner: A, B, C etc: from the top to bottom of the cabinet. The label will be on the left side of the Patch Panel.
f. The mid-couplers will be labelled as follows (The label will indicate the destination of the fibre), “123/G/A/B/1-4”, where:
   - 123 – building number
   - G – Floor
   - A – Cabinet Number
   - B – Fibre Optic Patch Panel Number
   - 1-4 – Mid-coupler numbers.
g. All labelling shall be printed permanent ink PVC labels. All printed labels shall be black on white with a font size of at least 8 mm.

A15.7 ACCEPTANCE AND TEST PLAN (ATP)

The Contractor shall submit samples of splice trays (complete with mid-couplers, splice organizers, dust cover etc.), labels and warning tags to be installed to the CLIENT for approval. This approval will be a once off event – thereafter a delivery notes from the supplier indicating that the approved item was utilized will be sufficient for the acceptance certificate.

A15.7.1 FIBRE OPTIC CABLING TESTING

a. On completion of a fibre link an acceptance testing of a fibre link with an Optical Time Domain Reflectometer (OTDR) or a light source and power meter shall be performed from both ends. The readings shall then be recorded, and the bi-directional event and average link lost shall be calculated.
b. The test results shall be stored in both hard and soft copies for the acceptance documentation.
   - Maximum connector mated pair loss shall not exceed 0.75dB.
   - Maximum connector loss shall not exceed 0.5dB.
   - Maximum splice loss shall not exceed 0.3dB.
c. The Contractor shall inspect and complete an inspection certificate, certifying that:
   - The installed products are approved by the CLIENT and that a certificate certifying such approval and the delivery note for the installed items are available on request.
   - The splice trays are installed in the correct positions in the cabinet.
   - Splice Trays are labelled correctly.
   - Fibre cables are labelled correctly. (Fibre identifier and warning tags)
   - That the above specifications are adhered to and that such adherence is verified and that an inspection report to that extent is available.
   - All relevant documentation is presented and that the documents are correct and complete.

A15.8 EARTHING AND BONDING

All exposed metallic elements of the cable system and cable containment system shall be earthed (grounded) for safety and electromagnetic compatibility requirements.

A15.9 SUBMITTALS

A15.9.1 DRAWING, OPERATING AND MAINTENANCE INSTRUCTIONS

Documentation to be presented with every submission for signoff

a. Contractor’s inspection certificate, certifying the aspects nominated for inspection in the ATP.
b. Fibre optic test results. (Hard and electronic copy)
c. Fibre optic wiring schedule.

A15.9.2 TRAINING

Installation of the switchgear shall require no special tools. Product training shall be made available at the purchaser’s facility if required.

A16. VIDEO SURVEILLANCE SYSTEM (CCTV)

A16.1 QUALITY ASSURANCE

A16.1.1 CODES AND STANDARDS

The supply, delivery and installation of CCTV Cameras and equipment shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards. The latest issue of the SANS codes will be applicable:

a. SANS 10222-5-1-1: Electrical security installations Part 5-1-1: CCTV installations – CCTV surveillance systems for use in security applications - Operational requirements
b. SANS 10222-5-1-2: Electrical security installations Part 5-1-2: CCTV installations - CCTV surveillance systems for use in security applications - System design requirements
c. SANS 10222-5-1-3: Electrical security installations Part 5-1-3: CCTV installations - CCTV surveillance systems for use in security applications - Installation, planning and implementation requirements
d. SANS 10222-5-1-4: Electrical security installations Part 5-1-4: CCTV installations - CCTV surveillance systems for use in security applications - Testing, commissioning and hand-over requirements
e. SANS 10222-5-1-5: Electrical security installations Part 5-1-5: CCTV installations - CCTV surveillance systems for use in security applications - Maintenance requirements
f. SANS 10222-5-2: Electrical security installations Part 5-2: CCTV installations - Application guidelines

A16.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

a. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
b. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A16.1.3 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A16.2 CAMERAS

a. Minimum acceptable characteristics for colour, pan-tilt -zoom (PTZ)
    - Internal site monitoring cameras are to be of “dome” type construction, where the camera, control signal receiver, and pan-tilt-zoom mechanism are constructed as a single integral unit.
    - Fence site monitoring cameras are to be housed in a weather and vandal proof enclosure and are to be the fixed type with remote zoom and focus functions.
    - Surveillance monitoring to be monitored at the central control room.
    - Communication from each CCTV to the control room will be via a fibre optic backbone (fibre backbone to be supplied and installed by others)
    - Surveillance monitoring and playback to be integrated within a SCADA / BMS system.
b. Tenderers must be aware of the high salt, dust and wood dust contamination in the area.

A16.3 ENVIRONMENTAL ENCLOSURE

a. The outdoor camera housing shall have provision for either wall or pole mounting. The enclosure shall enhance the ability of the camera to withstand exposure to temperature, moisture, dust, and other contaminants. For dome cameras, the upper dome shall be constructed of UV stable white plastic, steel, or acrylic. The lower dome shall be made of distortion free acrylic.
b. The enclosure shall contain an electric 50-watt (min) heater with a thermostat for temperature control. The enclosure shall contain a blower that is on continuously to aid in the heating and cooling of the camera.
c. Camera enclosures shall be made from stainless steel S316 or better with minimum IP65 rated enclosure. Cameras enclosures, especially the image viewing portion should be self-cleaning. Automation cleaning systems like wiper blades will not be acceptable.

A16.4 HIGH-DEFINITION NETWORK SURVEILLANCE CAMERAS

A16.4.1 GENERAL

The IP-based surveillance cameras supplied by the contractor are required to function in conjunction with the Network Video Management Software (NVMS) to provide a complete solution that delivers full situation awareness and indisputable detail, leading to faster response times, reduced investigation times, compliance validation and superior overall protection. To achieve this level of detail all camera types supplied and installed should not provide less than 170 pixels/meter of digital clarity. All cameras must be able to adequately cope with variable lighting conditions and in scenes where simultaneous low and high light exist concurrently. This will ensure facial identification in all scenes where cameras are to be installed.

A. General Specifications for ALL DOME and BOX-TYPE High-Definition IP-Cameras
   a. The High-Definition IP Camera shall support 100BASE-TX and PoE 802.3af network interfaces for streaming video and control data over standards compliant networks.
   b. The High-Definition IP Camera shall operate in the Control Centre environment with support for automatic detection of cameras, encoders, and NVRs in the same broadcast domain.
   c. The High-Definition IP Camera shall support user selectable image dimensions, or windowing, to enable lower bandwidth and/or higher refresh rates for the image or portion of the image being monitored.
   d. The High-Definition IP Camera shall support user configuration of network parameters including: Static IP address; Subnet Mask; Gateway; and Control Port for control communications.
   e. The High-Definition IP Camera shall support user configuration of camera parameters including: Camera Name; Location; and Security Level.
   f. The High-Definition IP Camera shall support user configuration of image acquisition parameters including: Automatic Exposure Control; Manual Exposure Control; Flicker Control; Auto-iris Control; Backlight Compensation; Day/Night Control.
   g. The High-Definition IP Camera shall incorporate a removable IR filter mechanism for improved performance in low light, night-time conditions or in applications requiring near IR illumination.
   h. The High-Definition IP Camera shall support a mode that automatically removes the IR filter and enters a monochrome mode when the available light drops below a set threshold.
   i. The High-Definition IP Camera shall support user configuration of an unlimited number of independent motion detection zones within the camera field of view.
   j. The High-Definition IP Camera shall support user configuration of up to 4 privacy zones within the camera field of view.
   k. The High-Definition IP Camera shall support user configuration of compression quality and image rate per individual camera.
   l. The High-Definition IP Camera shall have I/O terminals for connecting alarm inputs and alarm outputs.
   m. The High-Definition IP Camera shall support UDP transport.
   n. The High-Definition IP Camera shall be remotely upgradeable over an IP network for feature enhancements and investment protection.
   o. The High-Definition IP Camera shall be functional in both indoor and outdoor environments.

B. NETWORK SPECIFICATIONS

a. Network:100BASE-TX
b. Cabling: CAT-6
c. Connector: RJ-45
d. Security: SSL
e. Protocols: UDP, TCP, SOAP, DHCP, Zeroconf

C. CERTIFICATIONS AND REGULATIONS
a. FCC, Class A
b. CE, Class A
c. UL/CUL Listed

A16.5 MULTI-MEGAPIXEL NETWORK VIDEO RECORDERS (NVR)

A16.5.1 GENERAL

Each Multi-Megapixel Network Video Recorder (NVR) Workstation is to be designed to achieve the highest performance for high-definition video recording and playback. The NVR must be scalable to operate seamlessly in an environment with multiple NVRs, as a single solution. Each NVR must be preloaded with Multi-Megapixel Network Video Management Software and configured for maximum performance and reliability. **The NVR is to record up to 320 MB/s of image data from up to 64 camera channels running at 30 images per second.** It is to be of enterprise-class reliability, and the option for redundant power supplies. Both the hard drives and the power supplies are to be hot-swappable for online repairs. The NVR must have an effective 10TB of onboard recording capacity.

A16.6 MULTI-MEGAPIXEL NETWORK VIDEO MANAGEMENT SOFTWARE (NVMS)

A16.6.1 GENERAL

a. The video management software provided is to run seamlessly on the NVRs provided. It is to function in conjunction with the cameras installed to provide a complete solution that delivers full situation awareness and indisputable detail, leading to faster response times, reduced investigation times, compliance validation and superior overall protection.
b. The Network Video Management Software (NVMS) is to be a secure distributed-network platform with enterprise class reliability for capturing, managing, and storing high-definition multi-megapixel surveillance video while efficiently managing bandwidth and storage.
c. The NVMS is to have the capability to manage both audio and video from a broad range of multi-megapixel IP cameras. In addition, the system must have the capability to accommodate conventional and PTZ analogy cameras and both audio and video from a broad range of 3rd party IP cameras, and encoders from leading manufacturers.
d. Removal and replacement of this system will NOT be accepted. The NVMS is to be powerful, yet intuitive, with an easy-to-use interface that allows operators to efficiently evaluate and respond to events with minimal training.
e. As it is a requirement to integrate the NVMS into both Access Control and Intercom Control systems the NVMS is to be an open-source platform with access to the Control Centre SDK source code and technical support from the software developer.
f. The NVMS is to have all video and integration licenses provided as a once-off fee with unlimited client connections to all NVRs at no charge. Recurring annual license fees are not acceptable.

A16.7 HIGH-DEFINITION MONITORS

A16.7.1 GENERAL

The contractor shall provide high-definition video surveillance monitors together will all cabling, mounting brackets and accessories to ensure a full and complete installation, with the following specifications:

A16.8 POWER-OVER-ETHERNET NETWORK SWITCHES

A16.8.1 GENERAL

To provide adequate support for bandwidth intensive applications, such as multi-megapixel IP cameras as intended to be used here, the contractor shall provide managed gigabit speed, power-over-ethernet (POE) network switches with fibre uplink ports, together will all patch-cables, cabinets, mounting brackets and accessories to ensure a full and complete installation, with the following specifications:

A16.9 OVERALL CAMERA SYSTEM SPECIFICATION

A16.9.1 POWER SOURCE

The cameras operate and connect via Power over Ethernet (PoE). It is also required that a 230v, 50 Hz Power supply will act as the redundant power source and will only operate when no primary power supply is available. Power supply will be made available at each camera point as required.

a. Primary Power: PoE
b. Back-up power: External AC Power supply

A16.9.2 IP BASED

All cameras to be IP based.

A16.9.3 ETHERNET BASED

All communication to and from the cameras must be via Ethernet protocol.

A16.9.4 ENCODERS

Supply and install the necessary encoders that will provide high quality without any delay of image transfer.

A16.9.5 RECORDERS

Supply and install the necessary recorders that will provide high quality recordings and playback when required. Minimum recording period should be for thirty (30) days. Thereafter, recordings must be compressed in an acceptable format and archived.

A16.10 ACCESSORIES

All necessary accessories must be provided as part of the system solution. A PTZ and camera selection joystick keyboard to be provided for complete control of all the functionality for viewing live footage, managing playback of recorded video and operation of PTZ controls.

A16.11 INSTALLATION

Installation of cameras should be as per drawings. However, based on the solution offered, cameras could be repositioned, or the number minimised to suite the solution offered.

A16.12 SUBMITTALS

A16.12.1 DRAWING, OPERATING AND MAINTENANCE INSTRUCTIONS

a. Two copies of a fully detailed and dimensioned drawing of the recommended mounting locations and positions for each CCTV camera location.
b. Two copies of a dimensioned outline drawing of the system architecture and topology.
c. One paper copy and one electronic copy of the schematic wiring diagram of a typical CCTV arrangement and connection.

A16.12.2 INSTALLATION ARRANGEMENT:

a. HD Dome PTZ Camera on pole at 8m mounting height.
b. HD Long range remote fixed zoom and focus cameras on pole at 6m mounting height.
c. HD Dome PTZ Camera under entrance canopy.
d. HD cameras fixed remote zoom and focus under entrance canopy.

A16.12.3 PRE-DELIVERY INFORMATION

Within four weeks of receipt of the purchase order, the tenderer shall submit for the engineer's review, comment, and approve the following:

a. Finalised schematic diagram and dimension drawings
b. Operating characteristics of the cameras and equipment.
c. Shipping/ transport details.

A17. PABX SYSTEM

A17.1 QUALITY ASSURANCE

A17.1.1 CODES AND STANDARDS

The supply, delivery and installation of PABX system and equipment shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards. The latest issue of the SANS codes will be applicable:

a. The Occupational Health and Safety Act, Act No 85 of 1993.
b. The Minerals Act, Act No 50 of 1991, which includes the Mines and Works Regulations.
c. The local Municipal bye-laws and regulations as well as the regulations of the local Supply Authority.
d. The local Fire Regulations.
e. The National Building Regulations and Building Standards Act including the Code of Practice for the Application of the Regulations, SANS 10400.

A17.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

a. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
b. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A17.1.3 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A17.2 CONSTRUCTION OF CONTROL CONSOLES

A. General layout
a. The construction of the operating face shall be such that equipment to be controlled such as individual controllers, toggle switches, push buttons and other equipment protrude from the face of the console and are clearly visible to an operator. They shall be within easy reach of an operator sitting on a normal swivel desk type chair.
b. The equipment to be controlled must be grouped and installed as compactly as is practical. The grouping of equipment must in general be according to the following main groups:
c. Equipment for controlling emergency situations.
d. Main control equipment used during a particular operational function.
e. Subsidiary control equipment for individual control of components normally used in conjunction with the main control equipment.
f. The operating face of desk type consoles shall be inclined between 5˚ and 7˚ to the horizontal.
g. The inclined control panel of the console must be provided as a hinged panel which is installed flush in the console framework. The hinges of the panel must be provided at the far side of the console operating side whereas panels housing measuring instruments shall be hinged at the side. The panels shall be hinged to allow easy access to the wiring and connections to potentiometers, switches, push buttons, instruments, etc.

h. The hinged panels shall be secured at the non-hinged side by means of flush type “Philips” screws or “Dzus” type latch screws.

i. Desk type consoles shall be manufactured as a unit or alternatively the top section of the console must be manufactured as a separate unit from the plinth or base section of the console. The base or plinth section must be manufactured so that the console will be provided with sufficient knee space for an operator sitting on a chair in front of the console.
j. The height of the console panel nearest to the operator shall be approximately 750mm. The base or plinth section of the console and the side and rear section of the base shall be wide enough to allow for the entry of cables on the side and bottom of the console base.
k. The vertical section of the plinth or base must be provided with removable cover plates similar to the panels of control boards to allow access to the console plinth and terminals installed in the console plinth. The latter cover plate panels must be installed flush in the sides and rear of the console plinth or base and must be fixed to the base section as specified for panels.

B. External connections

External connections to the console must be done via the plinth or base frame of the console and must be connected to the terminals to be supplied and installed as part of the console.

C. Finish

a. Unless otherwise specified, the finish of consoles must comply with the requirements specified in the project specification.
b. Should hinged steel panels be provided for inclined desk type consoles, the panels must be finished in a light grey colour. The surrounding framework of the console must be finished in a darker grey colour unless a different type of finish is specified in the project specification.
c. Should stainless steel type panels be specified, these panels must be brushed to a 150-grain finish parallel to the sides of the console. Samples of such a finish must be submitted to the Engineer for approval.
d. Should aluminium panel finished be provided these aluminium panels must be of the anodized type similar to the aluminium panel finishes provided for standard 19” (483mm) racks.

A17.2.1 GENERAL CONSTRUCTION OF CONSOLES

A. Conductors and Wiring

a. Conductors of the internal wiring shall be large enough to carry the current in each respective circuit. Conductors shall be derated to comply with the regulations when bunched in trunking or bound together as installed.
b. Wiring shall be done by means of PVC insulated conductors neatly arrange in horizontal and vertical rows and bound by means of suitable plastic band or installed in PVC type wiring ducts provided complete with snap-in type PVC cover plates.
c. The colour of the insulated conductors of the internal wiring of the boards shall be done according to a colour code used throughout the installation and the following colours must be utilized in agreement with regulations:
    - Alternating voltage phase conductors – red, white, and blue.
    - Neutral conductor – black.
    - Earth continuity conductor – green or green/yellow.
    - Control wiring – grey.
    - DC voltage conductors – orange.
d. All wiring shall be kept free and away from any exposed terminals, or other insulated current carrying components.
e. The boards shall be completely wired before installation. All external connections to the boards and consoles shall terminate in terminal strips.

B. Terminals

a. All external connections for control, alarm interlocking and measuring circuits must be connected to terminal strips.
b. The terminals shall be of the “Klippon” type SAK series or similar, the type number depending upon the current rating as required or as recommended by the supplier for the particular conductor size connected to those particular terminals.

C. Grouping of equipment and circuits
   a. Control circuits and individual control components for one particular control function or for a particular section of the installation, shall be grouped separately from, but may be installed in the same control board or console as other similar control equipment.
   b. The extent of each individual group shall be clearly marked and fitted with a separate label in the English language, e.g.

POWER SUPPLY	**24V DC**

D. Racks
   a. Racks, also called cabinets, for housing electronic equipment shall be standard 483mm (19") racks fitted with guides to slide into the board or console framework on sliding rails.
   b. The racks shall be manufactured of an extruded aluminium framework.
   c. Each rack shall have a nominal width of 483mm, but the depth and height may vary according to standard multiples for housing the specified electronic equipment in each particular case.
   d. Racks shall be installed in individual cubicles or sections of the control board or control consoles. Such cubicles shall be provided with extruded aluminium sub-frames fitted with the required support brackets and sliding rails to house the racks in a vertically tiered fashion.
   e. A locking screw shall be provided for each rack to lock the rack in its normal operating position.
   f. Two individual U-type slider rails shall be provided for locating and housing each printed circuit board (PC board) in the rack.
   g. These slider rails shall be manufactured of extruded aluminium or suitable glass fibre bonded synthetic material or equivalent and pairs shall be installed in a vertical configuration so that frames of PC boards slide into the rails in a vertical fashion.
   h. Each PC board shall be provided with two guide pins or guide buffers engaging in two corresponding sockets or notches in the rack to ensure that male and female sockets mate correctly.

E. Subdivision in sections
   a. The Contractor shall verify the position of all consoles on site.
   b. Each section of the console shall be of suitable size to pass through doorways, passages, etc. each section shall be rigidly manufactured to ensure that damage to the equipment will not occur during transportation and handling.
   c. Where required, consoles shall be provided with temporary timber or steel bracing to protect the equipment and facilitate handling.
   d. When positioned the sections shall be bolted together. Rubber packing shall be installed between joints to provide a finished appearance.

F. Identification labels
   a. Identification labels shall be installed for identifying the main function of the equipment or group of components or equipment within the area assigned to that equipment.
   b. Control components such as switches, relays, etc, shall each have an identification label corresponding to the identification letter and/or number shown on the schematic diagram.
   c. All labels shall consist of engraved plastic strips of the "Traffolik" type black letters or numerals on a white background and shall be fixed to or on the panel framework or below components with a non-ageing adhesive such as an epoxy type adhesive.
   d. For individual components or equipment, the size of the letters or numbers must be 6mm.

G. Finish
   a. All metal parts shall be degreased, rinsed, pickled, rinsed, phosphated, neutralized and then thoroughly dried.

b. Within 48 hours the metal parts shall be painted with one layer of a zinc chromate or other suitable primer utilized for an epoxy-based paint followed by two coats of good quality epoxy-based paint.
c. The consoles shall be finished with a cured epoxy-based poly-urethane paint, ensuring that the surface finish of the console is exceptionally smooth and has good wear and tear properties.
d. In general, the paint finish of control boards and control consoles shall comply with the general requirements as specified for steelwork.
e. After the boards and consoles have been installed on site, any damage done to the paint work shall be neatly repaired by means of the specified epoxy-based paint to the satisfaction of the Engineer.
f. The general external colour of the consoles shall be navy light grey code G35 unless otherwise specified. The inside surfaces shall be cloud white code G80. Samples of all colours must be provided to the Engineer for approval. The finish of the paint must comply with the general requirements as specified for paint work.
g. Cable support brackets shall be repainted after holes have been made in these panels to ensure that the openings made in the plate for support brackets will not be the cause of future corrosion of these panels and consoles.

H. Drawings
a. Drawings of the consoles shall be submitted to the Engineer for his approval prior to the manufacture of these consoles. The Engineer shall be informed so that he may inspect them in the factory and that he may be present when the control systems are tested before dispatch.
b. Upon completion of the installation, final “as-built” schematic diagrams of all control boards and consoles, including detail of all control and power interconnections between boards and consoles shall be submitted to the Engineer in agreement with the requirements of the project specification. Should no requirements be specified, three copies of such drawings shall be submitted to the Engineer.

A17.3 EARTHING OF ELECTRONIC EQUIPMENT

A17.3.1 GENERAL

a. Interconnections and proper earthing between electronic components must be done on a radial wiring system.
b. To minimize interference with the operation of electronic components, the earthing system of the components must comply with the following:
   - The individual earth connections must be interconnected by means of suitable green PVC insulated conductors.
   - The total earthing network must be connected at one point at the substation directly to the low earth resistance main earth pin at the substation by means of green PVC insulated conductors.
   - All connections to individual electronic components must be connected from the main insulated earth bar on the control board and must be radially connected to each individual component to prevent earth loop currents between individual control equipment and components.
   - Should the Contractor consider it essential that the interconnecting earth connections between individual components be done according to the floating earth principle, such interconnections shall be done according to the radial method of gas discharge diodes connected directly to the domestic earth so that peak voltage transients in the electronic earthing system can be discharged via the gas diodes. This must be done to protect electronic components and circuits against such peak voltages and transients which could be induced in such electronic circuits.
c. To avoid formation of earth loop currents in electronic circuits, printed circuit layout must be designed so that a common earthing track or point is established.
d. Where digital integrated circuits are used, decoupling of the supply line (VCC) to earth must be done with suitable decoupling capacitors at regular intervals to avoid fluctuation of potentials during switching.

e. Common earthing bars or points should be utilized where banks of electronic equipment are connected to function on common banks. These points could either be at “absolute” earth potential i.e., returning to the earth of the input power circuits, or may be at “floating” earth potential i.e., an earth potential isolated (by making use of an insulating transformer) from the supply earth potential.
f. The resistance between the earth electrode and earth strata for earth connections utilized for electronic equipment shall be less than 5 ohms.

A17.3.2 CONNECTIONS TO ELECTRONIC EQUIPMENT

a. Earthing methods applied in electronic equipment shall be basically the same as that used in electrical circuits. The size of earthing bars and lugs, etc, could be of a lower rating.
b. Any conducting material that has been anodized, e.g., aluminium may not be used as an earth busbar unless special precautions have been taken to ensure that the anodising material has been removed where the earthing connections are made.
c. Connections to electronic equipment must be made using cadmium plated lugs, bolts and nuts fixed to thoroughly cleaned and prepared surfaces on the electronic sub-racks or trays.
d. From the sub-rack earthing point to all the individual earthing points of the electronic equipment, separate copper conductors must be installed for each electronic rack.
e. The conductor size shall be determined according to SANS 10142 - 1 and must be sufficient for that particular rack and must be soldered to the terminal(s) of edge connector(s) on that rack.
f. All connections between racks or sub-racks used to transmit digital data must be made using coaxial type cable having the correct matching impedance.
g. Terminations of coaxial cables shall be in proper connectors (plugs and sockets) of the BNC, RG8U or equivalent approved type, depending on the particular application.

A17.4 SUPPLY VOLTAGE AND POWER REQUIREMENTS

a. An electrical supply of suitable capacity will be provided for the PABX Installation in the PABX/Data room. The electrical supply will be fed from the normal power supply in the building and will be a 2-wire single-phase supply with earth at 231 Volt plus 5% and minus 10 per cent and at a frequency of 50Hz.
b. The Contractor shall provide a suitable Uninterruptible Power System (UPS) for un- interrupted service of the PABX Telephone System and all ancillary equipment for at least 60 minutes.
c. General Availability of Service
    - Only PABX manufacturers tendering their own equipment through ICASA registered agents will be considered for this PABX installation.
    - Only authorized agents or dealers with valid ICASA LMOI licenses for the equipment offered will be considered. The manufacturers ICASA license for the equipment must be provided together with SABS ISO 9000 certificates.
    - Manufacturers must have a service center, where sufficient spares and qualified personnel are based, in Kwazulu-Natal. This service center must be in operation for at least five years.
    - All personnel based at the Service Centre must be in the full and permanent employment of the manufacturer or his agent.

A17.5 GENERAL TECHNICAL INFORMATION

A17.5.1 STANDARDS

The equipment shall comply with this specification and the following CCITT recommendations:

a. Q.23: Technical features of push-button telephone sets.
b. Q.711: Pulse Code Modulation for voice frequencies.
c. Q.712: Performance characteristics for pulse code modulation channels at audio frequencies.
d. Q.732: Characteristics of primary pulse code modulation multiplex equipment operating at 2 048 kbits/s.

A17.5.2 PROVEN DESIGN REQUIREMENTS

The tenderer shall submit at tender stage a list of installed system sizes with commissioning dates. The list shall clearly indicate whether the tendered equipment is of identical or modified design to that previously installed.

The system will be digital, stored program controlled, pulse code modulation (A-law encoding).

A17.5.3 GENERAL TECHNICAL REQUIREMENTS

a. The following general technical requirements shall be applicable to the equipment offered as a minimum standard:
b. All equipment shall be Telkom approved at closing date of tenders.
c. All workmanship e.g., cabling etc. will be done in accordance with Telkom specifications and standards.
d. All peripheral cards will be compatible to fit any slot on the equipment shelf.
e. All outdoor extensions shall be lightning protected on the MDF or as specified else- where in this specification.
f. The system will be able to accommodate the following options:
    - Pulse dialing.
    - DTMF (tone dialing) direct into the digital Telkom exchange.
    - Digital DDI via PCM 30 link directly connected to the Telkom main exchange.
    - Digital DDO via PCM 30 link directly to the Telkom main exchange.
    - The systems are able to support a wide and varying range of technologies and communication protocols.
    - The system must be designed to utilize Time Division Multiplexing (TDM) to allow the apparent simultaneous transport of two or more signals via a single communication channel and thus both extending system capacity and reducing waiting time.
    - The system must be designed to utilize SIP (Session Initiation Protocol) and provide the means to manage audio or video conferencing and Voice over Internet Protocol (VoIP).
    - Software must enable an administrator to add applications, allocate rights and configure various built-in functions with ease.

A17.5.4 GENERAL DESCRIPTION OF SCOPE OF WORK

This specification makes provision for the following:

a. The PABX unit complete with extension and exchange line units suitable for EURO ISDN as specified.
b. The Main Distribution Frame as a Data Distribution Panel suitable for patching UTP type cable with RJ 45 connectors.
c. The Telephone Call Management System complete with hardware and suitable programmable software as specified.
d. Two (2) operators consoles, Windows NT based.
e. The VDU terminal and printer for maintenance and facility changes on the PABX unit.
f. The Telephone instruments.
g. The UPS system with suitable capacity to guarantee uninterrupted service of the complete PABX Telephone system and ancillary equipment for at least 60 minutes.
h. The Telephone network cabling necessary to integrate the PABX system effectively with the structured wiring system by others.

A17.6 EQUIPMENT, ACCOMMODATION AND EARTHING

A17.6.1 GENERAL INFORMATION

The tenderers shall take note of the allocated accommodation for the PABX system. The following requirements shall be incorporated in the design, manufacture and earthing of the tender equipment offered:

a. The equipment shall be enclosed in steel cabinets and sized to permit transportation into the computer room without the removal of partitioning, doors, etc.
b. It shall be possible to mount the equipment cabinets, if more than one cabinet is required, back-to-back or against a wall.
c. Special raised flooring will be supplied and installed by others in the Data Room for the installation of the equipment offered by the PABX Contractor. The cost of this flooring shall not be included in this tender. Tenderers must however allow for liaising and coordinating with other contractors to enable a suitable and functional PABX installation in accordance with the specified requirement.
d. Tenderers shall state the mass of apparatus, fully equipped in kilograms.
e. Tenderers shall state the dimensions of cabinets in millimeters (width x height x depth)
f. Tenderers shall indicate whether the main distribution frame is an integral part of the system or whether it is a separate unit, stating the dimensions.
g. Tenderers shall state whether PABX cabinets are floor mounted and whether rear access is required.
h. It should be noted where the operator's consoles are to be installed as indicated on the drawings and that sufficient interconnecting cable length is allowed.

A17.6.2 CABLE NETWORK REQUIREMENTS

A. Conduit, Sleeves, Manholes, etc.

Tenderers must refer to the schedule of drawings of the specification for a layout of the conduit, sleeves, manholes and ancillary services that form part of the contract for the purpose of accommodating the telephone system for the project.

B. Structured Wiring System

Tenderers must take note that the internal telephone system for the site and buildings forms part of a structured wiring system. The telephone cable wiring and all other communications systems, and specifically the data cabling system, will be installed as a structured wiring system which shall enhance the flexibility and interchange ability of the wiring and interconnecting system.

C. Cabling under this Scope of Work

Tenderers shall take note that the cabling for the internal telephone system will be specified in a separate specification. The minor portion of cabling and wiring that is however required to connect the PABX unit to the 'MDF' or Data Distribution Panel, shall form part of this contract and is included as a single item in the Bill of Quantities.

A17.7 TECHNICAL REQUIREMENTS OF THE SYSTEM (CPU AND ENVIRONMENT)

A17.7.1 SYSTEM CONFIGURATION

a. The system shall be fully electronic, using the latest technology available. The Exchange shall use Stored-Program Control in CMOS logic and affect switching by digital techniques. Preference is given to systems carrying a SABS certificate for Manufacturing and Maintenance.
b. The system shall in general be configured to fulfill the requirements of this Specification and all the features and facilities described shall be enabled when and where specified without resource to additional hardware and/or software, unless otherwise specified. All facilities shall be pre-programmed and stored in the Exchange on a permanent basis. Should modifications or additions (i.e., additional line cards) be deemed necessary at some future date, it shall be possible to update the database to accommodate these changes without incurring additional expenses. The programming must also be done on site.
c. If called for in the system description or Schedule of Requirements the system must be equipped with PCM 30 EUROISDN signaling as per Telkom requirements for both incoming, and outgoing traffic. No other signaling system shall be considered. The system must also be able to accommodate ISDN universal S0 basic access and S2 primary access interfaces that comply with the current CCITT specifications. The system shall employ QSig for networking to other PABX systems.

d. The design must be modular, permitting expansion of the exchange by simply adding printed circuit boards as the need arises. In this respect, the exchange shall be designed to permit printed circuit board addition, be it extension, (analogue or digital) exchange or tie-line, based on the universal slot principle, i.e., cards need to be located in dedicated frame positions. All equipment cards, racks and shelves shall be fully accessible from the front of the cabinets. Systems requiring side or rear access for maintenance and upgrading purposes are not preferred.
e. The software language preferred is the CCITT high level language CHILL. Tenderers must state the language used. The system shall support both Dual Tone Multi Frequency (DTMF) and dial pulse telephone instruments in any mix without the need to add any hardware like DTMF receivers, etc. No programming must be required when switching telephone instruments.

A17.7.2 SERVICE TERMINAL

a. A VDU terminal and printer shall be supplied with the PABX for maintenance and facility changes on the PABX.
b. It must be possible to effect changes to the data base at any time in order to introduce or refine say a service class, change an extension number, add another abbreviated dialing code telephone number, etc. These changes must be easily accomplished via either the service terminal or via a remote terminal.
c. Although it should be possible to gain access to the data base at any time for amendment or examination purposes, the System must not allow unauthorized personnel such access and must be so designed as to prevent said parties from introducing changes or modifications thereto. The system must also be able to allow authorized users to access only certain parts of the database (i.e., different levels of entry).
d. Access to the service terminal must be controlled as follows:
e. By means of a series of passwords.
f. Passwords must be assigned on a function related basis.
g. All access to the service terminal must be recorded in a logbook file.
h. Remote access to the system by means of a modem must be provided. Access must be on a “return call to service center" basis.
i. It shall be possible to make a back-up of the data base on a disk or tape for reference purposes which, in the event of loss or corruption of the data base, may be used to reload the system. Tenderers must state what options are available for re- loading the system from the back-up device and typically what times to reload are envisaged.
j. The successful tenderer shall retain a back-up disk or tape for reference purposes which in the event of loss or corruption of the data base, may be used to reload the system. The tape or disk shall be brought up to date every two months as part of the maintenance contract procedure.
k. The exchange data base must be protected against mains power failure where RAM is used. Details of the power arrangements and the back-up time must be submitted with the tender. Tenderers shall also submit details of precautions that has been taken and in the event of a power failure what happens to transient data, e.g., features activated by extensions, individual speed call numbers, etc. Tenderers shall also indicate what medium is used for data storage as protection against power failure and in the event of a prolonged power failure, what mains failure circuits are provided on the incoming and outgoing lines.

A17.7.3 SIGNALLING CONSIDERATIONS

The system shall comply to the following signaling conditions:

a. The system shall accept dial pulses of 5 - 12 pulses per second with a 30 - 70 % break/maximum and a minimum interdigital time of 215 ms.
b. The tones of the PABX shall be in accordance with the Telkom specifications for PABX’s.

A17.7.4 NUMBER SCHEME

The system offered shall make provision for a full flexible numbering scheme. Any number level may be used for any facility within the PABX. A six-digit extension numbering scheme is required, starting

at level I to 7, access to operator level 9, access to public exchange level 0. No other numbering scheme is permitted, unless otherwise stated.

A17.7.5 SYSTEM PERFORMANCE

A. Frequency response

The frequency response shall be in accordance with the Telkom specification for PABX's.

B. Crosstalk

The crosstalk attenuation from extension-to-trunk and extension-to-extension shall exceed 65 dB in the range of 300 - 3400 Hz.

C. Call Logging

The PABX shall be capable of providing the necessary data so that incoming and outgoing calls could be monitored by a Telephone Management System.

D. (4) Quantitative reliability

The equipment shall operate efficiently in the normal office environment. The mean time between failures (MTBF) shall not be less than 1,000 hours. The MTBF time shall be demonstrated.

E. (5) Electromagnetic radiation

The electromagnetic radiation of the system shall meet the requirements of a good commercial specification, number of specifications to be submitted when complying with the specification.

F. (6) Earthing safety

The PABX shall be provided with a single earth point on the cabinet for safety reasons. The dedicated earth point for the PABX system will be supplied and installed by the electrical Contractor. The dedicated earth will comprise of a 70 mm square PVC insulated stranded copper conductor connected to a dedicated earth point with suitable connectivity to enable an earth resistance of less than 5 ohm. Should this earthing system not be suitable tenderers shall allow upgrading the earthing system to their specific requirements and allowing for such additional cost in their tender price

G. (7) System self-test

The system must automatically, on an ongoing basis, scan and test all ports. Faulty ports must automatically be taken out of service, periodically tested and automatically or remotely placed back into service when the fault is cleared.

H. (8) Integrated Voice and Data
   a. The system shall support the 2B + D connection formats for voice and data or two data connections over a single telephone line (two wires).
   b. Two 64 kbit 'B'' channels and one 16 kbit 'D' channel over a single pair of wires, giving a simultaneous voice and data call, using the CCITT transmission correction of Echo Cancelling.

A17.7.6 LIGHTNING PROTECTION

The building structure housing the Data room where the PABX Exchange will be installed will be earthed and bonded for protection against lightning. The lightning protection will make use of the steel roof structure as the air terminal, the steel columns as down conductors and earth electrodes as earth terminals, all to Standards specified in SANS 10313 as amended. Should the Contractor for the PABX installation requires additional protection against lightning to enable a safe and functional system any additional material and installation cost to acquire such protection shall be included in the tender price.

A17.7.7 MDF AND SURGE PROTECTION

a. The manufacturer and supplier of the PABX system shall supply the Main Distribution Frame (MDF). The type of terminating block used on the MDF shall make provision for the fitting of

gas filled surge arresters. The tenderers shall provide full details of the MDF frame, terminating blocks and recommended gas filled surge arresters that can be accommodated on the terminating blocks.

b. The exchange equipment shall be protected internally to withstand surges not absorbed by the gas filled surge arresters.
c. The contractor shall provide and install all cabling between the equipment cabinets and the MDF.
d. Surge protection is normally provided by means of gas filled surge arresters with a dc stoking voltage of 350 volts ±15 per cent and an impulse stoking voltage of maximum 700 volts at a rising speed of I kV per microsecond. The nominal impulse discharge current rating is either 16kA or 20kA for an 8/20 microsecond wave, and the nominal AC discharge current rating is either 16A or 20A for a 50Hz surge of one second duration.
e. Equipment that is sensitive to interference and surges in electrical power, variations in voltages and frequencies that normally occur in the electricity reticulation network and municipal supplies and which cannot be prevented, shall be finished supplied with the necessary stabilizers, over and under voltage detection equipment, suppressors etc.
f. The design, manufacture and installation of equipment shall be such that it will not create an interference of any kind to other equipment (it must be supplied amongst others with suitable suppressors) to prevent that it will negatively affect the operations of other equipment.
g. The design and manufacture of components intended for mounting on boards with printed wiring and printed circuits shall be in accordance with Publication 321 of the International Electrotechnical Commission, as amended, which is affiliated with ISO.

A17.7.8 EXCHANGE OFFERED

The exchange offered shall:

a. In all respects conform to the Standard Specification for Private Automatic Branch Exchanges of Telkom.
b. Utilize the Pulse Code Modulation technique for speech processing and trans- mission.
c. Shall have a thirty-two-channel capacity with 'A' law encoding as per CCITT Recommendation G.711/712.
d. Shall be suitable for use either with dial, digital or DTMF telephone sets. The DTMF and digital capabilities shall be in accordance with SAPT requirements.

A17.7.9 OPERATING LOOP LIMITS

The system shall provide the following loop features:

a. The extension line maximum loop resistance, including the resistance of the telephone, shall not be less than 1000 ohm.
b. The trunk and tie line shall be capable of detecting a signaling current from the distant end, with the supply at a minimum of 45 volt.
c. A system with distributed control is preferred.
d. Tenderers shall also indicate at tender stage:
   - Whether the system can be equipped with duplicated controls and processor unit.
   - What type of main processor/s will be supplied?
   - Which components are duplicated, e.g., main memories, clock generator, switching network, multibus, signal unit, conference equipment, and voice mail?
   - What the size of the main system memory is.
   - What the dynamic traffic value is as specified in Busy Hour Call Attempts (BHCA) on the basis of CCITT Q514.
   - Whether the main processor can be upgraded to allow for a greater number of BHCA.
e. The databases of the system and the computer (i.e., extension records) will be synchronized; changes on one database will automatically be reflected on the other.
f. The switching network must be non-blocking to both voice and data and the overall connection availability (connection factors etc.) must be stated for each major section of the system.

g. Tenderers shall submit the necessary traffic handling calculations to show how the required traffic will be catered for and where and how much spare capacity exists in the configuration offered.
h. The tenderer shall also state the reliability of the equipment in terms of Mean Time to Repair (MTTR) and (MTBF) Mean Time Between Failure.

A17.7.10 VENTILATION AND PROTECTION

a. No additional or peripheral ventilation equipment, over and above the air- conditioning already provided in the Data/Server Room should be necessary for the effective operation of the PABX system.
b. However, should the equipment being offered by the tenderer, require any special environmental conditions or apparatus to ensure its reliable operation, such as:
   - Additional air-conditioning, including the structural changes.
   - Forced ventilation.
   - Or, anti-static floor mats, etc.

   These costs for the supplying, installation, and maintenance of such equipment, must be provided for in the tenderer's pricing.

A17.7.11 SYSTEM TECHNOLOGY

The modular concept that is required for the PABX system shall also include the distribution of power within the system, a separate supply being available for each subassembly.

The internal numbering scheme of the exchange must be completely flexible, allowing changes to and removal of extensions K so desired without rewiring i.e., by programming only.

A17.7.12 DATA

a. The system and equipment offered shall comply with the concept of ISDN (Integrated Services Digital Network) and CCITT recommendations in this regard.
b. The system must allow for voice and text messages (mail) to be left for senior personnel, to access on return to the office or remotely via external line using either a computer (for data) or digital pulse codes (for voice) and incorporating security measures to prevent unauthorized access.
c. Tenderers must submit technical details of data communication capabilities of the system in respect of data, text and voice. Transmission rates, protocols, and details of data communication interfaces (where required) are also to be stated. Tenderers shall also state the following at tender closing:
   - To what levels the system can support data/text communication.
   - What effect voice and data traffic would have on each other in the system offered, and what impact a busy hour upsurge of one type of traffic could have on the other.
   - How the system offered could be upgraded and/or expanded to cater for an in- crease in each type of traffic as referred to above.
   - What type of data ring and/or LAN is supported and provide the specifications thereof?
   - What the cost is of providing extra ports.
d. Tenderers must also state at tender stage whether any of the following Gate- ways/Facilities are available and submit full technical details:
   - Packet switching interface to provide access to the X25 Packet Switched Data Network (SAPONET).
   - Text interface (X21, X25).
   - Local Area Network interface to connect broadband/base band LAN system.
   - Wide Area Network interface.
   - Modem interface for pool or modem.
   - Whether the system is data transparent and states the bit rate.

e. The ISDN capability of the system offered must include the ability to carry data at the current recommendation of up to 19.2 Kb/s asynchronous speeds, on a simultaneous Voice and Data, or 2 x Data Channels basis over the standard twisted pair supplied for the voice network, as per CCITT recommendations for 2B + D working. The system shall also be capable of interfacing Modem Pools in such a way as to allow maximum use of the total voice network facilities and recourses, to expand and exchange these other communication Networks.

A17.7.13 NETWORKING

a. The PABX offered must be capable of supporting the following networks:
   - Non-integrated networks (Auto-to-auto and exchange line tie lines).
   - Partially integrated networks (E+M Tie Lines).
   - A combination of both.
   - QSig supported integrated networks.
b. The system offered should be inherently capable, even if not initially equipped, for networking with other Nodes of equipment (not necessarily from the same supplier) in any topology.
c. It should be noted that the sites of these Nodes and decentralized modules are distant from each other and require Telkom supplied links. DIGINET or E+M tie lines therefore are required.
d. The system shall support the following types of interfaces regarding the net- working of ISDN connectivity:
   - Two wire auto/auto (loop disconnect and DTMF signaling).
   - Four wire "E + M" signaling (options to be listed).
   - PCM 30, 2 Mb/s signaling (options to be listed).
   - CCITT SO basic rate ISDN (2B + D): options to be listed.
   - CCITT S2 primary rate ISDN (30B + D): options to be listed.
e. It should be noted that a network signaling system based on the CCITT recommendation (Q93x) for public ISDN network which meets OSI (Open System Interconnections) requirements for open communication is preferred.
f. Regarding Facility Transparency, the system offered shall be capable of working in a network system utilizingQSig. All facilities on the system shall be transparent throughout the network. Facilities shall also be transparent from one node to an- other, including those supplied by other suppliers.

A17.8 FEATURES AND FACILITIES OF THE SYSTEM

A17.8.1 GENERAL

The PABX system described in this specification shall have the following minimum features and facilities integrated into the system and ancillary equipment:

a. DDI and DDO
   - The PABX system offered shall have Direct Dialing In (DDI) and Direct Dialing Out (DDO) facilities to be utilized to full advantage by the user to and from all extensions.
b. The system will make provision for internal dialing.
c. The baring of individual telephone extensions for at least 10 levels will be provided.
d. Individual code baring will be possible (e.g. the baring of code 087).
e. The system will allow for Data Detection.
f. The system will allow for three (3) way conference.
g. The system will allow for eight (8) way conference.
h. The system will make provision for call transfer.
i. The system will have a shuttle enquiry service possible.
j. The system will have ring back when free.
k. The system will make provision for speed call numbers. A common pool of at least 600 will be possible.
l. The system will make provision for Individual Speed Call. At least ten (10) speed call numbers per extension will be possible.
m. The system will make provision for Call Park.

n. The system will make provision for Code Looking of extensions
o. The system will make provision for Automatic Booking of outgoing lines.
p. The system will make provision for Last Number Redial.
q. The system will make provision for Call Hold.
r. The system will make provision for Cut in Priority.
s. The system will support DTMF and dial impulses analogue telephones.
t. The system will support two (2) wire digital telephones.
u. The system will make provision for nuisance call tracing.
v. The system will make provision for the Do Not Disturb function
w. The system will allow for the leaving of a message on an unanswered telephone.
x. The system will allow for Call Pick-up. Tenderers must specify the number of groups and the maximum number of members in a group.
y. The system will allow for single Digit Dialing and it will be possible to various services on site e.g., manager, security officer on duty, etc.
z. The system will make provision for Call Forwarding / Follow Me as follows:
   - To another phone when no reply.
   - To voice mail system.
   - To switchboard.

A17.8.2 RCOM FACILITIES

a. The Exchange shall allow for an intercom facility on the digital telephones. The pressing of a button must activate the intercom facility. The called terminal must be switched directly into the hands-free mode.

b. It must also be possible to make an all call to ALL the intercom telephones in the institution as listed in the schedule of Requirements, by the pressing of a single key. The result of this action will set up a one-way speech connection between the calling terminal and all free intercom terminals in the institution. The calling terminal must be informed whether all terminals in the group were reached or whether some terminals were busy.

c. If the above-suggested method of operation is not possible Tenderers must put forward an alternative proposal in order to achieve the above-mentioned objectives

A17.8.3 TELEPHONE INSTRUMENTS

a. The contractor shall supply, install, test and commission telephone instruments intended for use with the PABX installation for all indoor extensions, as well as those outdoor extensions which are included in the telephone schedule included else- where in the specification.
b. The contractor shall functionally check each telephone jack point, using a standard telephone instrument, for successful operation.
c. The PABX system must offer a choice of telephone instruments to meet the various requirements of the users. The telephone instruments should include:
   - Basic analogue 2 wire DTMF connections.
   - Digital 2 wire connections for both B + D, and 2B + D connections.
   - The system shall have the capability of handling telephone instruments with 16-digit keypads.
   - Integrated Data Connections.
d. The tenderer shall define clearly in his tender every type of telephone instrument which may be used in conjunction with the system offered, as well as the type of analogue and digital telephone instruments that will be supplied, the facilities which each type of telephone offers and the cost of these instruments.
e. All telephone instruments shall be provided with a standard three-(3) meter connecting cable with a plug.
f. The tenderer must take note that the quantities of telephone instruments may be increased or decreased during the construction phase of this contract. The final contract sum will be adjusted accordingly.

A17.8.4 DIGITAL TERMINALS

Digital terminals, when required, must have the following features:

a. Hands-free function - the hands-free function must be of good quality employing state of the art components.
b. Feature buttons must be programmable and the pressing of one button must activate the feature.
c. Users of digital telephones shall be able to program their own telephone instruments.
d. The digital terminals must have a liquid crystal display showing the time and date whilst in the idle state.
e. Where required digital telephones must have LC displays that provide comprehensive information on call status and the following are minimum requirements:
   - Name and number display for all extensions.
   - Telephone number of internal callers, from other nodes in the network.
   - Feature activation, e.g., Call Forward, Do Not Disturb, Ring Back-, and Message Waiting.
   - Call Waiting Display.
   - Name and number of Calling and Called parties on Call Pick Up.
   - Details of both Voice Mail and Fax messages.
   - Prompting on the use of Voice Mail and Fax Mail systems.
f. As secretaries will use digital telephones to answer many telephones, these telephones must be capable of showing the status, busy or free, of a minimum of eight extensions. Each extension will be indicated on a different button.
g. Digital telephones must be capable of accepting external devices such as tape recorders, second microphones, etc.
h. The Tenderer should state any additional features.

A17.8.5 TELEPHONE CALL MANAGEMENT SYSTEM

The Contractor shall provide a suitable Telephone Call Management System with the PABX Installation. The Telephone Call Management System (TCMS) shall be of the Hotel type and provide the following:

a. The required software programming and associated interface equipment to monitor calls on the PABX System continuously.
b. The required software to generate reports and accounts for calls in the typical Hotel Industry environment.
c. Suitable functionality and software to register hotel guests and process wake-up calls over the system K required.
d. A suitable report printer for printing of reports and accounts on a regular basis.

A17.8.6 DECT (DIGITAL ENHANCED CORDLESS TELECOMMUNICATIONS)

The Contractor shall provide a fully functional Digital Enhanced Cordless Telecommunications (DECT) System with appropriate equipment with the following requirements as part of the PABX Installation:

a. The DECT System shall comply with the latest international and local standards and codes related to digital cordless telecommunications.
b. The DECT System shall include all required equipment and interface cards as part of the PABX switch unit to support the number of remote units, known as radio fixed ports (RFP's) in the terminology of some suppliers and associated handsets.
c. The DECT System shall include all the RFP's and handsets in accordance with the Schedule of Quantities that form part of this document.
d. The Contractor for the PABX System shall allow to do a proper survey with appropriate tests to establish the most suitable location for remote equipment and the optimal usage of handsets.
e. The Contractor for the PABX System shall allow for all license applications on behalf of the Owner at the appropriate institutions required and include such fees in the tender bid at tender stage.

A17.8.7 OPERATOR'S CONSOLES

Two operator consoles are required. It is a specific requirement that incoming calls must be identifiable to allow the operators of the two departments to work totally independent of each other.

A17.9 SUBMITTALS

A17.9.1 DRAWING, OPERATING AND MAINTENANCE INSTRUCTIONS

a. Two copies of a fully detailed and dimensioned drawing of the recommended locations and positions for each energiser system and zone location.
b. Two copies of a dimensioned outline drawing of the system architecture and topology.
c. One paper copy and one electronic copy of the schematic wiring diagram of a typical fence energiser and zone arrangement and connection.

A17.9.2 INSTALLATION ARRANGEMENT

Installation arrangement for PABX system:

a. To new Data Room.

A17.9.3 PRE-DELIVERY INFORMATION

Within four weeks of receipt of the purchase order, the tenderer shall submit for the engineer's review, comment, and approve the following:

a. Finalised schematic diagram and dimension drawings
b. Operating characteristics of the PABX system and equipment.
c. Shipping/ transport details.

A18. ACCESS CONTROL SYSTEM

A18.1 QUALITY ASSURANCE

A18.1.1 CODES AND STANDARDS

The supply, delivery and installation of ACCESS CONTROL system and equipment shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards. The latest issue of the SANS codes will be applicable:

a. The Occupational Health and Safety Act, Act No 85 of 1993.
b. The Minerals Act, Act No 50 of 1991, which includes the Mines and Works Regulations.
c. The local Municipal by-laws and regulations as well as the regulations of the local Supply Authority.
d. The local Fire Regulations.
e. The National Building Regulations and Building Standards Act including the Code of Practice for the Application of the Regulations, SANS 10400.
f. The regulations of Telkom SA Ltd.
g. SANS 2220-2:2005: Electrical security systems Part 2-1 to 7: Access control systems
h. SANS 10222-2:2007: Electrical security installations Part 2: Access control

A18.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

a. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
b. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A18.1.3 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A18.2 ACCESS CONTROL SYSTEM

A18.2.1 OVERVIEW

An access control system must be installed including biometric fingerprint readers in the following locations under stage 1, as per drawings. The installation, testing and commissioning under stage 1 will be used as a test for the full project. An ineffective system could result in the system being rejected if it does not conform to the requirements of the final overall solution.

A18.2.2 READERS LOCATION

- Staff Rest Room
- Server Room
- Block G Passage
- Block F Passage
- Block E Passage
- Block C-D Passage
- Block H Passage
- Block B Passage

A18.2.3 HARDWARE

- Door Strike Locks for above mentioned doors
- Power supplies to manage hardware
- Release buttons as per drawings
- Emergency release buttons for above mentioned doors
- Cabling to complete the installation
- 8 port Network Switch & Cabling to complete installation
- Cabinet with power supply
- Controller & Controller mounting plate
- Universal Reader Interface to manage doors (Wiegand version)
- Biometric Enrolment reader USB
- Dongle and licenses required to compete

A18.2.4 SOFTWARE

Windows 10 Professional or Ultimate edition, SQL 2008 Express Command Centre Software Biometric licenses required to complete the installation.

A18.2.5 COMPUTER

Minimum, Intel® Core™ i7 processor min, 8Gb RAM, 2gb Video card, 10/100 Network card 250GB SSD, DVD+/-RW.

A18.2.6 GENERAL

a. This specification calls for the supply, installation, and commissioning of a complete, integrated security system in accordance with appropriate local and international standards; and the technical and performance criteria set out in this document.
b. This specification covers:
   - Access Control
   - Intruder Alarm System
   - Alarms Management
c. The system is to be supplied with all equipment, hardware, software, cabling, and ancillary services as required to provide an integrated system complete and functional in all respects. The tenderers are to familiarise themselves with all matters related to such requirement and to account for such in the tendered price.
d. Other security system components not included in this specification shall be fully integrated with this access control system.
e. It is the responsibility of the tenderer to obtain clarification of all matters in which doubt exists as to the exact intent of this document or in which a conflict appears to have arisen. Such information must be obtained prior to the closing and lodging of tenders.
f. The response shall clearly detail all pricing for components, cabling, installation, engineering, training, commissioning, setting to work, and 24 months comprehensive warranty.
g. The tenderer must include as part of the tender submission a complete, clause-by-clause response.

A18.3 RESPONSE FORMAT

a. The tenderer shall respond to each clause with one of the following Responses. Should the tender wish to clarify or amplify the Response, then the clarification or amplification shall not change the given Meaning of the Response statement.

Response	Meaning

Complies	The equipment/system offered complies fully in all respects with the specification clause.
Substantially Complies	The equipment/system offered does not comply fully but offers most or a substantial part of the requirements of the particular clause. Compliance in excess of 75% of the requirement qualifies for this category. Areas of non-compliance must be clearly identified and explained.
Partially Complies	The equipment/system offered provides only a part of the requirements of the clause. Less than 75% compliance with the clause should invoke this response. Areas of non-compliance must be clearly identified and explained.
Does Not Comply	The equipment/system offered does not provide the requirements of the particular clause.
Accepted	The Tenderer understands and accepts the conditions imposed or enunciated by the particular clause and has included provision for such in the tender.
Not Accepted	The Tenderer does not accept the condition imposed by the particular clause and as such is not included in the tender. Reasons for non-acceptance must be given.

b. The consultant reserves the right to accept or reject any tender where clauses are tagged.

A18.4 PRODUCT COMPETENCE

a. The successful tenderer will be required to demonstrate their competence to supply, install, commission, and maintain the product line proposed in the tender submission as follows:
b. Provide a letter of reference from the product manufacturer confirming the tenderer's status with the manufacturer advising:

- Exclusive or non-exclusive agreement to provide the system in the geographical territory for this specific project.
- The tenderer will be fully supported by the manufacturer in meeting the requirements of this specification.

c. The tenderer shall provide evidence of competency in carrying out the following areas of work:

- System design
- Installation management
- System configuration
- System commissioning
- System maintenance

d. When working on the system, each employee of the successful tenderer shall be required to carry an identification card issued by the product manufacturer showing evidence of current manufacturer factory training; indicating the level of training as defined above.

A18.5 FUNCTIONAL OVERVIEW

a. The system shall provide comprehensive access control and intruder alarm functionality; allowing multi-site configuration able to be managed by one or more of the connected sites.
b. The system shall provide a means to control access through nominated doors having electric locking door status monitoring and token or biometric access control readers. Access rights associated with a presented access token or biometric identifier shall be checked for validity

based on token or identifier, access area, access time and any other access management function defined in this specification as stored in intelligent field controllers. Access shall be granted or denied, dependant on the access privilege. Access rights shall be programmed in a variety of ways to allow flexibility as defined elsewhere in this specification.

c. The system shall be able to be integrated with the existing or new intruder alarm system.
d. The system shall be OPC (Alarms and Events) and OPC (Data Access) enabled using Microsoft COM and DCOM enabling integration of event data with other third party OPC enabled automation and business systems.
e. The system shall allow data exchange with other applications using XML protocols for schedule changes, and card record changes.
f. All system communications must be totally integrated with either existing or new LAN/WAN networks. Tenderers must make themselves familiar with the specific requirements for this project.
g. Connection to Intelligent Field Controllers (IFCs) shall be achieved using cabling supporting Ethernet and TCP/IP protocols. The network connection must be on-board the IFC. Interface transceiver units (Ethernet to RS485, RS232 etc) are not acceptable.
h. Remote IFCs not permanently connected to the network can be connected via a PSTN service, using TCP/IP protocols.
i. Connection from the remote IFC to the server shall be either via dialup to an Internet Service Provider (ISP) using encrypted TCP/IP, and then via an approved firewall through into the IT environment or via dialup directly to a RAS connection on the Server.
j. All system software upgrades shall be downloadable through the network to the IFC.
k. All data communication internal to the system on the TCP/IP network between IFC's and between IFC's and the Server shall be encrypted using symmetrical session keys and an industry-standard encryption algorithm to a minimum of 128-bit AES. Session keys shall be changed on a regular basis at intervals no longer than 24 hours. Communication authentication shall use 1024-bit RSA keys.
l. The system shall report all events to the operator(s) as configured and shall produce and maintain a log of all system events, alarms and operator actions.
m. The system shall provide a means for an operator to extract information relative to the event log and system configuration and produce this information in the form of printed reports, screen displays or ASCII files.
n. The system shall provide for a Windows based User Interface with Site Plans and interactive icons representing the location and real-time status of Access Control, and Alarm Monitoring equipment.
o. The system shall provide emergency evacuation reporting.
p. The system shall be designed and manufactured by a reputable company who shall be certified under the ISO 9001:2000 quality procedures.
q. All equipment shall have the following approvals:

- FCC Part 15
- CE approval BS EN 50130-4 Alarm Systems Electromagnetic Compatibility (Immunity)
- CE approval BS EN 55022 Emissions
- UL294 Access control
- UL1076 Burglar Alarms
- CSA C22.2 No. 205
- ULC-ORD-C1076

r. Encoders and readers shall also meet:

- CE ETS 300 683 Short Range Devices
- C-Tick AS/NZS 4251 Generic Emission Standard
- C-Tick RFS29

s. The system software shall be written in a fully structured, fully validated and commercially available language that provides a strictly controlled development environment.
t. The user interface for operational management of site security shall be developed using Microsoft .net and Windows Presentation Foundation (WPF) development tools.
u. Comprehensive backup and archiving facilities shall be incorporated as an integral part of the system software.

v. The system shall include system division suitable for multi-tenanted buildings. Operators shall only be able to access those parts of the system which fall within their division and operator privileges.
w. IFC's must support peer to peer communications for input and output communications between IFC's. Systems that require the main server for communications between panels are unacceptable.

A18.6 SYSTEM REQUIREMENTS

a. The system shall be in commercial operation with the same or similar configuration as detailed in this specification and shall be available for inspection. A reference list of such similarly configured systems and details of contact persons shall be submitted with the tender response.
b. The system described in this specification must have the following capacity as a minimum:

• Graphical Site Plans	Unlimited
• Access Readers	Unlimited
• Fully Supervised 4 state Alarm Inputs	Unlimited
• Output relays	Unlimited
• Access Control Zones	Unlimited
• Schedules per day	100
• Schedule categories	50
• Holiday days	30
• Operators	Unlimited
• Concurrent Operator Sessions	Unlimited
• Cardholders	Unlimited
• Cardholder Issue Levels	15
• Cardholder Personal Data Fields	64

c. The system architecture shall be a tiered system consisting of:
   - One or more installations of the head-end software application operating on computer servers and operator workstations.
   - Intelligent Field Controllers (IFC's) managing the system in a distributed intelligence format.
   - Semi-intelligent subunits (outputs, inputs, readers, etc) which rely on IFC's to function.

A18.7 CENTRAL CONTROL ANDSYSTEM MANAGEMENT SOFTWARE

a. The system shall use the Microsoft Windows© operating system as defined previously. The version of Microsoft Windows shall be a currently supported version.
b. The system database shall be a version of Microsoft SQL Server appropriate for the system size required. The version of Microsoft SQL Server shall be a currently supported version as defined previously.
c. The system shall be OPC enabled in accordance with the current OPC specification for OPC (Alarms and Events) and OPC (Data Access).
d. The central server shall employ a high quality personal or server computer incorporating current generation design and components. It shall be of a Microsoft approved model for operation with current versions of Microsoft Windows operating systems. The PC specifications, including processor speed, internal memory and hard disk size shall be specified by the supplier and must be sufficient to meet or exceed the specified system requirements.
e. The system shall be capable of supporting a minimum of 20 PC based operator workstations simultaneously running. Operator workstations running terminal emulation software will not be accepted.
f. The system shall automatically log and time/date-stamp all events within the system including intruder alarm set/unset events, access control events, operator actions and activity.
g. The central control software shall be easy to use, make extensive use of menus and windows and require a minimum of operator training to operate the system proficiently. Systems requiring a program language approach to configure the system will not be accepted.
h. The central control must be capable of receiving simultaneous alarm signals from a number of remote locations, without loss or excessive delay in their presentation to the operator. Any

authorised operator should be allowed to acknowledge, view and/or process an alarm from any screen.

i. The central control shall be fitted with a real time clock, the accuracy of which shall be preserved over the period of main power supply failure. Synchronisation between the central control and Ethernet connected IFCs shall be automatic, not requiring operator intervention.
j. Operator selection of processing tasks shall be via menu selections. Authorised Operators shall be able to process alarms, produce reports and modify database records without degrading system performance.
k. The following is the minimum operational and monitoring facilities required. The ability to:

- Program either a group or individual card readers with access control parameters, without affecting other card readers.
- Program the access criteria for individual Cardholders or groups of Cardholders.
- Store at least 64 non-access control data fields for each cardholder. The names of these "Personal Data" fields shall be user definable.
- Authorise or de-authorise a Cardholder in the system with the result reflected immediately throughout all readers in the system.
- Enable a "Card Trace" against selected Cardholders so that an alarm is raised each and every time that cardholder presents their access card or token.
- Pre-program holidays so that different access criteria apply compared to normal working days. The system must have a capacity to set at least 30 holiday days.
- Recognise and manage regional holiday requirements
- Define as many access zones as there are card readers fitted.
- Allow or disallow individual Cardholder access to anyone, or group of card readers, in real time.
- Log all system and operator activity to hard disk as they occur.
- Program alarm response instructions into the system so that these are presented to the Operator when processing an alarm event.
- Enable an Operator to enter messages against alarm events.
- Override (temporarily) a Cardholder's, or group of Cardholder's, pre-programmed access criteria.

l. The central control shall display a one-line plain language event message for every activity event (alarm or otherwise) occurring in the system. All activity logged shall be time and date stamped to the nearest second (hh:mm:ss). On having the appropriate operator authorisation, it shall be possible to drill down into the properties of each component that makes up that event for future details. The event message shall advise:

- Time of event
- Action
- Successful or unsuccessful
- If the transaction is unsuccessful, the reasons for the denial.

m. This includes but is not restricted to the following items:

- All card attempts.
- All door alarms
- All operator activity including log on, log off, alarm response messages and any alteration of system data files
- All alarm monitoring activations
- All communications link failures.

n. Time schedules for different "day types" shall be configurable.
o. Regional holidays shall be configurable to allow for regional variations.
p. The system shall provide a detailed operator help file. This help file shall provide operators with text, audio and video help instructions and tutorials.
q. The system shall allow for searching of items configured within the system based on the following:
   - Item characteristics
   - Related items

- Times related to events including the item.

A18.8 MULTIPLE SERVER CONNECTIVITY

a. Systems based on multiple servers installed at several locations shall be supported.
b. Alarms and events from all servers shall be able to be displayed on any or all of the system workstations.
c. The cardholder database shall be automatically replicated to all servers as a “global” entity.
d. Replication of cardholder changes shall occur as changes are made and not batch processed.
e. Communication between servers shall be peer to peer.
f. The multiple server environment shall allow for evacuation reports for each site on the multiple server system to be generated on one server, for one or more remote servers.
g. Operator views and access privileges shall follow the same rules across multiple servers as apply within a single server.
h. Security system items configured on existing servers shall automatically be recognised by any servers added to the multiple server group. Likewise, system items configured on the server(s) being added shall be automatically recognised by the existing multiple server group.
i. Use of software interface modules, custom written, to connect servers into a multiple server configuration shall not be permitted.
j. Manual or script re-entry of data for existing servers into any new servers being added to the multiple server group shall not be permitted.
k. Synchronisation of data across all servers shall be automatic, real-time function not requiring operator intervention or initialising.
l. Should communication be lost between two or more servers, the individual servers shall continue to function independently and shall resynchronise all changes made whilst offline automatically.
m. Should a conflict occur resulting from two items being created in two or more servers whilst servers are offline then an alarm shall be raised when the servers are re-joined advising of the conflict.
n. Should an existing record be modified in two or more servers whilst the servers are offline then on reconnection, the modifications shall be carried out in time order of the modifications.

A18.9 GRAPHICAL USER INTERFACE

a. Configuration Graphical User Interface
   - The system access shall be via a Graphical User Interface (GUI)
   - All functionalities shall be managed via the GUI
   - Drop-down menus shall be provided to select all configuration functions.
   - System items (hardware items and software items) shall all have an associated properties menu to allow item configuration.
   - Configuration or operation using scripting or other forms of text-based programming will not be accepted.
b. Operator User Interface

In addition to the User Interface defined above, the Operator User Interface shall be provided as follows:

- Full screen, user configurable Viewers, designed specifically for the task and the information needs of the operator.
- Default viewers shall be provided covering the primary site management functions of:
  - Alarm management
  - Cardholder management
  - Monitor Site
- The system shall allow customised viewers to be created.
- The Operator User Interface shall be fully configurable by an operator with authorisation to configure Viewers.

A18.10 SITE PLANS AND SITE PLAN ICONS

a. It shall be possible to manage and monitor alarms, overrides, the general status of site items and open doors through the Graphical User Interface with the use of interactive real time dynamic site plans and icons.
b. Site plan usage shall support touch-screen technology.
c. All site plans stored on the server PC shall be automatically updated if amended at any of the networked workstations.
d. External drawings shall be imported into the system from external drawing software.
e. The ability to import at least the following drawing formats shall be supported:

- BMP
- WMF, EMF
- JPG
- GIF

f. It shall be possible to assign icons to system functions and place these at any position on a site plan.
g. Provision for drawing lines and areas to form “objects” shall be available. These objects shall be able to be associated with system items allowing system item status to be visually indicated by the object.
h. It shall be possible to place free text onto a site plan.
i. Site plans shall be “nested” allowing a single action (mouse click on a current site plan icon) to move from one site plan to another.
j. The following functions should, as a minimum, be able to be executed by clicking on Site Plan icons:
   - View the current status of a Door, Input or Output.
   - Monitor and acknowledge an Alarm.
   - Open an access-controlled door.
   - Move from one plan to another plan.
   - Activate an Intercom on a reader
   - Override an alarm, access, or perimeter fence zone state.
   - Display the properties of the item.

A18.11 ACCESS CONTROL, SECURITY ALARM AND I/O PROGRAMMING

a. The system shall provide complete flexibility and be capable of programming an unlimited combination of access control, security alarm and I/O parameters subject only to performance and memory limitations within the IFC.
b. Keypad access control:
c. Every incorrect PIN attempt shall be notified at the central control as an alarm condition.
d. Each reader shall be capable of automatically switching the access mode at a door at different times of the day, based on control parameters received from the central control.
e. The following access criteria modes are required:
   - Free access: Door is unlocked, no card entry required.
   - Secure access: Door is locked, a successful card attempt is required for valid entry. Door re-secures after access attempt.
   - Secure + PIN access: Door is locked, a successful card and correct PIN number attempt is required for valid entry. Door re-secures after access attempt.
   - Override from reader: Members of certain access groups shall be able to change the access and PIN’s mode of the door at certain times.
   - Dual Authorisation: Access is granted when two different, but legitimate cards are presented within a given time frame.
   - Escort: A second card is required to be presented from a cardholder who is nominated in the “Escort Access Group”.
   - Shared PIN Number: The system Operator determines what the PIN number will be and programs this into the system. Access is allowed through the door when the correct 4-digit PIN is pressed followed by the “Enter” key.
   -

A18.12 PRE-PROGRAMMED OVERRIDE MACROS

a. To allow for making changes to the system configuration on demand, it shall be possible to pre-configure the required changes and assign them to a macro command.
b. An operator shall be able to initiate the macro (to carry out the changes) via either a menu item or by a site plan icon.
c. Macro assembly must be by the use of GUI features such as drop-down lists and drag-and-drop techniques. The use of script language to write macro's is not acceptable.
d. Macros shall be able to be initiated on a time schedule.
e. Macros shall be able to execute command line actions.
f. Up to 300-character variables shall be able to be specified for each command line.
g. Each Macro shall be able to contain multiple command line entries.
h. The configuration and execution of command line Macros shall be user account name and password protected. These usernames and passwords shall be obscured on entry and transmitted and stored at the central command system server in an encrypted format.

A18.13 ON-LINE DOOR CONTROL

a. Access control for a door shall allow for the following features where specified:
   - Access reader
   - Emergency release switch input
   - Reception control switch input
b. Egress control for a door shall allow for the following features where specified:
   - Exit reader.
   - Push button request to exit.
   - Emergency exit break-glass
c. Push button request to exit as referred to shall record the exit in the event database.
d. When requested by a valid means of access or egress, the door shall unlock for a present period, after which the door shall relock.
e. If access or egress is completed prior to the present time expiring, then the door shall relock immediately the door has closed.
f. The period of unlock shall be extended should a cardholder be a member of an access group where extended entry time is required.
g. The door shall be monitored for both door open/closed, and door unlocked/locked using concealed monitor switches appropriate for the door installation.
h. Where the door is a double door, the inactive door leaf shall also be monitored for door open/closed and door unlocked/locked. The inactive leaf door monitor switches may be connected as part of the active door leaf monitoring.
i. It shall be possible to configure the door in a way that generates a forced door alarm should the door be unlocked and/or opened without reference to the system.
j. Should a door be left unlocked or open after a present time, an alarm shall be generated reporting the condition.
k. The door open/unlocked warnings shall provide an audible warning at the door.
l. It shall be possible to disable the reader audible warning.
m. It shall be possible to generate the audible warning via a relay connected elsewhere in the system.
n. Should a valid request to access a door be generated and access not taken, it shall be possible to ignore the request (not record it as an entry event) and automatically re-secure the door after a present time.
o. When a valid access through a door is undertaken, the door shall immediately re-secure on re-closing.
p. It shall be possible to "lock-down" an Access Zone by assigning an input condition to the access zone. When the input is operated, all doors in the access zone shall go to secure mode.
q. It shall be possible to assign specific cardholders the right to access a zone when the access zone is locked, whilst refusing access to all other cardholders.
r. It shall be possible to create an interlock relationship between a group of doors. Up to 20 doors shall be included in any interlock group.

s. It must be possible to configure interlock groups via GUI" drag and drop" functionality, without the requirement to write scripted logic.
t. The system shall support a challenge or video verification mode as specified below:
    - When a card is presented at a reader, images from the cardholder database (as many as required) shall be displayed in the challenge window.
    - Associated with the images, it shall be possible to display a video image from one or more assigned cameras. .
    - In challenge mode it shall be possible to view a site plan showing the location and status of the controlled entry point and nearby items.
    - In challenge mode it shall be possible for the operator to view the status of the cardholder's cards and competencies for the purpose of informing the cardholder, at the time of entry, if any expiries are imminent.
    - Specific personal data shall also be able to be displayed, associated with the cardholder (name details, department etc).
    - Associated with a challenge entry, the selection and layout on screen of cardholder images, cardholder personal data, cardholder card or competency status, site plans or video images must be configurable using simple drag and drop or click and drag techniques to resize or reposition information.
    - The challenge made shall be configurable to either:
        - Automatically grant access to a valid card. In this case the system shall be able to display the current access decision (granted or denied) to the challenge operator.
        - Require operator intervention to grant access to a valid cardholder.
    - Should a second challenge be requested while an unanswered challenge remains in the system, the second and subsequent challenges shall queue automatically awaiting response.
    - It shall be possible for an operator to view waiting challenge events and to select and process challenge events within the queue in any order they choose.
    - The system shall allow challenge events to be managed from a single full-screen view per operator or multiple filtered views, as dictated by the customer.

A18.14 BIOMETRIC (FINGERPRINT) READERS

a. Where specified, biometric (fingerprint) readers are required for this project.
b. The reader shall be designed for wall mounting, positioned to allow ease of use for the user.
c. Visual (LED's) and audible feedback shall be provided to indicate:
    - Reposition the finger for a valid read.
    - Access granted.
    - Access denied.
d. Tamper protection shall be provided against the unit being opened and against the unit being removed from the mounting surface.
e. The sensor resolution shall be 500dpi or greater and FBI PIV-IQS certified
f. Fingerprint read time shall be less than one second.
g. The reader shall be able to handle at 1000 users.
h. The reader database must be upgradable to at least 5000 users.

A18.15 CARDHOLDER MANAGEMENT

a. The cardholder database shall be structured so that the name field is the master field for each record. A background unique identifier may be used as the key field for each record, but this must not be required by an operator to identify a cardholder. Use of the card number as the key field is not acceptable.
b. Each IFC shall cater for the number of cardholders as defined in the schedule of requirements.
c. The system must allow at least 15 Issue Levels per card or token to match that specified in this specification. This must deny access and raise an alarm to the operator when a wrong issue level is presented to a reader.
d. Cardholders must be able to be issued with more than one access token of different description and different number (i.e., access card, biometric identification and vehicle token) whilst maintaining only one cardholder record in the database.

e. Where biometric identification is required, the fingerprint data shall be a property of the cardholder record.
f. Encoding and printing cards shall be properties of the cardholder record.
g. The options for encoding and printing shall be:
h. Print card.
i. Encode print.
j. Print and encode card.
k. Access groups shall be linked to cardholders by both assigning access groups to cardholders or cardholders to access groups.
l. At least 64 user-definable “Personal Data” fields shall be provided which may be selectively reported on.
m. Personal Data Fields shall be able to be set up as either:

Text	User data may be entered.
Text List	User selects text from a pre-prepared list of text strings.
Numeric	User must enter numeric data.
Date	Calendar dates may be entered based on the workstation date format.
Default Value	The field has a default value assigned.
Image	The field may only contain an image to the field.
Email/Mobile used for	The field contains an email address or mobile number to be notifications.

n. Personal data Fields shall also be able to be configured as:

Required field	Data must be entered.
Unique Values	Data must be unique from all other card records.
No default Value	Default value disabled.

o. Personal data fields shall support rules to ensure data accuracy. Examples: @ in email addresses; employee codes are in the correct format.
p. A notes/memo field shall be available, associated with each card record.
q. The notes field shall support word-wrap, insert, delete, cut, copy, and paste functions.
r. It shall be possible to “group” or “filter” cardholders for the purposes of editing access, generating reports, and assigning operator privileges.
s. The following information fields shall optionally be displayed on the Cardholder editing window:

- The date when a cardholder record was created.
- The date when the record was last modified.

t. For ease of programming Cardholders shall be grouped into access groups sharing the same access criteria and default personal data fields.
u. It shall be possible to enter an automatic expiry date/time for the card.
v. It shall be possible to automatically expire cards that have not been used for a predetermined period of inactivity of up to 999 days.
w. It shall be possible to allocate start and end dates and times for an Access Groups access to a particular access zone.
x. Access shall have start and end dates and time to within one minute.
y. The system shall be capable of importing database information, on selected cardholders, from other systems and be capable of exporting that cardholder’s data, either with or without controlled alteration or amendment, to other databases.
z. The system shall support the capability to allow bulk changes to card records. It shall be possible to carry out the following changes as a bulk change:
    - Delete selected cardholder records.
    - Change personal data fields.
    - Change card details.
    - Change access options.
    - Change the system division the records are assigned to.
aa. A bulk change shall be able to be saved and scheduled to run later.
bb. A window shall be provided to show details of created, saved, edited, pending, successful and failed bulk changes.

cc. A personal user code (4 or 6 digit) shall be a property of the cardholder record to allow alarm setting and unsettling.
dd. System operator management shall be a property of the cardholder record.
ee. A change history record associated with each cardholder record shall list all changes made to a cardholder record, including details of who made the changes.
ff. The system shall support an event trail for the cardholder which details recent card usage events for the cardholder as well as operator events which have modified the cardholder record. The number of prior events to be shown or prior length of time to be covered shall be configurable. The system shall allow different prior length of time / number of prior events to be displayed for different operators.
gg. The system shall allow an operator to search for a cardholder by entering any part of their first and/or last name, in any order and separated by a space if using both. After three characters have been entered the system shall automatically return matching results and filter these dynamically as the operator continues to type.
hh. The system shall allow the cardholder search fields and search results to be configurable. The system shall allow different operators to use and see different search fields and search results for the purpose of cardholder administration tasks.
ii. The system shall allow the information returned for a cardholder and visible to the operator to be configurable and include any sub-section of the total information stored in the cardholder record (e.g., personal data, cards, access groups, competencies, biometric information etc). Different operators shall be able to view different sub-sections of the cardholder information.
jj. The system shall allow design of different screen layouts for the purpose of cardholder administration, for use by different operators.
kk. The system shall allow cardholder information to be viewed and updated in one screen.
ll. Configuring operators shall, subject to the required privileges, be able to design single screen cardholder management viewers adapted for the specific screen resolution of the operator(s) who will use the viewer, to ensure best use of available screen real-estate.
mm. The system shall provide tools to maximise, on screen, specific cardholder details when required. Maximising an area and returning to standard layout must both be single-clicking actions.
nn. The system shall allow all cardholder administration functions to be managed solely via keyboard.

A18.16 VISITOR MANAGEMENT

a. The system shall provide visitor management functionality as described in this section.
b. Visitor details shall be able to be pre-registered into the system.
c. Visitor details for several visitors associated with a single visit shall be able to be pre-registered into the system.
d. A visitor escort shall be able to be assigned to each visitor.
e. Attributes associated with the visitor(s) shall be configurable and set as mandatory or option fields. These shall include:
    - The reception where the visitor(s) will be expected to arrive.
    - The visitor category.
    - The person the visitor(s) will be meeting.
    - Visitor arrival time.
    - Visitor departure time.
    - Building access rights to be given to the visitor(s).
    - Visitor photo-ID image.
f. Visitor badges shall be able to be printed on a reception label printer.
g. Visitor personal details shall be stored if required, to be reused for future visits.
h. Visit details shall be recorded in the system event database.
i. The system shall raise an alarm should a visitor not sign out by the due time.
j. Multiple visitor management (reception) workstations shall be allowed.
k. A visitor management screen shall provide a visitor “snapshot” showing the following parameters:
    - Expected to arrive during the day.
    - Location status - currently on site, due to leave or temporarily off site.

- Cards associated with visitors remaining after the expected departure time plus a predefined grace period, shall be automatically disabled.

l. Groups of visitors shall be selectable as a group and their status processed as a single action.
m. The visitor management (reception) workstations shall support configurable macro actions. The macros shall be preconfigured system macros.

A18.17 SYSTEM OPERATOR MANAGEMENT

a. Operators shall be members of operator groups.
b. Operator establishment and maintenance shall be limited to assigned Senior Operators.
c. It must be easy to define operator privileges for a group of operators and it must be easy to add an operator to the group.
d. Operator access to the system is to be restricted by means of an operator identifier and individual password.
e. Passwords shall be managed by using either non-restrictive or force password changes. Forced changes shall include options for:
   - Minimum password length greater than 8 characters.
   - Mixed case characters
   - Mixed alpha and numeric characters
   - Change password after a defined period of up to at least 365 days.
   - Remembering and rejecting at least 8 previously used passwords.
f. The system shall also support Mifare card logon.
g. Each operator shall have the authority to alter his own password, but not that of other operators.
h. Automatic logoff shall occur after a pre-set time of up to at least 60 minutes of operator inactivity.
i. It shall be possible to configure the system to only allow one logon per operator.
j. It must be possible to allow or deny Operator's access to system menu functions, including viewing of Cardholder Personal Data fields, Personal Notes, and Images.
k. It must be possible to restrict Operator access to Cardholders based on system division.
l. It shall be possible to assign different access rights for each division an operator is required to access. For example, "advanced user" for division 1; "view only" for division 2; and "no access" for division 3.
m. Any menu option not available to an Operator should be either greyed out or not visible.

A18.18 INPUT AND OUTPUT CIRCUIT FUNCTIONALITY

a. Input circuits shall be connected to the IFC as described in "Field Hardware".
b. Inputs from detection devices covering the same region for control purposes are to be grouped into alarm zones. Alarm zones can be in any one of four states and shall handle alarms differently depending on the state. The first two shall be defined as set (armed) and unset (disarmed). The names of the other states shall be able to be defined at the central control for other purposes such as maintenance testing.
c. Alarm priorities can be assigned to any of the four input states.
d. The system shall provide entry and exit delays for the setting and unsettling of alarms.
e. The entry delay shall be configurable from 0 to 5 minutes in steps of one second.
f. An optional audible warning must sound during the entry delay (from the time that the alarm occurs to the time that the Zone state is changed). It must be possible to designate specific card readers and remote arming terminals to sound entry delay warning beeps. Selected output relays should also be able to be operated during the entry delay period allowing suitable sounders to be connected at required locations.
g. An exit delay is to be provided to groups of inputs so that a change of state of an exit delayed zone is delayed by the exit delay period, which can be adjusted, from 5 seconds to 5 minutes in steps of one second.
h. An optional audible warning must sound during the exit delay (from the time that the alarm occurs to the time that the zone state is changed). It must be possible to designate specific card readers and Remote Arming Terminals to sound exit delay-warning beeps. Selected output relays should also be able to be operated during the exit delay period allowing suitable sounders to be connected at required locations. This applies to both manually and automatically changing the state of a zone in the case of automatically changing the state of a zone the exit

delay and audible warning gives people working late in the building time to unset the alarms or leave the building.

i. The system shall include Alarm Escalation as an event. The new event shall correspond to the original alarm but may have a different (usually higher) priority and may require a different set of alarm relays to operate.
j. Escalated alarms shall be able to be displayed in a Window specifically provided for this purpose.
k. Alarms shall be able to be escalated under the following conditions:
    - Escalate if alarm not acknowledged after (X) seconds.
    - Escalate if in inactive state for (X) seconds.
    - Escalate if zone contains (X) alarms.
    - Escalate if two events from same point within (X) seconds.
    - Escalate if two events from different points in same zone within (X) seconds.
        - It shall be possible to have automatic time-based setting and unsettling of alarms.
        - It shall be possible to configure the system such that events (such as a card swipe or operation of a key switch connected to an input) can change the state of a zone.
        - Authorised cardholders shall be allowed to set and unset alarm zones by:
    - Operation of the Card plus PIN reader as an alarm panel.
    - Presenting a valid access card to a card reader associated with the alarm zone, twice within a nominated time period (double card badging).
l. It shall be possible to set and unset multiple alarm zones from a Remote Arming Terminal.
m. All alarm occurrences shall be presented at the central control within 4 seconds of their occurrence at the remote field device.
n. All Alarm events shall be viewable from an Alarm Stack.
o. It shall be possible to view all alarm events by clicking on interactive Site Plan icons that, because of their changing audible and visual states, indicate the presence of alarms.
p. All alarm events arriving at the central control shall be "time stamped" with the time they occurred and the time they were logged at the central control.
q. All alarm events shall have a user definable alarm priority assigned. A minimum of 8 alarm priority levels plus non-alarm event and ignored shall be provided.
r. It shall be possible to assign a different audio warning sound to each alarm priority.
s. Incoming Alarms shall be presented in the Alarm stack according to their assigned priority with the highest level at the top. Alarms with the same priority shall be presented in time order.
t. The priority of Alarms in the alarm stack shall be identifiable by a user definable colour.
u. Identical consecutive alarms that occur within a predefined time span shall be report as a single alarm with the number of occurrences reporting as a flood alarm quantity.
v. The Central control must be able to control the actual priority assigned to any alarm activation throughout the day. This means any alarm activation may be programmed as "Low Priority" during office hours and "High priority" at all other times.
w. It shall be possible to nominate an Input (e.g., Smoke, Fire or Gas detection) as an “Evacuation Input” in which case certain doors within the Site will revert immediately to Free Access.
x. Operators shall be required to complete 2-stage alarm processing as:
    - Acknowledge Alarm.
        - An Acknowledged alarm shall remain in the alarm stack and be easily identified as having been acknowledged but not yet processed.
        - The central control shall record in the hard disk activity log that the operator has acknowledged the alarm. An alarm is “acknowledged” by the operator selecting the “Acknowledge” button in the alarm-viewing window.
        - A second alarm from the same source as the acknowledged alarm shall be indicated as a new alarm.
    - Process Alarm.
        - A Processed alarm shall clear from the Alarm Stack.
        - The central control shall record in the hard disk activity log that the operator has processed the alarm. An alarm is ‘processed’ by the operator selecting the ‘Process’ button that is displayed in the alarm viewing window.
y. The system shall allow an operator to multi-select contiguous or non-contiguous alarms in the list in order to add a note, acknowledge or process all selected alarms in one action.
z. The alarm list shall support mandatory fields of alarm time, alarm priority and alarm state.

aa. The system shall allow a suitably privileged operator to configure any of the following additional fields to be visible in the alarm list and to configure their order:
- full alarm message
- related cardholder name
- acknowledging operator's name
- alarm zone
- alarm source
- related access zone
- event type
- event group
- division of the alarm source
- count (occurrences of alarm)

bb. It must be possible for an operator to sort the alarm list by any of the available fields.

cc. The system shall display a summary of alarms, by priority, which is always visible to the monitoring operator and updated dynamically as new alarms occur or existing alarms are actioned.

dd. The alarm summary shall indicate if there are any unacknowledged alarms for a given priority.

ee. The system shall allow configuration of filtered alarm lists. Alarm lists shall be filterable based on any combination of selected divisions, escalation status or alarm priority.

ff. The system shall allow different information to be configured and displayed to a monitoring operator based on the type of alarm.

gg. Door Open Too Long alarms must display selected and configurable information (including, as an example, the photo and contact details) for the person who left the door open (last successful access).

hh. Cardholder related alarms shall automatically display recent events and selected information (name, photo, personal details etc) for the person causing the alarm.

ii. An active alarm shall not be able to be finally processed and cleared from the Alarm Window until the cause of the alarm has been removed and the alarm condition has returned to the normal state.

jj. Pre-programmed alarm instructions shall be available for the operator to provide instructions for acknowledging and processing each alarm.

kk. Alarm Instructions shall have the following features:
- Default Alarm Instructions shall be able to be programmed and automatically applied to all events of a common type e.g., all wrong PIN events applicable to all readers.
- Individual Alarm Instructions shall be able to be programmed and applied to individual alarm events.
- A table of contact names, phone numbers or other frequently used volatile information shall be available when programming Alarm Instructions and applied to Alarm Instructions from a pick list.
- When items in the picklist are updated, the linked Alarm Instructions shall automatically update.
- The alarm instruction text shall be able to be formatted using common text formatting features.
- It shall be possible to copy and paste Alarm Instructions between alarm events.

ll. The Alarm window shall allow the operator to enter a comment. Such comment will be date/time stamped by the system and recorded against that alarm event in the audit trail.

mm. When required, a pre-defined list of alarm responses shall be available for operators to select the appropriate response to an alarm. The alarm responses shall be user configurable to suit site requirements.

nn. Keyboard function keys (F1 to F8) shall be mapped to the first 8 alarm response messages to automatically insert the associated message as required.

oo. The system shall provide relay output facilities that are system activated in response to alarm activations. Relay functions required are:
- Activate and latch a relay in response to an alarm. Relay to remain latched until alarm processed.
- Activate a relay for pre-set "pulse" time. The relay to release after the "pulse" time lapses.
- Relay activation to "mirror" or "follow" the alarm input activation.

pp. The system shall incorporate relay outputs that can be activated according to time schedules, rather than alarm event. These outputs may be used to control lighting, heating, or to electronically lock or unlock non-monitored doors.

A18.19 REMOTE ARMING TERMINALS

a. Remote Arming Terminals (RATs) shall be provided to allow keypad functionality as described in this section.
b. Logging on to the RAT functionality shall be by:
    - A User Code (PIN) assigned to each cardholder.
    - Presenting a card to a reader associated with the Remote Arming Terminal.
    - Presenting a valid card to a reader associated with the Remote Arming Terminal plus entering a 4- or 6-digit PIN on the Remote Arming Terminal.
c. Authorised cardholders shall be able to:
    - Set and unset all or selected intruder alarms zones that have been assigned to a Remote Arming Terminal.
    - Acknowledge alarms.
    - Shunt inputs for alarm zones.
    - View a summary of status of all devices associated with the RAT.
    - See and operate on the appropriate alarm zone information they have access to.
d. Cardholder and groups of Cardholders shall be able to be assigned to operate any number of Remote Arming Terminals across a system.
e. Communications between the Remote Arming Terminals and the controllers shall be encrypted to a minimum strength equivalent to 40-bit AES.
f. Remote Arming Terminals shall be capable of being programmed to handle combination of up to any 30 alarm zones and up to 100 of their associated Inputs across a complete system.
g. Multiple remote arming terminals can be used anywhere in the system to remotely manage assigned Intruder alarm zones.
h. Remote Arming Terminals shall be capable of arming and disarming perimeter fence zones.

A18.20 NOTIFICATIONS

a. Specific event and alarm messages shall be able to be configured to be sent to nominated users via either email or SMS message.
b. It shall be possible for persons receiving alarm messages to be able to acknowledge the alarms via email or SMS message.
c. It shall be possible to send notification of imminent card or competency expiry to an individual, their manager or other nominated person. Refer also to Sections 13 and 39.
d. A comprehensive filtering feature shall be provided to manage notification information transmission.

A18.21 AUDIT TRAIL

a. The Server hard disk shall be used to record all system activity for archiving purposes. It shall not be possible to alter archived data.
b. Every system activity event along with all details, including but not limited to the following list, shall be time stamped with the time of occurrence to the nearest second and shall be recorded in the system activity log for archiving.
    - All access attempts (allowed and disallowed).
    - Alarm events.
    - System events.
    - Operator activity.
c. The central control shall provide an on-line facility to archive system data and event records to an archive file to free hard disk space for further activity logging.
d. The archive process shall be initiated by either manual operation or automatically by time.

e. It shall be possible to nominate the number of days of data that shall remain on the server subsequent to an archive process.
f. It shall be possible for an operator to view filtered event trails, e.g., for filtered for selected site items.

A18.22 REPORTS

a. The central control shall provide historical reporting capabilities from the following sources of information:
    - System activity data
    - Cardholder's access
    - Cardholder Personal Data fields
    - Cardholder access groups
    - Site configuration and setup data.
b. The report generation feature shall be easy to use and based on a “wizard” style of parameter selection and preparation. The wizards shall provide features to simplify report generation by incorporating selections such as report for “yesterday”, “last week”, “last month” etc. This is for the purpose of quickly generating recurring, standard format, reports.
c. The parameters for producing the report must be fully user definable and must be capable of searching on any cardholder or access event criteria.
d. It shall be possible to automatically produce the reports listed in this clause. The methods available to generate the report(s) are defined in previously.
    - Activity: Any site activity
    - Evacuation: Last known location of all cardholders on site.
    - Exception: Unprocessed alarms, un-acknowledged alarms and doors temporarily overridden from secure to free
e. The report shall be generated by any of the following means, as may be required by the operator:
    - Operator running a macro.
    - An alarm event trigger.
    - On a recurring schedule.
f. The central control shall generate and format reports in "background". This means the operator must be able to process alarms, alter database parameters and perform other system changes while the report is being generated. Report generation must continue if the operator decides to perform any other task.
g. The central control shall have a screen preview function, so that reports can be previewed on-screen before they are printed.
h. It shall be possible to email reports to nominated people or groups of people.
i. Report formats shall be able to be saved for future use.
j. The central control shall have a "printer spooler" so that reports can be printed at any network-supported printers connected to the system.
k. The central control shall have a printer queue facility to enable reports to be queued if the target printer is off-line, busy, not connected, or faulty.
l. The central control shall be able to produce voltage reports for electrified fencing perimeter security voltage monitoring.
m. Visitor management reporting shall provide reports as follows:
    - Visitor status (expected, on site, departed).
    - Planned visits.
    - Past visits (who visited who, who escorted a visitor).

A18.23 COMMUNICATIONS & DIAGNOSTICS

a. The central control shall automatically restart full and complete processing after a power failure.

b. The central control shall provide a full diagnostic performance log to enable system engineers to monitor system performance in the event of a system malfunction.
c. The diagnostic performance log shall be stored in a separate file on hard disk from all other data files.
d. The diagnostic performance must be available without shutting down or "freezing the system".
e. The central control shall provide on-line system diagnostic facilities which enable authorised operators or systems engineers to monitor and then tune the system performance (communications network performance tuning, for example).

A18.24 SYSTEM SERVERS AND WORKSTATION HARDWARE

a. The server and workstation equipment shall support the Microsoft Windows environment as described in this section.
b. The server installation shall support 64-bit operating system.
c. The operating system used by the system server shall be either:

- Microsoft Windows 2008 Server.
- Microsoft Windows 2008 Server R2 (64 bit only)
- Microsoft Windows 7 Professional/Ultimate (64 bit)

d. A Microsoft SQL Server shall be used as the database engine for the system. The system server shall be either:

- Microsoft SQL2005, 2008 or 2008R2 Server.
- Microsoft SQL 2005 or 2008 Express Edition

e. Workstations shall support multi-monitor operation, allowing an operator to set up one or more monitors for each workstation.
f. Where a workstation is configured for a lower resolution, dragging the view onto a higher resolution monitor shall cause the view to resize, taking advantage of the higher resolution.
g. Manual Deployment using installation media shall also be supported.
h. It shall be possible for an operator to run a workstation solely from files stored on and run from a USB memory device and without requiring any pre-installation of software on the PC.

A18.25 SUBMITTALS

A18.25.1 DRAWING, OPERATING AND MAINTENANCE INSTRUCTIONS

a. Two copies of a fully detailed and dimensioned drawing of the recommended locations and positions for each Access control point and location.
b. Two copies of a dimensioned outline drawing of the system architecture and topology.
c. One paper copy and one electronic copy of the schematic wiring diagram of access control point and connection.

A18.25.2 INSTALLATION ARRANGEMENT

Installation arrangement for Access Control system:

a. In Security Control Room.
b. Throughout Facility

A18.25.3 PRE-DELIVERY INFORMATION

Within four weeks of receipt of the purchase order, the tenderer shall submit for the engineer's review, comment, and approve the following:

a. Finalised schematic diagram and dimension drawings
b. Operating characteristics of the Access Control system and equipment.
c. Shipping/ transport details.

A18.26 CONSTRUCTION OF X RAY INSPECTION UNIT

Refer to Part B: Particular Specification

A19. WALK THROUGH METAL DETECTOR UNIT

A19.1 QUALITY ASSURANCE

A19.1.1 CODES AND STANDARDS

The supply, delivery and installation of WALK-THROUGH METAL DETECTOR UNIT system and equipment shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards. The latest issue of the SANS codes will be applicable:

a. The Occupational Health and Safety Act, Act No 85 of 1993.
b. The Minerals Act, Act No 50 of 1991, which includes the Mines and Works Regulations.
c. The local Municipal by-laws and regulations as well as the regulations of the local Supply Authority.
d. The local Fire Regulations.
e. The National Building Regulations and Building Standards Act including the Code of Practice for the Application of the Regulations, SANS 10400.
f. Hazardous Substances Act (Act 15 of 1973)

A19.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

a. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
b. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A19.1.3 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A19.2 CONSTRUCTION OF WALK-THROUGH METAL DETECTOR UNIT

Refer to Part B: Particular Specification

A20. AUDIO & VISUAL

A20.1 QUALITY ASSURANCE

A20.1.1 CODES AND STANDARDS

The supply, delivery and installation of AUDIO-VISUAL system and equipment shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards. The latest issue of the SANS codes will be applicable:

g. The Occupational Health and Safety Act, Act No 85 of 1993.
h. The Minerals Act, Act No 50 of 1991, which includes the Mines and Works Regulations.
i. The local Municipal by-laws and regulations as well as the regulations of the local Supply Authority.
j. The local Fire Regulations.
k. The National Building Regulations and Building Standards Act including the Code of Practice for the Application of the Regulations, SANS 10400.
l. Hazardous Substances Act (Act 15 of 1973)

A20.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

c. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
d. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A20.1.3 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A20.2 CONSTRUCTION OF AUDIO-VISUAL SYSTEM

Refer to Part B: Particular Specification

A21. BUILDING MANAGEMENT SYSTEM

A21.1 QUALITY ASSURANCE

A21.1.1 CODES AND STANDARDS

The supply, delivery, and installation of BMS system and equipment shall comply fully with the applicable SANS specifications as set out below and all equipment shall bear the mark of approval of the South African Bureau of Standards. The latest issue of the SANS codes will be applicable:

m. The Occupational Health and Safety Act, Act No 85 of 1993.
n. The Minerals Act, Act No 50 of 1991, which includes the Mines and Works Regulations.
o. The local Municipal by-laws and regulations as well as the regulations of the local Supply Authority.
p. The local Fire Regulations.
q. The National Building Regulations and Building Standards Act including the Code of Practice for the Application of the Regulations, SANS 10400.
r. Hazardous Substances Act (Act 15 of 1973)

A21.1.2 MANUFACTURERS

If they comply with these specifications and requirements, products of the following manufacturers will be acceptable:

e. The manufacturer must be an ISO9001 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.
f. Products must carry the SABS mark or an international certification and approved for use in South Africa.

A21.1.3 INSTALLERS

Installers must be certified or registered installers of the manufacturers or their representatives. Manufacturers or their representatives must also have registered offices in South Africa and the local office must carry sufficient stock and spare parts for the project.

A21.2 CONSTRUCTION OF BUILDING MANAGEMENT SYSTEM

Refer to Part B: Particular Specification

A22. TESTING

A22.1 INSTALLATION TESTS

a. Tests as stipulated in the " Occupational Health and Safety Act no. 85 of 1993, as amended, and in the "Code of Practice for the Wiring of Premises" SANS 10142 (as amended), must be done. Test report forms must be filled in fully and correctly in ink, signed by the installation electrician and handed to the Engineer or its representative.
b. Tests must be conducted on site after the whole installation is complete unless the Engineer grants written permission to the contrary. The tests must include a full-load test for an adequate period to ensure the satisfactory working of the installation. If negative test results are obtained, faults must be rectified, and tests again done.
c. The contractor must supply all testing apparatus, correctly calibrated.

d. All tests shall be carried out in conjunction with and to the satisfaction of the Supply Authority and in the presence of the Engineer or his representative. The contractor shall make all arrangements for testing and inspection, the costs thereof being included in the Tender Price.
e. Each length of cable shall be tested for insulation and polarity by means of a 1000 Volt Megger designed for that purpose. In the case of underground cables this shall be done before back filling. In addition, the earth-loop impedance of each conductor earth electrode shall be measured. The earth resistance shall be tested by means of an approved instrument.
f. "Danger" notices shall be displayed at remote ends of cables under test.
g. The contractor shall ensure that the installation is completed in every respect and that there are no major defects prior to notifying the Engineer (in writing) for a first delivery inspection. The Engineer will accept zero minor defects during the final inspection. Should the number of defects be exceeded at the final inspection then the Engineer will terminate that inspection and request that the contractor arrange an additional final inspection.

A22.2 SUBMITTALS

Submittals shall include, but not be limited to, the following:

a. Three (3) copies of certified test results for each test indicated herein, for approval and future references.
b. Certifications as required herein.
c. Additional information as required in the specifications.

A22.3 CONDUCTOR TESTS (600 VOLTS OR LESS)

a. Prior to energizing of all new feeders, test all conductors for continuity of circuitry and for short circuits. No submittal is required for this test. Each wiring system with devices connected must test free from short circuits and grounds.
b. Each new feeder conductor shall have its insulation resistance tested after its installation is completed except for connection at its source and point of termination.
c. Test shall be made using a Megger or equivalent at a voltage of not less than 1000 VDC, and after one minute of operation at slip speed. Resistance shall be measured by connecting one terminal of the megger to the conductor and other terminal to earth. Reading shall be observed after 15 seconds of operation of the megger.
d. Conductors which do not meet or exceed the following insulation resistance values shall be removed, replaced, and retested.
e. Conductor test results shall indicate weather conditions, temperature, relative humidity, date and time, feeder tested, conductor size and type and resistance measurements.

A22.4 SERVICE SWITCHBOARD EARTH RESISTANCE TEST

a. Perform an earth resistance test on the switchboard earthing system for comparison of future inspection and testing data by the Owner. Overall system resistance shall not exceed 25 ohms. Eliminate any stray currents, shorts, or non-consistencies in the grounds system.
b. The test shall be performed using a Megger Earth Tester or equivalent test instrument and shall not be performed immediately following wet weather conditions.
c. Switchboard earth resistance test results shall indicate weather conditions for test, earthing system tested, earthing configuration and test results.

A22.5 EARTH FAULT PROTECTION SYSTEM TESTS

A. <u>Factory test</u>
   a. The switchboard ground fault protection system shall be factory tested prior to shipment.
   b. The switchboard manufacturer shall provide factory ground fault interlocking and protection system test for circuit testing, and verification of interlocking and tripping characteristics. The manufacturer shall pass predetermined values of current through the relay sensors, and measure the relay tripping time for each phase, and neutral. The measured time/current relationships shall be compared to the relay trip characteristics curves. If the

relay trips outside the range of values indicated on the curve, the relay shall be replaced. This test shall include verification of polarity of the ground sensor circuits' interconnection.
c. Certified "factory test" results shall indicate relay number, device served, actual characteristic curves, design characteristic curves and overall test results.

B. Field test
a. Following completion of the construction and prior to final acceptance testing, the earth fault protection system shall be field tested and reset to the manufacturer's recommended setting for both time and current, by a representative of the Manufacturer. The field test shall be conducted in a similar manner to the factory test in that a cable from a low voltage, high-current test set shall be passed through each current sensor. This test shall also demonstrate the complete system reliability in that it must operate the associated shunt trips and show that the overcurrent devices which they operate will actually open.
b. Certified "field test" results shall indicate relay tested, relay settings, and test results.

A22.6 GENERATOR SYSTEM TESTS

a. Upon completion of installation of the electric generating system and after the building normal power source has been energized, test the package electric generating system to demonstrate standby capability and compliance with specified requirements, including automatic start-up, controls, full load acceptance, and automatic shut-down.
b. Tests shall include operation of the standby electric power system with voltage check while the system is operating to ensure proper operation of the generator, transfer switches, and other system components.
c. Operation of the system shall simulate standby power conditions, that is, a simulated loss of main electrical power to the building with sufficient load available in the building systems or through the use of a portable load bank to sufficiently demonstrate packaged electric generating system. Test period shall be minimum of 2 hours continuous trouble-free operation with at least 4 automatic transfer switch operations (each switch) within the period of operation.
d. Refer to the relevant specification for additional generator systems tests.

A22.7 SPECIAL TESTING

Certify in writing that the system operation is in accordance with specifications and code requirements.

A22.8 BALANCING OF ELECTRICAL CIRCUITS

a. The system of feeder and branch circuits for power and lighting shall be connected to distribution board busbars in such a manner that loads connected thereto will be balanced on all phases as close as practicable.
b. Should there be any unfavourable condition of unbalance on any part of the electrical system, the electrical contractor shall make such changes that may be necessary to remedy the unbalanced condition.
c. Prior to completion of the project, provide a complete list of all panels stating the measured loads on each phase. Test results shall indicate panels tested, amperage per phase, and any remedial action taken.

A22.9 OPERATIONAL TESTING

a. Take voltage and currents readings for each feeder and motor circuit under maximum operating conditions. Questionable readings shall be repeated at no cost for confirmation.
b. Controls for lighting and receptacle circuits shall be demonstrated.
c. Demonstrate running of motors with controls and interlocks.
d. Demonstrate operation of electrical equipment appliances.

A22.10 CABLES

a. Each cable shall be tested after installation in accordance with SANS 1507 (up to 1kV) and SANS 97 (up to 11kV) as well as the requirements of the local and supply authorities.

b. LV cables shall be tested by means of a suitable megger at 1kV and the insulation resistance shall be tabulated and certified.
c. MV cables shall be pressure tested in accordance with the manufacturer's recommendations and exact leakage current shall be tabulated and certified.
d. The contractor shall make all arrangements, pay all fees and provide all equipment for these tests. The cost of testing shall have been included in the tender price.
e. The contractor shall notify the Engineer and if applicable the Supply Authority timeously so that their representative may witness the tests.
f. On completion of the tests on any cable, the contractor shall without delay submit three (3) copies of the certified test results to the Engineer.
g. The contractor shall provide all the testing equipment as required for the respective tests.

A22.11 DENSITY OF BEDDING AND BACK FILL MATERIAL

a. The Engineer may demand a density test to determine the grade of density at the bottom layer of the trench and of the approved back fill material.
b. If the density is lower than specified the Engineer may demand the removal of the material, replacing of the bottom layer or the back fill material with the same or other material, and the re-compaction, on the contractor's own expense.

A22.12 ELECTRICAL TESTS

a. Every part of the cable network between CDU's and substations must be tested for electrical continuity and for insulation resistance. Acceptance tests must consist of the following.
   - Phase identification test
b. A test must be done to determine if the connections between the end points are correct. All cables must be phased out before connected to the switchgear.
   - Insulation resistance test (Low voltage cables)
c. The resistance of the insulation of every core to earth and to every other core must be determined. These tests must be done with a 2 000 V insulation resistance tester on paper and PVC insulated cables.

PART B: PARTICULAR SPECIFICATIONS

B1. OVERVIEW OF SCOPE OF WORKS

The Work to be performed under this Contract is in connection with the construction and erection of the electrical and electronic installation at **King Dinizulu Highway, Thulasizwe Hospital, Ulundi, Kwazulu-Natal**, on behalf of **KZN Department of Health**.

Work Included: The Work includes, but is not limited to, the supply installation and commissioning of material and equipment associated with the following systems, equipment, and services:

A. ELECTRICAL SYSTEM
   a. Electrical service provisions, LV distribution network, LV equipment, distribution boards and small power.
   b. Conduits and boxes in slabs on or below grade, inaccessible space below slabs above grade, and walls below grade, in cooperation with other trades.
   c. Earthing and Lightning protection system.
   d. A system of empty conduits and other provisions as required for installation of the telephone, data, fire alarm and security systems.

B. LIGHTING SYSTEM
   a. Interior lighting, emergency lighting, area lighting
   b. Security Lighting
   c. Testing and commissioning of the full electrical system
      EMERGENCY GENERATOR SET
      a. Outdoor Emergency Generator Set
      b. Automatic Changeover system

C. INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) SYSTEM
   a. Manholes and sleeves
   b. ICT Infrastructure, hardware, and support
   c. Network security
   d. Connectivity

D. SECURITY SYSTEM
   a. CCTV System
   b. Access Control System

B2. SITE AND SYSTEM CONDITIONS

A. Site Conditions

Altitude: above	The altitude in the area varies between 480 m and 1600 m mean sea level.
Temperature:	Ambient temperature between 5ºC and 44ºC.
	Average daily maximum ambient: 30ºC.
Humidity:	Maximum – 100 %
	Average – 80 %
Rainfall:	Approximately 900 mm per annum. An average of 2 – 3 working days per month is lost due to inclement weather. No claims for delays because of adverse weather conditions will be considered.
Lightning:	The area is subject to severe lightning storms, approximately 4, 5 flashes/km²/year.

Pollution:	MEDIUM. Inland
Wind:	Design wind speed of 108 km/h (700 pa).
Mean annual value of solar radiation:	1,0 kW/m2

B. Electricity Supply System

- The nominal system voltage in the Ulundi area is 11 kV, 400 V three phase and 230 V single phase.
- The maximum MV system voltage is 12,5 kV.
- The system frequency is 50 Hertz, and the phase rotation is R-W-B anti-clockwise.

B3. DETAILED SCOPE OF WORK

The works is further described below and provides information of the various items described as part of the Scope of Works

A. Provision for Transformer from Eskom Utility Power Supply
   a. Connection of Main Incoming Electricity supply from the 315Kva Transformer Eskom Supply(pending the approval of the application by Eskom).

B. Power, Data & Telephone Infrastructure
   a. Internal Power infrastructure.
   b. Data & Telephone infrastructure. First Fix to Final Fix.

C. Lighting Infrastructure
   a. Internal Lighting infrastructure,
   b. External Lighting infrastructure

D. Security & Access Control
   a. Internal & Site Access Control infrastructure. First Fix to Final Fix.

E. CCTV
   a. Internal & Site CCTV infrastructure. First Fix to Final Fix.
   a.

F. Power Distribution
   a. Distribution of power throughout the site as required.

G. Power Distribution
   a. Distribution of power throughout the Clinic lighting purposes.

H. Earthing & Lightening Protection
   a. Provided Earthing & Lightening infrastructure within the site.

I. Emergency Standby Power
   b. Provided Generator Unit for back up to mains supply.

B4. DRAWING SCHEDULE

The following drawings are part of the tender and should be priced accordingly.

Drawing Number	DRAWING DESCRIPTION	REVISION
DNA-TC-ELE-PL-1000-00	SITE PLAN LAYOUT	C
DNA-TC-ELE-PL-1001-00	POWER LAYOUT	C
DNA-TC-ELE-PL-1002-00	LIGHTING LAYOUT	C
DNA-TC-ELE-PL-1003-00	WIREWAY LAYOUT	C
DNA-TC-ELE-PL-1004-00	EARTHING AND LIGHTNING PROTECTION LAYOUT	C
DNA-TC-ELE-PL-1005-00	SECURITY AND ACCESS CONTROL LAYOUT	C
DNA-TC-ELE-PL-1006-00	NURSE CALL AND BED-HEAD UNIT LAYOUT	C
DNA-TC-ELE-PL-1007-00	SOLAR PV LAYOUT	C
DNA-TC-ELE-PL-1008-00	POWER, EARTHING AND LIGHTING RESIDENTIAL PLAN LAYOUT	C
DNA-TC-ELE-PL-1009-00	ELECTRICAL SCHEMATIC	C
DNA-TC-ELE-PL-1010-00	ELECTRICAL DETAILS LAYOUT	C

B5. MEASUREMENT AND PAYMENT PRINCIPLES

a. The basic principles of measurement and payment for cable trench excavations is that the rate tendered for excavations covers the cost of excavations, the re-use of excavated material for back filling and the removal of all surplus material along the trench routes within 0,46 km from the source.
b. The rate for the laying of the cable covers the cost of the handling and placing of the cable in the approved trench, as well as any other costs concerning the laying of the cables.
c. Trench excavations for cables, etc. is measured volume wise, but can be measured according to length.
d. Except when differently stated in the project specification or differently demanded, the depth will be measured from the ground level, along the centre line of the trench, down to the bottom of the specified bottom layer. The ground level is that which was formed after mass ground works was completed, measuring the excavated level or the backfilled level, except where another execution sequence is demanded.
e. The source of the approved back fill material and the bottom layer is the contractor's own responsibility. He is free to use approved material excavated from the side of the trench or other excavations on site, providing such material meats the applicable requirements. He is

also free to buy one or both the materials from commercial sources or to excavate along the cable route at his own cost.

f. Additional and separate payment for the backfill of over-excavations and the removal of surplus materials or any other unforeseen works will only be made if such works was specified by the Engineer.
g. The requirements of sub clause 8.3.3 of SANS 1200 DA apply to additional transport distances. All additional distances will be measured only via the shortest route possible and only in one direction to the nearest 0,1 km measured and the volumes will be calculated as specified in 8.2.3.

B6. CALCULATION OF QUANTITIES

a. The length used for calculations is the total length of the cable, cable trench, etc from one end to the other or from one structure face to the next structure face. No deductions will be made for any manholes, etc.
b. Excavations will be measured as if excavated with vertical sides, regardless of whether it was excavated with sloping sides.
c. If volumetric measurements are required, the volume will be measured from the depths shown on the drawings or to the bottom of the specified base, whichever is the largest, and a minimum base width of 450mm in the case of high voltage cables and 300mm in the case of low voltage cables.
d. The volume of the backfill will be calculated from the minimum base with of the trench and the depth of the backfill needed. No allowance shall be made for loss of volume of the compacted material.
e. Imported material as per b. must be disposed of along the cable servitude within a distance of 50m from the source unless specified otherwise by the project specifications. Additional transport of material if ordered must be handled as specified in sub clause 8.3.3.4 of SANS 1200 DB. Free haul as specified in sub clause 5.2.6.1 of SANS 1200 DA shall be applied.

Specifications for 30 kVA 3:1 220 VDC UPS

		6 pulses			12 pulses		
Input	Voltage (V)	380 V	400 V	415 V	380 V	400 V	415 V
	Connections	L1, L2, L3, PE[5]					
	Input voltage range (V)	304-456					
	Frequency (Hz)	45-55					
	Nominal input current (A)	58	55	53	59	56	54
	Maximum input current (A)	73	69	67	73	70	67
	Input current limitation (A)	100					
	Total harmonic distortion (THDI)[6]	6 pulses ≤15%			12 pulses ≤10%		
	Input power factor[6]	≥0.9					
	Maximum short circuit rating	Icc=10 kA					
	Protection	Breaker					
	Ramp-in	15 seconds					
Bypass	Voltage (V)	220 V	230 V	240 V	220 V	230 V	240 V
	Connections	L, N, PE					
	Overload capacity	110% continuous; 125% for 10 minutes; 150% for 1 minute					
	Bypass voltage range (V)	165-275					
	Frequency (Hz)	50					
	Nominal bypass current (A)	136	130	125	136	130	125
	Nominal neutral current (A)	136	130	125	136	130	125
	Maximum short circuit rating	Icc=10 kA					
Output	Voltage (V)	220 V	230 V	240 V	220 V	230 V	240 V
	Connections	L, N, PE					
	Overload capacity	110% continuous; 125% for 10 minutes; 150% for 1 minute					
	Output voltage regulation	± 1%					
	Dynamic load response	20 milliseconds					
	Output power factor	0.8					
	Nominal output current (A)	136	130	125	136	130	125
	Total harmonic distortion (THDU)	<2% at 100% linear load; <4% at 100% non-linear load					
	Output frequency (Hz)	50 ± 1%					
	Output short-circuit current at 60 ms (A)	408					
	Output performance classification (according to IEC/ EN62040-3)	VFI-SS-111					

TECHNICAL SPECIFICATIONS – UPS-13, UPS-14	
Design	The UPS units shall be designed to: SANS 62040 / IEC 62040: Uninterruptible power systems (UPS): Part 1: General and safety requirements for UPS Part 2: Electromagnetic compatibility (EMC) requirements Part 3: Method of specifying the performance and test requirements. SANS 60950 / IEC 60950: Information technology equipment - Safety Part 1: General requirements The UPS manufacturer must be an ISO9001 2000 certified company. Proof of certification is to be submitted together with the tender document, failing which the tender may be disregarded.

B7. VIDEO SURVEILLANCE SYSTEM (CCTV) TECHNICAL SPECIFICATIONS

A. HIGH-DEFINITION NETWORK SURVEILLANCE CAMERAS
TECHNICAL SPECIFICATIONS:

The camera is a DOME-TYPE and FIXED-TYPE Camera of 2.0 Megapixels and shall meet or exceed the following design and performance specifications.

- Image Sensor:1/3” progressive scan CMOS
- Active Pixels:1280 (H) x 720 (V)
- Imaging Area:4.1 mm (H) x 2.3 mm (V)
- Minimum Illumination: 0.2 lux in colour mode

0.02 lux in monochrome mode

- Dynamic Range: 61 dB
- Lens: 3-9mm vari-focal
- Image Compression: H.264
- Image Rate:39 @ full resolution
- Resolution Windowing: Down to 640 x 480 window
- Motion Detection: Selectable sensitivity and threshold
- Electronic Shutter: Automatic, Manual (2 to 1/30,000 sec)
- Iris Control: Automatic, Manual
- Day/Night Control: Automatic, Manual
- IR Illuminator: 850 nm wavelength, 15 m (50 ft) range
- Flicker Control:50 Hz, 60 Hz
- White Balance: Automatic, Manual
- Backlight Compensation: Automatic
- Privacy Zones: Up to 4 zones
- Audio Compression Method: G.711 PCM 8 khz
- Audio Input: External 3.5 mm microphone input
- I/O Terminals: Alarm In, Alarm Out; terminal strip
- Serial Communications:RS-485; terminal strip
- Including NVR Software Licencing each

Electrical Specifications:

- Power Source: PoE: IEEE 802.3af Class 3 compliant

  24 VAC, 12-24 VDC

- Power Consumption:6 W

  + 5.5 W with heater

+ 3.5 W with IR illuminator

- Power Connector:2 pin terminal strips

B. MULTI-MEGAPIXEL NETWORK VIDEO RECORDERS (NVR)
TECHNICAL SPECIFICATIONS

- Recording Rate: Up to 320MB/s
- Camera Channels: Up to 64
- Recording Image Rate: Up to 30 ips per channel + total 1920ips for 64 channels
- Local Viewing: No
- Operating System: Microsoft Windows 10 Professional 64-Bit
- Hard Drive Configuration: 8 x SATA HDD/SSD, hot-swappable, RAID 10 and N+1

- Recording Storage Capacity: Up to 8x16TB effective
- Network Interface: 2 Gigabit Ethernet RJ-45 ports (1000Base-T)
- Video Outputs: 2xVGA, 2xHDMI
- Optical Drive: 1 DVD-ROM
- Form Factor: 2U 19” Rack
- Power Supply: Single hot-swappable, dual-redundant optional
- Power consumption: Max 600 W

C. MULTI-MEGAPIXEL NETWORK VIDEO MANAGEMENT SOFTWARE (NVMS)

TECHNICAL SPECIFICATION

a. The Network Video Management Software (NVMS) shall be a software solution that shall be scalable from one client, server, and camera to an unlimited number of clients, servers, and cameras.
b. The Network Video Management Software (NVMS) shall consist of server software applications and client software applications.
c. The Network Video Management Software (NVMS) shall support High-Definition Stream Management (HDSM) architecture which includes:

   - Support for industry standard JPEG2000, MJPEG, MPEG-4, and H.264 compression formats
   - Support for reducing the required client bandwidth and processing power by only transmitting what is necessary to view the video stream at full quality (e.g., if a user is viewing a 5MP camera in a 1MP window then a 1MP representation of the 5MP image shall be transmitted).

d. The Network Video Management Software (NVMS) shall support live viewing, recording and management of video and audio sources including:

   - Composite video from analog cameras, PTZ domes and thermal imagers via analog encoder
   - IP Devices
   - All ONVIF Cameras

e. The Network Video Management Software (NVMS) shall digitally sign recorded video and audio using 256-bit encryption so video can be authenticated for evidentiary purposes.
f. The Network Video Management Software (NVMS) shall support integration with other international platforms for Electronic Access Control and Alarm Monitoring (Access System).

   - Network Video Management Software (NVMS) will provide the mechanism by which individual alarm(s) from the Access system can be pre-selected and configured to be monitored and, in turn, trigger event driven video operations.
   - The Network Video Management Software shall support software level integration for facilitating real-time response to monitored events processed by alarm events. The API integration should include:
     - Bi-directional alarm event processing for monitoring and acknowledgement
     - Receiving card access activity events
     - Receiving digital input events
     - Receiving intrusion zone events
   - Occurrences for “Alarm” and “Reset” conditions for each of the pre-selected Access system alarms will be processed and managed from the NVMS system’s Live View workspace that is reserved for displaying alarm notifications in the alarm list message pane or from the alarm viewer. If the Alarm pane is hidden, the alarm can be acknowledged from the Camera display tile.
   - Once an Access system-initiated alarm occurrence is acknowledged from the NVMS system, it should be automatically acknowledged and processed in the Access System alarm monitor queue without further operator intervention.

g. The Network Video Management Software (NVMS) shall be capable of being upgraded from one version to another without having to uninstall the previous version. The system shall automatically detect and upgrade new software.

h. The Network Video Management Software (NVMS) shall allow system administration, and live and recorded video and audio monitoring all from a single client application that can be located anywhere on the network.

- record video and audio streams based on a recording schedule that can be defined individually for each video source. The schedule shall be created with the following parameters:
  - Recording Mode
    - ∅ Continuous
    - ∅ Motion
    - ∅ Digital Inputs
    - ∅ Alarms
    - ∅ POS Transactions
    - ∅ License Plates
  - Time and Date Settings
    - ∅ Daily
    - ∅ Weekly
- the ability to reduce the image rate of recorded video over time as a means of increasing record time. The image rate shall be able to be reduced.
- The Network Video Management Software (NVMS) shall authenticate users before granting access to the system. Access rights for each user shall be able to be defined individually for each user.
- The Network Video Management Software (NVMS) shall maintain an event log for the following events:
  - User Events
  - Device Events
  - Server Events
- The Network Video Management Software (NVMS) shall have the capability to execute any of the following actions in response to any of the events listed above:
  - User Notification Actions
    - ∅ Display on-screen message.
    - ∅ Send an email.
    - ∅ Send an SMS or MMS
    - ∅ Play a sound.
  - Monitoring Actions
    - ∅ Start live-streaming video.
  - Device Actions
    - ∅ Reboot camera
    - ∅ Trigger digital output.
  - PTZ Actions
    - ∅ Go to preset.
    - ∅ Run a pattern.
    - ∅ Set auxiliary.
    - ∅ Clear auxiliary
  - Alarm actions
    - ∅ Trigger an alarm.
    - ∅ Acknowledge an alarm.

i. The Network Video Management Software (NVMS) shall provide:

- a maintenance log and audit trail of all system errors and events.
- the ability to define a region of an image where license plate detection is performed. Detected license plates shall be stored along with the video data.
- support a wide range of PTZ camera protocols.
- the ability to change the equipment and network settings for a video and audio source.
- the ability to control the system using a PC keyboard or joystick.
- the ability to import and export client settings such as maps, views, and web pages.

j. The Network Video Management Software (NVMS) shall:

- support live or recorded video monitoring of video streams simultaneously on a single monitor.
- support the ability to display the following list of image overlays:
  - Camera Name
  - Camera Location
  - Timestamp
  - Record Indicator
  - PTZ Controls
  - Motion Activity
  - License Plate
- support an unlimited number of monitors for monitoring video and audio streams.
- support monitoring live and recorded video and audio streams simultaneously on the same monitor.
- support controlling mechanical pan-tilt-zoom, iris, and focus as well as setting presets and patterns.
- synchronously playback recorded video and audio from selected video sources.
- support the ability to assign alarms to users and acknowledge alarms.
- support searching through recorded video and audio based on various search criteria including time, date, video source, license plates and events.
- support the ability to export recorded video in the following formats:
  - Native
  - JPEG
  - PNG
  - TIFF
  - AVI
  - WAV
  - PDF
  - Print

D. HIGH-DEFINITION MONITORS

TECHNICAL SPECIFICATIONS

- Diagonal Screen Size: 43”
- Type: 60Hz LED BLU
- Resolution: 1920 x 1080p
- Aspect Ratio:9
- Viewing Angle: 170°/160°
- Brightness: 250 cd/m²
- Contrast Ratio: 1000:1
- Response Time: 2ms
- Input: Display Port / DVI to suite RMWS
- Mounting: Desktop Tilt

B8. POWER-OVER-ETHERNET NETWORK SWITCHES

A. POWER OVER-ETHERNET NETWORK SWITCHES

TECHNICAL SPECIFICATIONS

- 8 10/100/1000 Ethernet ports
- 2 Small Form-Factor Pluggable (SFP) slots (shared with 2 copper ports) for fibre Gigabit Ethernet uplink
- IEEE 802.3af PoE delivered over any of the 8 10/100/1000 RJ-45 copper ports
- Up to 15.4W available on the copper ports for powering POE-enabled IP-cameras, with a maximum per-device POE delivery of 185W available for all ports
- Dual images for resilient firmware upgrades
- 48-Gbps, non-blocking, store-and-forward switching capacity

- Simplified QoS management using 802.1p, Differentiated Services (Diff Serv), or type of service (ToS) traffic prioritization specifications
- Fully resilient stacking for optimized growth with simplified management
- ACLs for granular security and QoS implementation
- Can be configured and monitored from a standard web browser
- Secure remote management of the switch via Secure Shell (SSH) and SSL encryption
- 802.1Q-based VLANs enable segmentation of networks for improved performance and security
- Private VLAN Edge (PVE) for simplified network isolation of guest connections or autonomous networks
- Automatic configuration of VLANs across multiple switches through Generic VLAN Registration Protocol
- (GVRP) and Generic Attribute Registration Protocol (GARP)
- User/network port-level security via 802.1X authentication and MAC-based filtering
- Increased bandwidth and added link redundancy with Link Aggregation Control Protocol (LACP)
- Enhanced rate-limiting capabilities, including back pressure and multicast and broadcast flood control
- Port mirroring for non-invasive monitoring of switch traffic
- Jumbo frames support up to 10KB
- Simple Network Management Protocol (SNMP) versions 1, 2c, and 3 and Remote Monitoring (RMON)support
- Including Class 2/3 Surge protection Built in.

Fully rack mountable including rack-mounting hardware

B9. GENERATOR SCHEDULE OF TECHNICAL SPECIFICATIONS

A. General

Supply, deliver, install, commission, test and maintain an emergency generating set at, Thulasizwe Hospital, Ulundi, Kwazulu-Natal.

This installation must comply fully with all the sections and drawings of this document. This technical specification is supplementary to the Equipment Requirements, General Specifications, and must be read together where they are at variance the Technical Specification shall apply.

Supply, delivery, installation and commissioning of the complete outdoor emergency generator set inside an IP65 canopy/container on a concrete plinth as specified in this document and indicated on the drawings.

Concrete plinth to be provided by other as per drawing: DNA-TC-ELE-DE-1010-00

The surface of the concrete plinth shall be 50mm higher than the existing ground level. The thickness and strength of the plinth shall be designed by the consulting engineer and are detailed on the drawings.

A tap to be provided to drain all the water that accumulates inside the bund wall. Final position of the tap will be determined on site. It is the engineer's responsibility to ensure plinth design complies with generator dimensions and weights. The bund wall shall contain 110% of the fuel, oil and water capacity of the generator. The bund wall shall not constrain the canopy doors from opening completely.

The contractor shall install an earthing system in the concrete plinth. The contractor shall install two (2) earth studs 1.8 meters long on opposite corners of the concrete plinth into the ground. The earth studs shall be connected by means of a 70mm2 bare copper earth wire to the main earth bar in the control panel. The earth conductor shall be connected to the earth bar, canopy, bass, skid and earth bar by means of suitably crimping lugs and brass bolts.

B. Site Information and Conditions

a. Location

The site is at King Dinizulu Highway, Thulasizwe

GPS co-ordinates: 31.36785717 | -37.9526937

b. Site Conditions

The following site conditions will be applicable, and equipment shall be suitably rated to develop their assigned rating and duty at these conditions.

a) Height above sea level : 1600m Meters
b) Maximum ambient temperature : 45 °C
c) Maximum ambient humidity at lowest temperature : 100%

C. Output and Voltage

After the de-rating factors for the engine and generator due to site conditions have been considered, the set must have a site output and voltage as follows: -

No load voltage	:400/230 Volt
Rating	:260kVA
Power at 0.9 power factor	:234kW
Frequency	:50Hz
Fault Level	:16kA

D. Switchboard/Control Panel Unit

a. All switch- and control gear shall be rated for a fault current level of 16kA.
b. The switchboard/control panel unit shall be enclosed in the IP65 canopy/container.

E. Cables

a. The contractor will be responsible for all electrical cable connections associated with the complete generating set installation.
b. The following cables will be supplied, installed, and terminated at the Switchboard by others. Adequate provision shall be made for the termination of these cables at the Switchboard:
Fed to DB: MAIN-PANEL
Feeder Cable: (315Kva transformer pending approval by Supply Utility alternatively)1x240 mm² XLPE 4C Cu PVC SWA PVC from the existing Supply

F. Engine

a. A sump drainpipe must be fitted with a shut-off valve placed in a convenient position outside the base frame to facilitate drainage.
b. Recommended oil types must be indicated on the engine, or base frames, by means of suitable labels.
c. All engine instruments shall have clear markings on the faceplates, indicating the normal operating zone(s), maximum and minimum allowable values/limits and danger zone(s).
d. The flywheel shall be covered by approved hoods.

G. Alternator

a. The Alternator shall be of the low harmonic type.

H. Load Acceptance

a. The generator set shall be capable of accepting 75% of the specified site electrical output 10 seconds after the starter motor is energised and the remaining 25%, 5 seconds thereafter, i.e., 100% load acceptance shall not exceed 15 seconds.

I. Enclosure

The standby set is a free-standing unit and shall be mounted in an enclosure as detailed below: -

a. General

The enclosure, shall be completely vermin-proof, powder coated and shall be constructed of 3CR12 stainless steel or within 50km from the coast with grade 316 steel housing of a minimum thickness of ±1.5 mm.

The enclosure shall allow easy access to the engine, alternator, radiator filler cap and control cubicle for maintenance purposes.

The door shall be flush with the rest of the canopy and of the side opening type. A minimum of four doors are required i.e., two on either side.

The door hinges and locking bars shall be of a heavy-duty type and be manufactured of 3CR12 stainless steel or within 50km from the coast with grade 316 steel and shall be fitted with a grease nipple.

The doors and panels shall be suitably braced and stiffened to ensure rigidity and to prevent bending and warping.

Suitable door restraints shall be fitted to all the doors, enclosure including the control panel to prevent wind damage. The restraint shall consist of a steel rod in a steel groove or slide with a spring-loaded catch, which is to be manually reset to close the door.

No flexible restraints will be accepted.

The diesel fuel level indicator and alternator rating plate shall be clearly visible with the doors open.

Unless specified the silencers shall be mounted within the enclosure.

Perforated sheeting shall be fitted over all the insulating material inside the canopy of all soundproof sets.

Rubber seals on doors shall be equal to or similar to rubber pinch weld, wind lace.

b. Design

The enclosure shall be designed to be weather-proof and soundproofing as specified. Rivets or self-tapping screws will under no circumstances be allowed for fixing the various sections of the enclosure. Only cadmium coated nuts and bolts are acceptable.

c. Lamp fitting

A lamp fitting and it's associated on/off door switch shall be provided inside the enclosure for illumination of the control panel. The power for the lamp shall be obtained from the starter battery.

d. Soundproofing

The soundproofing on canopy engine sets shall be such that the maximum noise level generated by the set under any load condition shall not exceed 65 dB measured in any direction at a distance of 5m from the centre of the set with the doors closed.

The supply and discharge air paths will require separate attenuators on soundproof sets.

e. Padlock and keys

The contractor shall supply padlocks and keys for all the doors of the enclosure. The padlock shall be off the "Viro A82 keyed alike with stainless steel shackles" type.

Suitable brass metal plates shall be installed behind each lock for the protection of the enclosure against scratching or damaging, where the locks are hanging.

J. Alarms

a. The successful tenderer must pay particular attention to the requirements of the alarms as described in the General Specifications.
b. One alarm Siren and red light shall be supplied and installed on the outside of the generator container in a position as indicated by the Department's Representative.
c. The Siren shall consist of an electronic unit similar and equal to a "Klaxon" - type SY2/725 Siren with a continuously rated output and 110 dB at a distance of 2 metres and shall be IP55 weatherproof rated.
d. The warning light shall consist of a 40W flashing red light, which shall be mounted on a galvanised steel frame together with the Siren.
e. The Siren and light shall be switched on or off simultaneously after initiation or cancellation of an alarm condition. The supply and installation of the wiring between the control board and the alarm unit forms part of this contract.
f. The successful tenderer must ensure that the Siren control circuit resets automatically after cancellation due to a low fuel condition or battery charger failure, but the visible fault indication must remain, i.e., should the operator continue to run the set, the Siren must sound, should any other condition develop.
g. A remote alarm panel shall be supplied and installed by the contractor in the control room. This shall be of surface mounting, enamelled sheet metal (colour to approval), minimum depth construction, and shall incorporate a flashing red pilot alarm light, adjustable electronic sounder, and a silence push button. The silence button shall not switch off the pilot light - this shall only be switched off when the alarm is reset at the Generator Panel.
h. A cable will be supplied, installed and terminated by the electrical contractor between the Generator Panel and the Control room. The Generator Contractor shall connect, test and commission this cable at both ends and shall supply and install all switch gear relays, etc. to ensure satisfactory operation of the Remote Alarm Panel.

K. Remote Control Generator Switch

a. A Remote-Control Generator "ON/OFF/AUTO" switch will be supplied and installed by the generator contractor in the control room. The Cable link will be supplied and installed by the electrical contractor between the control room and the Generator Panel.
b. The generator contractor shall connect this cable at both ends, and shall supply and install all switch gear, relays, etc. to ensure satisfactory operation of the remote-control switch.

L. GENERATOR TECHNICAL SCHEDULE

ITEM	DESCRIPTION	DETAIL
1	Number required	1
2	Unit type	Emergency Standby Power
3	Engine type required	Diesel Powered
4	Unit rating (after de-rating)	250KVA Prime Power rated
5	Load bank	75KVA (10 Steps)
6	Voltage	400V, 50Hz, 3 Phase
7	Main Circuit Breaker	Yes, non-motorised
8	Type of connection	Standby
9	Indoor or Outdoor?	Outdoor in sound attenuated ISO container
10	Noise Levels	Per SANS 8528: <65dB @ 5m.
11	Number of phases	3
12	Rated frequency Hz	50Hz
13	Normal “ON LOAD” phase-to-phase voltages	LV: 400 Volts
14	Fuel Day Tank	Yes. Required in Base
15	Capacity of fuel Day tank	1000 litres
16	Fuel Pipes	To be Included from fuel tank to generator.
17	Weather louvers	Yes, Inlet and outlet
18	Exhaust Silencer	Yes
19	Sound attenuated enclosure	Yes
20	Ventilation	Yes. To be included within Canopy.
21	Alarms – local and control room	- Control Language, English - Warning - Low Battery Voltage - Warning - High Battery Voltage - Shutdown - Fail to Start

		- Shutdown - High AC voltage - Shutdown - Over/Under Voltage - Shutdown - Over/Under Speed - Warning & Shutdown – Engine temperature - Warning & Shutdown - Oil Pressure - Warning & Shutdown - Coolant Temperature - Warning & Shutdown – Fuel Level - Emergency Stop Switch – External - Display - Control LCD
21	Control system	Individual controller on generator.
22	Overall generator control system	1 x local + 1 x remote
23	Other items to be considered / included	- Alarm / Strobe light outside generator container. - Fuel level transmitter required on day tank to controller.
24	Other requirements	- To include, Delivery, installation, testing and commissioning - To include 12 months maintenance & Guarantee - Craneage to be provided for off-loading and placing in position.
25	Location for installation	Thulasizwe Ulundi, Kwazulu-Natal

M. Fuel Drip Tray
   a. A drip tray approximately 100mm deep shall be mounted below the generator and must be large enough to collect any fuel that drips from the generator fuel accessories. The drip tray shall be manufactured from black mild steel. The thickness of the drip tray sheet steel shall not be less than 2mm.

N. Completion Time
   a. The Generator Set is required to be commissioned in conjunction with the building contract.

O. Inform
   a. The successful tenderer shall inform the Engineer when the set is ready for Inspection & installation.

P. Fuel Supply Tank

a. The fuel tank shall be an integral part of the base frame of the generator set. The tank shall have sufficient capacity to run the engine on full load for a period of 24 hours. The base tank shall be an open channel self-bund walled type that shall be of sufficient capacity to contain a spillage equivalent to 110% in volume of the base tank. The containment tank shall be manufactured from black mild steel with a thickness of not less than 2mm.

b. A float level alarm connected to the generator controller shall be incorporated into the bund area located such that the alarm will be activated when 50% of the volume of the bund area has been reached in the event of any diesel fuel leakage.

Q. Tenderer's Schedules of Technical Information

The following Information is to be Fully Completed by the Tenderer:

a. Engine

NO	ITEM	REMARKS
1.	Manufacturer's Name	
2.	Country of Origin	
3.	Manufacturer's model No. and year of manufacture	
4.	Continuous sea level rating after allowing for ancillary equipment: a) In b.h.p. b) In kW	
5.	Percentage de-rating for site conditions, in accordance with SANS 8528 a) For altitude b) For temperature c) For humidity d) Total de-rating	
6.	Net output on site in kW	
7.	Nominal speed in r.p.m.	
8.	Number of cylinders	
9.	Strokes per working cycle	
10.	Stroke in mm	

NO	ITEM	REMARKS
11.	Cylinder bore in mm	
12.	Swept volume in cm^3	
13.	Mean piston speed in m/min	
14.	Compression ratio	
15.	Cyclic irregularity	
16.	Fuel consumption of the complete generating set on site in l/h of alternator output at: a) Full load b) ¾ load c) ½ load NOTE: A tolerance of 5% shall be allowed above the stated value of fuel consumption.	
17.	Make of fuel injection system.	
18.	Capacity of fuel tank in litres	
19.	Is gauge glass fitted to tank?	
20.	Is electric pump for filling the fuel tank included?	
21.	Method of starting	
22.	Voltage of starting system	
23.	Method of cooling	
24.	Type of radiator if water-cooled	
25.	Type of heater for warming cylinder heads	
26.	Capacity of heater in kW	
27.	Method of protection against high temperature	
28.	Method of protection against low oil pressure	
29.	Type of governor	
30.	Speed variation in %	

NO	ITEM	REMARKS
	a. Temporary b. Permanent	
31.	Minimum time required for as assumption of full load in seconds	
32.	Recommended interval in running hours for: a. Lubricating oil change b. Oil filter element change c. Decarbonising	
33.	Type of base	
34.	Can plant be placed on solid concrete floor?	
35.	Are all accessories and ducts included?	
36.	Is engine naturally aspirated?	
37.	Are performance curves attached?	
38.	Diameter of exhaust pipe	
39.	Noise level in plant room in dBA	N/A
40.	Noise level at tail of exhaust pipe in dBA	
41.	BMEP (4 stroke) at continuous rating (kPa)	
42.	% Load acceptance to SANS 8528, with 10% transient speed drop	

b. Alternator

NO	ITEM	REMARKS
1.	Maker’s name and model no.	
2.	Country of Origin and year of manufacture	
3.	Type of enclosure	
4.	Nominal speed in r.p.m.	
5.	Number of bearings	

NO	ITEM	REMARKS
6.	Terminal voltage	
7.	Sea level rating kVA at 0,9 power factor	
8.	De-rating for site conditions	
9.	Input required in kW	
10.	Method of excitation	
11.	Efficiency at 0,9 power factor and: a) Full load b) ¾ load c) ½ load	
12.	Maximum permanent voltage variation in %	
13.	Transient voltage dip on full load	
14.	Voltage recovery on full load application in milli-seconds	
15.	Is alternator brushless?	
16.	Class of insulation of windings	
17.	Is alternator tropicalised?	
18.	Symmetrical short circuit current at terminals n Ampere	
19.	Type of Coupling	

c. Switchboard

NO	ITEM	REMARKS
1.	Maker's Name	
2.	Country of Origin	
3.	Is board floor mounted?	
4.	Finish of board	
5.	Make of volt, amp, and frequency meters	

NO	ITEM	REMARKS
6.	Dial size of meters in mm	
7.	Scale range of voltmeter	
8.	Scale range of ammeters	
9.	Ration of current transformers	
10.	Make of hour meter	
11.	Range of cyclometer counter	
12.	Smallest unit shown on counter (Item 11)	
13.	Make of circuit breaker	
14.	Type of circuit breaker	
15.	Rating of circuit breaker in Amp and fault level in kA	
16.	Setting range of overload trips	
17.	Setting range of instantaneous trips	
18.	Make of change-over equipment	
19.	Make of voltage relay	
20.	Is control and protection equipment mounted on a small removable panel?	
21.	Type of control equipment	
22.	Make of mains isolator	
23.	Type of indicators for protective devices	
24.	Make of rectifier	
25.	Type of rectifier	
26.	Is battery charging	
27.	Are volt- and ammeters provided for charging circuit?	
28.	Is the alarm hooter of the continuous duty type?	
29.	Rating in Amps of: a. Change-over equipment	

NO	ITEM	REMARKS
	b. Mains on load isolator c. By-pass switch d. Circuit breaker to outgoing feed	
30.	Is manufacture of switchboard/control panel to be sub-let?	
31.	If yes, state name and address of specialist manufacturer	

d. Battery

NO	ITEM	REMARKS
1.	Maker's Name	
2.	Country of Origin	
3.	Type of battery	
4.	Voltage of battery	
5.	Number of cells	
6.	Capacity in cold crank amp	

e. Dimensions

NO	ITEM	REMARKS
1.	Overall dimensions of set-in mm	
2.	Overall mass	
3.	Is the canopy/container adequate for the installation of the set, switch board and fuel tank	

f. Deviation from the specification as an alternative (State Briefly)

Note: A Non-submission of this schedule or a Blank submission indicates the tenderer's intention to fully compliance with the specifications.

NO	DESCRIPTION

g. Spare Parts and Maintenance Facilities

NO	ITEM	REMARKS
1	Approximate value of spares carried in stock for this particular diesel engine and alternator	
2	Where are these spares held in stock	
3	What facilities exist for the servicing of the equipment offered	
4	Where are these facilities available	

B10. SOLAR PV SYSTEM

A Hybrid Solar PV System is required for the new Clinic facility as per comments received at

HIAC Stage 2. Following consultations with the client it was determined that the Solar PV System should be capable of supplementing the clinic's lighting load demand at a minimum. The total lighting loads within the clinic are calculated to be approximately 30kVA, 3-PHASE. A 20kWp, grid-tie, rooftop, solar PV system shall be designed to supplement the lighting loads within the clinic. This will require approximately 100m^2 of the available roof space at the clinic.

Please Refer to Drawing number DNA-TC-ELE-PL-1007-00 Solar PV System

A 40kWh Lithium-Ion Battery Energy Storage system has been provisioned for solar PV System providing a 2-hour back-up period for the lighting loads of the clinic

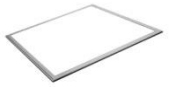
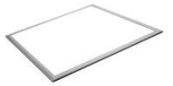
The specialist shall be appointed to do the full installation

Inverter Specification

Battery Input Data	
Battery Type	Lithium Battery
Battery Voltage Range (V)	160-180V
Max. Charging Current (A)	50+50
Max. Discharging Current (A)	50+50
Number of Battery Input	2
Charging Strategy for Li-ion Battery	Self-adaption to BMS
PV String Input Data	
Max. DC Input Power (W)	27000
Max. DC Input Voltage (V)	1000
MPPT Voltage Range (V)	180
Rated DC Input Voltage (V)	150-850
Max. Operating PV Input Current (A)	36+36+36
Max. Input Short-Circuit Current (A)	55+55+55
No.of MPPT Trackers/ No.of String Per MPPT Tracker	3/2+2+2
AC Input/Output Data	
Rated AC Input/Output Active Power (W)	27000
Max. AC Input/Output Apparent Power (VA)	30000
Rated AC Input/Output Current (A)	45.4/43.4

Max. AC Input/Output Current (A)	45.4/43.4
Peak Power (off-grid) (W)	1.5 times of rated power, 10s
Power Factor Adjustment Range	0.8 leading to 0.8 lagging
Rated Input/Output Voltage/Range (V)	220/380V, 230/400V
Rated Input/Output Grid Frequency/Range(Hz)	50/45-55, 60/55-65
Grid Connection Form	3L+N+PE
Total Current Harmonic Distortion THDi	<3% (of nominal power)
Efficiency	
MPPT Efficiency	>99%

B11. LUMINAIRE SCHEDULE

	TYPE	DESCRIPTION	LOCATION	IMAGE
1	Type A Light	1200mm X 600mm ceiling recessed, 60W, 4000K, Natural White, LED luminaire. Aluminium Extruded Frame, Translucent diffuser complete with power supply. Minimum Lumen output of 7000 Lumens. Control Gear: 180 - 250 Volts, with CRI greater than 90, low UGR, less than 19, For Medical Locations, Cyanosis Observation Index (COI) compliant. with surge protection. Supplied complete with 3m flex cable and 5 amp plug top.	Offices, Passages, Lobby, Restrooms Procedures, Vitals, Kitchen,	
3	Type A(E) Light	As per Type "A" Light with 60-minute emergency back-up battery at 100% output.	Circulation area, Emergency.Room and Procedure Room	
4	Type B Light	300mm recessed, 15W, 4000K, Natural White, Round LED luminaire, adjustable up to 60°. Aluminium Frame, Translucent diffuser complete with power supply. Minimum Lumen output of 1300 Lumens. Control Gear: 180 - 250 Volts, with surge protection. Supplied complete with 3m flex cable and 5 amp plug top.	Server, Garden Store, Male, Main circulation and Female Bathrooms	
6	Type B (E) Light	As per Type "B" Light with 60-minute emergency back-up battery at 100% output.	Main circulation	

9	Type C Light	1200mm x 300mm surface mounted, 40W, 4000K, LED luminaire. Vapour proof. Aluminium Extruded Frame, Polycarbonate diffuser complete with power supply. Minimum Lumen output of 6000 Lumens. Control Gear: 180 - 250 Volts, with surge protection. Supplied complete with 3m flex cable and 5 amp plug top.	Circulation Area, and Electrical Switch Gear Room	
	Type C (E)Light	As per Type "C" Light with 60-minute emergency back-up battery at 100% output.	Circulation Area, and Electrical Switch Gear Room	
10	Type E Light	Slim, 8W, surface mounted exit light, 4000K, cool white, Aluminium Frame LED luminaire with emergency back-up battery. To be supplied complete with 3.6V Ni-MH batteries and signage. Control Gear: 180 - 250 Volts, with surge protection. Supplied complete with 3m flex cable and 5 amp plug top. Construction to be polycarbonate with rear cable entries. Supplied complete with 3m flex cable and 5 amp plug top. Directional Arrow and running man to be verified on site	Exit points	
11	Type D Light	Aluminium, IP65, 40W LED Floodlight luminaire. Minimum lumen output of 2800 Lumens. Protector: Glass. To be supplied complete with all necessary accessories and fixtures. Nominal voltage of 200-264V, 50Hz. Light output colour: 4000 Kelvin (Neutral white)	Wall Mounted Exterior of the building	

12	Type H Light	die-cast, aluminium, IP66. high powered 300W LED mounted on 12m Stepped buried Pole. Minimum lumen output of 35000 Lumens. Protector: Glass. 12m MH, 0 to 60 degree mounting, 300W luminaire. To include access door MCB's, 12m pole. All fasteners to be stainless steel. Nominal voltage of 198-264V, 50Hz. Light output colour: 5700 Kelvin (Cool white). Including 12m MH Buried Pole and spigot	Exterior Building	
13	Type F Light	Ceiling mounted, IP54, 4000K LED Medical Procedure/Surgical Luminaire. Minimum central illuminance: 130000lux. Electronic control gear suitable for 220 - 240 volts- 50 hertz AC operating. To be supplied with all necessary equipment. Supplied complete with 3m flex cable and 5 amp plug top.	Medical Rooms	

B12. ACCESS CONTROL AND SECURITY EQUIPMENT SCHEDULE

Thulasizwe Clinic			
Security Equipment Schedule			
	Equipment	Description	Image
1	Proximity Device	Includes card/tag reader and keypad.	
2	Junction Box	PVC junction box for proximity device and electronic door locks.	
3	Surveillance Camera	Long range, bullet or box, cameras	
4	Infrared, Vandal Resistant, Dome Camera (Interior)	2 MP fixed dome camera	
5	Infrared, Vandal Resistant, Dome Camera (Exterior)	2MP fixed dome camera	

B13. XRAY INSPECTION UNIT SCHEDULE

A. GENERAL SPECIFICATION

a. Construction Details

- The unit must incorporate a facility to be controlled either from the right or the left-hand side.
- In addition, a facility must be incorporated so that, the operating keyboard and monitor can be operated remotely, at least 5m from the unit.

- Maximum height including the tunnel shall not exceed 1400mm from the floor level.
- The unit must be quiet when in operation.
- X-ray high voltage generator, shall be rated at 160kV and operate at 140kV
- Ambient conditions, under which the unit must operate:
  -0°C to 40°C
  -relative humidity 95%, non-condensing
- Control elements (pushbuttons, switches, etc.) are to be of sturdy design, selected for severe operating conditions.
- The unit must be of steel base construction on roller castors and not exceeding 700kg in total weight.
- Discharge rollers to be included with the unit. The discharge roller platform shall be long enough to prevent articles being X-rayed from falling off before it is recovered by the owner.
- The conveyor belt must be designed for 24-hour, heavy-duty operation.
- The unit shall not be longer than 900mm wide and 2600mm in overall length, including the conveyor belt platform.

b. Power ratings

- The unit has to operate from 230V ±5%, 50 Hz, single phase power supply.
- The maximum running current shall be less than 5A.
- A suitable power point will be provided on the site by others.

c. Image presentation

- Objects of the following dimensions must be able to be passed through the tunnel without any obstruction:
  - Height: at least 400mm
  - Width: at least 600mm
  - Length: unlimited
  Monitor display shall cover not less than 500mm of the object length.
  Full scan volume must be seen on the screen, without any corner cut-off. This is a firm requirement.
- Imaging scale of all objects should be constant with the minimum distortion.
- A zoom facility is essential. The optimum requirement is for the push-button selection of at least 9, independent zoom sectors. The selected sector must be identified by light frame before zoom is activated.
- A colour monitor (non-interlaced), screen size of at least 34cm, is required. Parallel operation of additional monitors, without modification to the unit, must be available.
- The image on the monitor screen must be flicker free.
- Control of brightness and of contrast must be provided on the front panel of the monitor.
- Possibility of switching over from “POSITIVE” to “NEGATIVE” image should be available as an option.
- A digital memory is essential.
- The capacity of the digital memory must exceed 1GB.
- The number of solid-state detectors shall be not less than 1152.
- Dual (Multi) energy colour system with a four (4) colour (Industry Standard) is a firm requirement.
- Organic/Inorganic colour stripping.
- High and low penetration.
- Variable colour stripping and variable gamma edge enhancement.
- Automatic density (variable) threat alert.
- Automatic organic material threat alert.
- Operator log-in identification facility.
- Video output capabilities for recording of images shall be included.
- Voltage stabiliser must be included.
- UPS shall be included to provide 10 – 15 minutes back-up.

d. Resolution and penetration

- A sample wire with diameter of 0.16mm (SWG 34) must be distinguished on a monitor, and 30SWG wire must be visible behind 21mm of aluminium.
- The image quality on the monitor must be uniform, without distortion in the centre or the edges.
- Penetration of 25mm steel minimum must be guaranteed.
- A pre-selectable density threat level must be a feature of the equipment, with a visual and/or audible alarm if any item being screened exceeds that pre-selected density.

B. CONTROL OPERATION – MINIMUM REQUIREMENTS

a. Controls

- A mains key switch for 230V main power supply is required.
- Push button – power “ON”.
- 3 Push buttons for conveyor control, “GO”, “STOP” & “REVERSE”.
- As a minimum, 9 push button keyboards for zoom sector selection and a separate push button for zoom activation is required.
- A robust, RED, emergency stop push button, fitted in a prominent position on the keyboard, as well as on the X-ray unit.
- Light symbols indicating “X-ray on”.
- X-ray warning signs, in accordance with the requirements of the SA Radiation Board, must be attached to each end of the tunnel in a visible position.
- Easy operation of the unit is essential.

b. Passage of luggage through X-ray unit

- Objects must be able to be conveyed through the unit in any orientation.
- All objects, also those which is only partially lying flat on the conveyor belt (e.g., guitars, etc.) must be fully screened.

c. Object representation

- The conveyor belt speed should be such that each point of an object, when passing through the unit, will be visible for at least 5 seconds

C. CONVEYOR BELT

a. Loading

- At least 75kg overall weight
- The conveyor belt must be driven by an almost noiseless drum-motor.

b. Dimensions

- Belt length: < 2100mm
- The height of the top of the conveyor belt above floor level shall be not less than 600mm, but shall not exceed 800mm

c. Speed and duty cycle

- Conveyor belt speed: approximately 0.2 m/sec.
- Up to 2400 objects must be screened per hour.

d. **Operation**

- Normal: Continuous operation in forward direction.
- Stop:
- Reverse: Intermitted operation by pressing the reverse button.

- Duty cycle: no warm-up period will be accepted.

D. SAFETY

a. **X-ray dose: Screened object**

- Standard –0.1 mrem per inspection. Lower dose units may be offered as an alternative.

b. **Radiation leakage to surrounding**

- Less than 0.5 mrems/h at any point on the surface, 5cm from the surface
- The unit must comply with all ruling international safety regulations such as the German TUV, Swiss SEV, UK NRPB or USA FDA.

c. **Conveyor belt**

- The feed and discharge end of the conveyor belt are to be of such design that fingers, etc. cannot be caught during normal operation.

d. **Operation under fault conditions**

- The X-ray tube shall be automatically de –energised when conveyor belt is stopped.
- X-ray radiation shall only be switched on with the moving conveyor belt, before the object passes through the unit.
- X-ray radiation shall be automatically switched off if the radiation shielding covers are removed.

e. **Film safety**

- Tenderers must guarantee the unconditional safety of photographic material of professional quality.
- Typical standards must allow for highly sensitive films of 1000 ASA to be irradiated at least 30 times without damage.

E. PLACING IN POSITION AND ASSEMBLING

a. The unit shall be placed in position and assembled on site by the successful tenderer. NOTE: The final placing will be determined on site.

F. BROCHURES

a. Brochures, furnishing description and technical specification, etc. of the unit offered, shall be submitted with the tender. If the brochures have information, which does not comply with the specification, the tenderer must submit a covering letter listing all brochure items, which do not comply and confirm that the equipment offered will comply with the specification, referring to these items.
b. The following information is also required:

Manufacturer: _____

ISO Rating: _____

Country of origin: _____

Model number of the unit offered _____

Date of manufacture _____

G. MAINTENANCE, SERVICE AND REPAIR

a. The unit design must be of the low maintenance type and with minimum future service. A statement confirming this is required from the tenderer, together with a copy of the service/maintenance schedule.
b. An overall design of modular type is preferred.
c. Electronic modules must be easily exchanged.
d. All sub-assemblies in the unit must be of such a design that, maintenance and repair can be carried out by a single person, including removal and exchange of the X-ray generator tanks.
e. Spare parts must be locally stocked, and availability guaranteed for a ten-year period, starting from the date of delivery.

H. GUARANTEE AND SERVICE

a. The successful tenderer shall guarantee and service the complete unit for a period of twelve (12) months from the date of delivery to site, and successful commissioning of the unit.
b. During the period of guarantee, the successful tenderer shall, at his own expense, carry out all necessary repair work, including material and labour, (excluding work required due to damage by others) in order to maintain the unit in a working condition.
c. The successful tenderer shall, during the period of guarantee, repair the unit to the satisfaction of the Engineer, within 24 hours after he has been notified that the unit is not operating.

I. TRAINING

a. The successful tenderer shall thoroughly train and instruct all the operators and supervisors, designated by the User Department in the operation of the unit.

J. ONBOARD COMPUTER

a. Video Memory: at least 512MB
b. Processor Speed: at least 3.2GHz
c. Storage Capacity: At least 160GB
d. A two-part training programme must be incorporated in the system.

- Part 1 – Initial training
  Pre-loaded images must be recalled by the computer, some without and some with threats. The operator must detect the threats and his progress is logged.
  Part 2 – Ongoing training
  The system must merge fake threat images into real time images and the performance of the operator must be logged.

K. MANUALS

a. Three complete sets of manuals, each with the following information shall be handed over to the Department when the unit is delivered to site:
(a) Operating instructions
(b) Technical description with diagrams and instructions for maintenance and repairs.

L. Tenderer's Schedule of Technical Information

The following Information is to be Fully Completed by the Tenderer:

NO	ITEM	REMARKS
1.	Maker's name and model no.	
2.	Country of Origin and year of manufacture	
3.	Total height above floor level	
4.	Maximum X-ray voltage	
5.	Dimensions of the unit	
	Height	
	Width	
	Length (including conveyor belt)	
6.	Total running current	
7.	Maximum dimensions of objects:	
	Height	
	Width	
	Length	
8.	Number of detectors	
9.	Capacity of digital memory	
10.	Number of shades of grey	
11.	Maximum over-all loading on conveyor belt	
12.	Conveyor belt speed	
13.	X-ray dose per inspection	
14.	Radiation leakage at any point, 5cm away from surface	

NO	ITEM	REMARKS
15.	Multi-Energy mode – State colours for material discrimination	

M. Deviation from the specification as an alternative (State Briefly)

Note: A Non-submission of this schedule or a Blank submission indicates the tenderer's intention to fully compliance with the speciation

NO	DESCRIPTION

B14. WALK THROUGH METAL DETECTOR SCHEDULE

A. GENERAL

a. The metal detector shall consist of a free-standing walk-through frame with an integral control unit and shall be suitable to detect metallic objects on a person by means of the magnetic field principle.
b. The metal detector shall be suitable to detect ferrous and non-ferrous metals.
c. The metal detector shall be equipped to eliminate false alarms.
d. The metal detector shall scan the entire area of the walk-through area and detect metal objects on a person passing through to the levels as specified.
e. The metal detector will incorporate self-test button to confirm that the system is operating correctly.
f. The metal detector shall be completely tampering proof.
g. The programme and sensitivity push buttons shall be so arranged that tampering by unauthorised persons is entirely eliminated.
h. The metal detector shall not be adversely affected by stationary metal bars or structures in the vicinity of the unit or moving metal near the archway.
i. The metal detector shall be capable of operating adjacent to an X-Ray inspection unit.
j. The detector is intended for indoor use at an altitude of up to 1800m above sea level.
k. The detector shall be capable of operating in the following conditions:

- Min. temperature: 0ºC
- Max. temperature: 40ºC
- Max. relative humidity:80%

l. The operation of the metal detector shall not be adversely affected by repositioning of the frame within certain limits of its original adjusted position.

B. CONSTRUCTION

a. The metal detector shall comprise a free-standing walk-through frame containing the detector coils and the control unit, complete with a 5m length of flexible cable and 16A 3-pin plug top. The cord and plug top shall comply with the relevant SABS specifications.
b. The frame and the control unit shall be of robust construction and the base of the frame shall be designed to ensure rigidity.
c. The unit shall be able to execute a full body scan and detect metal objects down to the lower feet level within the settings specified.
d. The finish shall be durable and maintenance free.
e. The type of material used for the construction of the frame and control unit must be stated by tenderers.
f. The colour range in which the metal detectors are available must be stated by tenderers. The Department will select a colour finish to suit the environment.
g. All material consisting of metal shall be treated against corrosion.
h. The approximate internal dimensions of the frame shall be as follows:

- Walk-through height: 2m
- State Walk-through width

C. CONTROL SYSTEM

a. The system shall operate by means of automatic level control adjustable to environmental changes, Without the need to reset.
b. The control unit shall be equipped with the following:

- "ON-OFF" main switch and "MAINS ON “indicator light.
- Selector switch with at least ten sensitivity settings, with a maximum sensitivity to consistently detect metal at least the size of a R5, 00 coin.
- The sensitivity settings shall be consistent at average walking speed.

Visual indication in the form of an LED Bar graph indicator having at least five green lights and five red lights representing the "PROCEED" and "ALARM" zones respectively. The indicator shall give an indication of the volume of metal on a person in accordance with the sensitivity settings of the selector switch. When the "ALARM" zone is activated, it shall simultaneously activate an audible alarm having a continuous tone and adjustable volume. The alarm system will automatically reset after the metal has passed through the frame.

The system shall be modular to facilitate maintenance and repairs.

D. SAFETY FEATURES

a. All electronic and electrical components shall be protected by lockable panels.
b. The detectors shall not have any effect on heart pacemakers.
c. The detector shall not affect magnetic storage media or camera film.

E. ELECTRICAL SUPPLY SYSTEM

a. The detectors shall be designed for connection to a 230V +/-5%, 50Hz, single phase, three wire (phase, neutral and earth) power supply.
b. The existing connection points on site comprises standard 16A, 3-pin, socket outlets.
c. A suitable and efficient battery back-up system to facilitate power failures of up to 1 hour must be incorporated in the detectors.

F. THROUGHPUT

The system shall accept a passage of at least 50 persons per minute without functional overload.

G. PLACING IN POSITION AND TESTING

a. The detector shall be placed in position, tested, commissioned and adjusted to the user Department's requirements by the successful tenderer. NOTE: The final positioning will be determined on site.
b. The system must be arranged so that the traffic-flow is channelled through the metal detector.

H. BROCHURES

a. Brochures furnishing descriptions and technical specifications, etc., of the unit offered shall be submitted with the tender.
b. The following information is also required:

Manufacturer _____

Year of manufacture _____

Country of origin _____

Model number _____

I. MAINTENANCE

a. The unit must be relatively maintenance-free and with minimum future service. A statement confirming this is required from the tenderer.
b. Electronic modules must be easily exchangeable.
c. Spare parts must be locally stocked, and availability guaranteed for a ten year period starting from date of delivery.

J. GUARANTEE AND SERVICE

a. The successful tenderer shall guarantee and service the complete unit for a period of twelve (12) months from date of delivery of every unit to site.
b. During the period of guarantee the successful tenderer shall at his own expense, carry out all necessary repair work including material and labour (excluding work required due to damage by others) in order to maintain the unit in a working condition.
c. The successful tenderer shall, during the period of guarantee, repair the unit to the satisfaction of the Department within 24 hours after he has been notified that the unit is not operating.
d. After the lapse of the initial twelve-month period of servicing under the guarantee, the successful tenderer may be required to enter into a service agreement with the Department.

K. TRAINING

a. The successful tenderer shall thoroughly train and instruct operators designated by the user Department in the operation of the unit.

L. MANUALS

a. Two complete sets of manuals, each with the following information shall be handed over to the Department when the unit is delivered to site:
   (a) Operating instructions
   (b) Technical description with diagrams and Instructions for maintenance and repairs.

B15. PABX SCHEDULE REQUIREMENTS

The following schedule of requirements has been compiled for the PABX system and must be read in conjunction with the General specification requirements included in the Project specification.

	PERIOD	INITIALLY 3 YEARS	ULTIMATELY 10 YEAS
1	**TRAFFIC INFORMATION**		
1.1	Incoming traffic from PSTN		
1.2 1.3	Outgoing traffic to PSTN Outgoing traffic via the operator's console		
1.4	Incoming traffic via the operator's console		
1.5	Extension to extension traffic		
1.6	Tie line traffic		
2	**EQUIPMENT REQUIRED**		
2.1	Windows NT based Operator's consoles		
2.2	Extensions		
2.3	DDI Answer Unit		
2.4	DTMF Receivers		
2.5	Power equipment		
3	**PUBLIC EXCHANGE CONNECTIONS**		
3.1	Incoming from PSTN (Digital)		
3.2	ISDN Primary Rate		
3.3	Both way Analogue		
3.4	2 Mbit Interface Card		
3.5	Outgoing to PSTN (Analogue)		
3.6	Additional DTMF Receivers if Required		
3.7	R2MFC Receivers		

3.8	ISDN basic rate lines		
3.9	256 Diginet lines		

* To be determined

4	**ADDITIONAL FACILITIES**	
4.1.1	Trunk Barring	YES
4.1.2	Right of Way Service	YES
4.1.3	System to Support Call Centre Functionality	YES
4.2	**Abbreviated Dialing**	YES
4.2.1	Number of codes	*……
4.2.2	Number of extension groups	*……
4.3	Hot line service	YES
4.4	**Add-On Conference facility**	YES
4.4.1	3-way	YES
4.4.2	8-way	YES
4.5.1	Secretarial interception	YES
4.5.2	Cut-in priority	YES
4.6	**Call Forwarding**	YES
4.6.1	Called Party Engaged	YES
4.6.2	No answer	YES
4.6.3	Follow me	YES
4.7	**Call Pick-Up**	
4.7.1	Number of groups	*……
4.7.2	Number of extensions per group	*……
4.8	Ring back when free	YES

4.9	Exchange Lines with Meter Pulse Recovers	N/A

* To be determined.

4.10	**System facilities**	
4.10.1	ISDN	YES
4.10.2	General system	NO
4.11.1	Direct dialing inward (DDI)	YES
4.11.2	Direct dialing outward (DDO)	YES
4.12	Call information logging service	YES
4.13	Networking	NO
4.14	Full transparency	YES
4.15	Internal dialing	YES
4.16	Data detection	YES
4.17	CLIP (Calling Line Identification)	YES
4.18	PIN Number Dialing	YES
4.19	Last number redial	YES
4.20	Call hold	YES
4.21	Nuisance call tracing	YES
4.22	Do not disturb function	YES
4.23	Message on an unanswered phone	YES
4.24	Single digit dialing	YES
4.25	**Call forwarding / follow me**	YES
4.25.1	To another phone when no reply	YES
4.25.2	To voice mail system	YES
4.25.3	To switchboard	YES
4.26	System to support analogue and digital telephones on a two-wire system	YES
4.27		

	System to support digital enhanced cordless telecommunication (DECT) systems in accordance with prescribed international standards.	YES

B16. AUDIO & VISUAL

The Audio and Visual requirements are based on the room dimensions and acoustic properties. All equipment to be provided as a solution Subject to Engineer & Client approval.

A. Cabling

a. Cable Management & Dressing

Securing of cabling shall be with hook & loop or other suitable reusable fixture for the looms.

Cable ties are not to be used in any audio/visual installation.

Non-interfering cables should be loomed together where they follow the same cable path. 240V power cabling should not be closely loomed to cables where it is likely to interfere with other signals.

All cabling in racks should be tied to either rack supports or frame and/or lacing bars with sufficient cable length to allow movement of rack.

All rack build cabling shall also conform to Cable installation & paths specification.

Any externally accessible cable looms must be concealed by a cable sleeve. The cable loom must be reusable and serviceable with variable diameter adjustment. Ends of cable sleeve shall be secured to ensure no fraying.

b. Cable Labelling

Cables should be labelling in accordance with INFOCOMM F501.01 Cable Labelling for Audio-visual Systems Standard.

Label text content shall indicate near (N) and far (F) end connections of the cable. For example.

- At the projector end of a HDMI cable connected to HDMI 1 input of a projector from a switcher output 2 should be labelled.

"N: Proj HDMI1 / F: Swt Out2"

- Conversely, the other end (connected to switcher output 2) of the same cable should read.

"N: Swt Out2 / F: Proj HDMI1"

Labels must have a clear layer on top of any printed text to reduce wear.

c. Audio cabling

Substitute cabling shall not be accepted unless written permission with relevant data sheet is supplied before installation.

1. Unbalanced Line-Level Audio

Unbalanced line audio is to be run over 2 conductor cabling (25 SWG or thicker) with foil shield and drain wire integrated. Outer jacket color should be either black or grey.

2. Balanced Audio

Balanced audio shall be run over 2 pairs of twisted conductors (21 SWG or thicker) cable with braided shield. Outer jacket color should be either black or grey.

3. Speaker – Constant Voltage

For 70v or 100v speaker cabling, a double insulated figure 8 wiring shall be used. 18SWG or thicker gauge should be used, with the gauge appropriate to support the systems required speaker and amplifier configuration. Individual polarity marked conductor insulation should be used for easy polar identification.

2. Speaker – Low Impedance

For Lo-z speaker cabling, a double insulated figure 8 wiring shall be used. The conductor gauge should be appropriate to support the systems required speaker and amplifier configuration. Individual polarity marked conductor insulation should be used for easy polar identification.

d. Control/ Low Voltage Power (Up to 100V)

Low voltage and control cabling are to be run using shielded + 2 core cable for RS-232 connectivity between devices, relays to screen.

1. Control

Where possible, the shield or drain wire is to be used as the common ground between devices either via Phoenix or DB-9 connectors.

24 SWG or thicker gauge cable to be used. Breaks in the cable or joins are prohibited, except where a wall plate connector is required.

2. Low Voltage Power (1-48V)

Only soldered and heat shrink joins of low voltage power are allowed. No screw terminals or tapes to be used. Breaks in the cable or joins are prohibited, except where a wall plate connector is required.

e. HDBaseT & Shielded Twisted Pair

All cables used for HDBaseT shall be a minimum of Cat6A rating.

Must be capable of passing 10.2Gbps over their length and transmission lengths greater than 70m under normal operating conditions.

All installed cables must use shielding, foil, or both (i.e., SF/UTP).

If the cable is too rigid to make required bend radii in racks or at equipment, then a fixed termination and suitable shielded patch lead should be installed.

Cabling shall NOT be white, blue, or red in color.

f. Video Cabling

1. HDMI
   - All HDMI cabling shall be capable of transmission of at least 4K @ 60Hz with a 4:4:4 color space.
   - Total sink to source cable lengths shall be no greater than 10 meters. Where lengths exceed 10m, STP or HDBaseT extension is required.
     - For a cable run with no breaks in cable, cable length shall not exceed 10m.
     - For a cable run with multiple breaks, no single cable should exceed 7.6m in length. There should be no more than 4 cable breaks in a cable run.
   - All HDMI cabling shall be compatible with HDCP 2.2, EDID and CEC control.
   - All HDMI cabling shall be passive type only unless otherwise specified.
   - Where required to convert signal to other digital formats, a short 20-30cm cable adapter shall be used.

2. DisplayPort
   - All DisplayPort cabling shall be capable of transmission of at least 4K @ 60Hz with a 4:4:4 color space.
   - Sink to source cabling lengths should be no greater than 3 meters with no breaks in the cable.
   - Where required to convert signal to other digital formats, a short 20-30cm cable adapter shall be used.

3. USB-C
   - Video transport over USB-C shall utilize USB-C ports with DisplayPort Alternate Mode (DP Alt Mode)
   - Cabling shall be capable of video transmission of at least 4K @ 60Hz with a 4:4:4 color space.

4. DVI
   - Where other digital video standards cannot be utilized, DVI to HDMI/DP adaptors should be used.
   - DVI cabling shall utilize the DVI-I single link or DVI-D single link connectors.
   - Where required to convert signal to other digital formats, a short 20-30cm cable adapter shall be used.

g. Interconnections (Wall Plates, Patch bays)

Suitable AV input plates shall be provided as specified. The Contractor may supply an alternative manufactured version of this plate type, with approval from the Engineer.

All specified input types on the plate must be printed/engraved in contrasted text above connector.

For non-standard wall plates, with permission from the Engineer, label printing machine labels may be used in place of on plate printing/engraving.

Standard BYOD wall plates shall be single gang Clipsal 2000 plates, with connector type (i.e., "HDMI") printed/engraved above the connector.

Standard analogue audio patch points (e.g., I/O for lectern mics, field recorders, live streaming, TIU videographers, external audio mixer, etc.) shall use surface rear mounted connectors, with the mounting plate printed/engraved with the purpose of each connector clearly labelled,

e.g., "Line Output", "Lectern Mic Input", "Line Input", etc.

The audio level type (Mic, Line) of the expected signal must form part of the wording.

Large patch fields must be arranged in a logical manner in order of patch point and function, with similar I/O grouped in clusters.

Rack mounted patch bays must include sufficient space for printed patch numbers above each connector. Additionally, a laminated patch sheet must be provided with the installation. The patch sheet must include diagrammatic and tabulated lists of all patch points and patch plates/fields, at the near and far ends.

Wall plates for speaker-level outputs shall be fitted with speak ON 4-pole connectors and must be clearly labelled as "Speaker Output".

Where Clear-Com style intercom patch points form part of a wall plate or patch field, the XLR connectors must be clearly labelled "Intercom".

a. **SANS**
- All Construction and Equipment to adhere to relevant SANS codes

b. **Warranty**
- Minimum 10 Years on Construction
-

B. Schedule

Below is the schedule of requirements of the audio & visual system.

	EQUIPMENT	DESCRIPTION	LOCATION	IMAGE
1	Speaker System per room	Wall Mounted Speakers on anti-vandal mounting. acoustics as to ensure fit for purpose.	Main Waiting Room & Play Area	
2	Smart Board	Smart Interactive Whiteboard. To have Built in Projector Unit, a hard whiteboard surface for writing on, 2xHDMI, 2xVGA & 2xUSB inputs. Including Software, once off licensing. Sized in accordance with room dimensions as to ensure fit for purpose.	Board room	
3	Motorised Projector Screen	Motorized Projector screen in Auditorium. sized in accordance with room dimensions as to ensure fit for prepose.	Board room	
4	Projector Unit	Ceiling Mounted projector unit including bracket in Auditorium, 2xHDMI & 2xVGA inputs. Remote Power on and off.	Board room	

B17. BUILDING MANAGEMENT SYSTEM (BMS)

A. Scope

The contractor shall supply, install and commission a web based Operations & Incident Management system capable of integrating with the CCTV & Access control system offered with this tender. The BMS shall be capable of extracting real time operational and maintenance related alarms and events from the CCTV & Access Sub-system hardware, and to present this data to a dedicated BMS workstation to be installed in the Security control room, as well as to relay the information in real time to an exterior control station anywhere in the country.

The BMS System shall provide a single dashboard overview of the various system components, to enable the user Department to determine at a glance where operational procedures are being ignored, are inadequate or require amending, as well as to determine the efficiency of Maintenance activities by Area or Site.

The system shall be exception based, whereby trends are analysed against a set of rules which can be configured per device. Only when the trend or activity for a device or sub-system deviates from the

configured rules shall an Operational Incident or Maintenance Activity be generated and reported. Such Incidents shall be escalated to the appropriate levels according to a configurable escalation schedule.

B. Integration

The BMS shall be able to integrate with the following Sub-system hardware, as well as any additional hardware detailed in the site-specific specifications under this tender:

1. Access Control System
2. CCTV System
3. Fire Detection System
4. HVAC system
5. Uninterruptible Power Supplies
6. Metering
7. Generator
8. Telephone system
9. DATA System
10. Solar PV System

C. System Overview

The BMS shall provide access to a Web based enterprise platform to capture and report data relative to incidents, investigations and exposure, providing a single dashboard view of any risk associated with the various hardware systems.

It shall be possible to intelligently action and query system data for risk, trending. The system shall enable the user Department to make informed decisions which optimize performance and illustrate the effectiveness of its operation.

The system provided shall be capable of integrating with any commercially available Security Management System and sub-system hardware, and to present analytical data from all subsystems to the user on a single dashboard view.

The system shall have the ability to interactively manage incidents and investigations from beginning to end, including a complete sign off and review process. Automatically generated notifications via email and SMS shall alert appropriate users to issues in real time.

The System shall be accessible by any number of users, from anywhere, at any time via thin client technology enabling the system to be accessed over the Internet, LAN or WAN through any secure connection. All data shall be SSL encrypted, providing secure data transactions, to enable users to log in remotely without compromising the system security.

The System shall enable users from multiple levels within the Client Department to access the same information for different reasons.

D. Functionality

The BMS shall offer the following functionality as a minimum:

- ✓ Permissions

The BMS shall have its own database security component to administer and control access to the underlying data. All users shall be granted access to the application by username and password, to allow strict control over the various levels that users are able to access. Generic username and passwords shall limit functionality, and shall be setup to cater for specific situations, for example where

many different personnel need to access, or enter data and where such personnel have not yet been designated and which may change on a day to day basis.

The system shall be capable of various levels of access, depending on the status of the user, for example, Management shall be able to view all outstanding incidents and investigation data, whilst others may be restricted to only those cases and investigations for which they are responsible. In addition, users shall be granted access to review certain aspects of a case but not to amend any of the details. The BMS's own Security shall be administered by users having specific administration rights, thereby allowing for the simple administration of existing and new user profiles.

- ✓ Reference Data

The reference data elements (i.e. locations, incident types, investigating officers etc.) shall be treated as reference data items that shall be added as and when required by authorized users. This element of the application shall be tightly controlled to ensure that the referential integrity of data remains intact (i.e. reference data items cannot not be deleted, but merely flagged as "no longer in use", and thus, not viewable from any of the drop down menus within the application).

- ✓ Event Management

The system shall provide for two types of Event entry. The first shall be an automated incident entry, whereby data received from the Security Management sub-system hardware e.g. A door open alert from the access control system, shall be automatically entered and an event created. The second type shall be a manual event entry whereby users are able to enter events related to assets not connected to the Security Management System.

An Electronic Occurrence Book/ Electronic Incident Book shall be a key component of the application and shall be available to build up a profile of various incidents (i.e. all related incident details such as an individuals, property, witnesses, vehicles, log file etc.) shall be reviewed as an extension of the incident.

Unique Event numbers shall be automatically established by the application, and once created, shall never be deleted to ensure integrity of the audit trail process. The incident shall become the primary source of input and all subsequent investigation activity shall be recorded as part of the incident.

New incident details shall be automatically entered or manually entered via a simple capture screen. It shall be possible to add specific details of the incident by the user. The capture of these details shall be standardized by means of pre-defined search lists to facilitate structured reporting (e.g. pre-defined Event types, locations etc.). Free form text input shall be limited to providing incident notes and wherever else it is considered necessary to cater for non-standard information situations. All entries into the application shall have standard time/date/user stamps for audit trail purposes. Incident details captured shall be validated as required to ensure that a minimum required level of detail is captured.

- ✓ Investigation

Subsequent investigations of an existing Event shall be treated as adding additional data to the original Event profile. Only authorized users shall be able to add and amend investigation data. It shall be possible for management to view investigation data, and to be able to add additional comments or issues that need to be followed up.

It shall be possible to conduct an investigation into the following Event categories as a minimum:

1. Security (CCTV & Access Control) Events
2. Maintenance (HVAC & UPS) Events
3. Health and Safety Events
4. Human Resources Events

System prioritized Events shall be automatically assigned to the investigations database, however, it shall be possible for authorized users to override non-prioritized incidents and flag them for investigation if necessary. Users assigned to an "Administrator" security level shall be able to create "auto

assignment rules" which shall automatically assign repetitive type investigations to relevant users without the manager's input.

It shall be possible for Investigation managers to be presented with an Events summary once they log in to the system, which provides a prioritized list of investigations which have been assigned to them for review.

a. Reporting

The system shall provide a range of standard and pre-defined reports, with the ability to create user defined reports on an ad-hoc basis, where users shall be able to specify report parameters at the time the report is generated.

It shall be possible to generate the following report types as a minimum:

1. Trending/ Graph Report
2. Statistical Report
3. Management Dashboard Report
4. Map Report

All reports shall be web based, with the ability to export to Microsoft Excel or PDF format. The Management Dashboard Reports shall be dynamically linked to the database, displaying any criteria that the user wishes to view.

b. Data Search

The system shall provide the ability to cross reference between all Events and related occurrences. The database shall be designed in such a way that the relationships between the various elements are automatically established at the point of entry, to provide advanced web based cross referencing of reports.

c. Equipment and Asset Register

The system shall provide an equipment and asset register, which shall enable users to capture the details of any asset or piece of equipment on the Clinic.

It shall be possible to Categorize and sub-categorize assets to three levels as a minimum, and provide the following Main Categories as standard:

1. Security
2. Electrical
3. Plumbing
4. Building

The following Sub-Categories shall be provided as standard

1. Security

- ✓ Access Control
- ✓ CCTV
- ✓ Control Room Equipment
- ✓ IT Equipment

- ✓ Ancillary Equipment
- ✓ UPS
- ✓ Power Distribution
- ✓ Cable and Wire-ways
- ✓ General
- ✓ Metering

2. Electrical

- ✓ Lighting Fittings and Fixtures
- ✓ Power Outlets and Switches
- ✓ Distribution Panels
- ✓ Cable and Wire-ways
- ✓ UPS
- ✓ Solar PV System
- ✓ Standby Generators
- ✓ Telephone System
- ✓ Telephone Distribution
- ✓ Network Switches
- ✓ General

3. Plumbing

- ✓ Boilers
- ✓ Domestic Heating
- ✓ HVAC
- ✓ Bathrooms
- ✓ Kitchens
- ✓ Piping
- ✓ Valves
- ✓ Pumps
- ✓ General

The system shall provide for the seamless integration of all related assets into the BMS Asset Register, by means of an automated import tool, which shall enable the Security Management System to automatically populate the BMS Asset Register database with the following fields as a minimum:

1. Category (e.g. - Security)
2. Sub Category 1 (e.g. - Security - Door Control)
3. Sub Category 2 (e.g. - Security Door Control – Swing Door)
4. Site Reference
5. Area Reference
6. ID Number (Unique per asset)
7. Bar Code Number
8. Manufacturer
9. Manufacturer's Part Number
10. Description
11. Distributor Name
12. Distributor Telephone Number

In addition to the automated import facility, it shall be possible to view and manually edit the details associated with any imported asset as well as to manually create new assets and populate the database in accordance with the above-mentioned fields.

The system shall provide a standard .csv import tool for all other categories of assets not forming part of the Management System. The tool shall allow the user to create their own asset register in Microsoft Excel for the Electrical, Plumbing and Building related assets, and to import these spreadsheets into the BMS via the CSV import tool provided.

The tenderer shall allow sufficient man hours for training of a suitable competent representative of the user, to enable them to create the necessary spreadsheets in preparation for importing into the system themselves.

d. Planned Preventative Maintenance Module

The system shall provide a full Planned Preventative Maintenance module which shall enable the Department’s maintenance division to configure the Planned Preventative maintenance schedules for each asset type. As an example, it shall be possible to schedule a routine maintenance activity for each individual asset by configuring a single asset sub-category type.

(i.e. all Access Controllers are to be serviced once every six months).

Once the service intervals have been entered per asset type, the system shall automatically generate the Annual maintenance schedule for each individual asset as well as to generate the daily schedule maintenance tasks for the assigned resources.

The following fields for the planned preventative maintenance schedules shall be provided within the BMS database as a minimum:

1. Category (e.g. - Security)
2. Sub Category 1 (e.g. - Security - Door Control)
3. Sub Category 2 (e.g. - Security Door Control – Swing Door)

4. Site Reference
5. Area Reference
6. ID Number (Unique per asset)
7. Bar Code Number
8. Manufacturer
9. Manufacturer's Part Number
10. Description
11. Maintenance procedure (Text field describing the maintenance procedure)
12. Assigned Resource (e.g. - Team or Individual)
13. Cycle (Annual, 6 Monthly, 3 Monthly, 2 Monthly, Monthly, Weekly, Daily)
14. Estimated service time

When changes are made to a specific asset's Planned Maintenance criteria, an option shall be generated to apply the same criteria to all assets within the same Sub Category or ID Type. (Apply to all function). As an example, if the manufacturer of a specific door controller revises their recommended service period, the user need only edit the "Cycle" field of one such device, which can then be applied to all products within the same site with a single click.

Planned Maintenance Schedule Report

The system shall automatically generate a daily Planned Maintenance schedule report for each resource to which tasks have been assigned. The following information shall be provided per daily report as a minimum:

1. Category (e.g. - Security)
2. Site Reference
3. Area Reference
4. ID Number Range (display each unique ID number to be serviced that day)
5. Asset Description
6. Maintenance procedure (Text field describing the maintenance procedure)
7. Cycle (Annual, 6 Monthly, 3 Monthly, 2 Monthly, Monthly, Weekly, Daily)
8. Scheduled Start Date
9. Scheduled Completion Date
10. Scheduled Time for completion
11. Actual Time Completed (Manual entry by resource)
12. Actual Time required (Manual entry by resource)
13. Assigned Resource (e.g. - Team or Individual with space for signature)

14. Resource Comments (Technician's description of the fault)

15. Spares utilized (Technician's description of parts used)

Upon completion of scheduled Maintenance tasks, the system shall allow for all information which had been filled in on the printed report by the Technician and Administrative assistant, to be entered into the system and recorded in order to provided statistical reports relating to the predicted and actual time required to complete a group of maintenance tasks. The system shall use such information to prompt the appropriate user to amend Estimated service time per asset type, in order to more accurately predict resource allocation.

e. Automated Breakdown Notification Module

The system shall provide a fully configurable Breakdown notification system whereby breakdown related events can be created, edited, or deleted as required. Events affecting the smooth operation of the Management System shall be automatically reported to the appropriate specialist sub-contractor via SMS and email in order to minimize the downtime related to the breakdown.

The following maintenance related events shall exist within the system as standard, and reported via SMS and email together with the date and time of the event and the breakdown category:

Access Control (Included, but not limited to)

Item	Access control Events
1	Door Fault on Closing alarm exceeding limit
2	Door Fault on Opening alarm exceeding limit
3	Door Control Node Communication Failure (with module No. notification)
4	Door Control Bus Segment Failure (with Bus segment No. notification)
5	Door Control Area Controller Failure (with controller No. notification)
6	BGU by pass Failure (with unit no. notification)
7	Intercom Tamper Alarm (with Area and Door notification)
8	Intercom Node Communication Failure (with Node No. notification)
9	Intercom Bus Segment Failure (with Bus segment No. notification)
10	Intercom Area Controller Failure (with controller No. notification)
11	Intercom Call Button wiring fault (with station No. notification)

CCTV & Digital Recording System (Included, but not limited to)

Item	CCTV & Digital Recording Events
1	Camera Signal/Image loss Alarm (with camera No. notification)

2	Camera Communications Failure Alarm (with camera No. notification)
3	NVR Communications Failure Alarm (with NVR No. notification)
4	NVR Proprietary Alarm (with NVR and Alarm No. notification)

UPS System (Included, but not limited to)

Item	UPS System Events
1	UPS Mains failure (with unit No. notification)
2	UPS Maintenance Alarm (with unit No. notification)
3	UPS Load on Bypass (with unit No. notification)
4	UPS Battery Low (with unit No. notification)
5	UPS Battery Failure (with unit No. notification)
6	UPS Load not protected (with unit No. notification)
7	UPS Surge Arrestor Failure (with unit No. notification)
8	UPS Communication Failure (with unit No. notification)
9	UPS Room Door Open Alarm (with room No. notification)
10	UPS I/O module communications Alarm (with module No. notification)
11	UPS I/O Input wiring fault (with module and Input No. notification)

Security Management System (Included, but not limited to)

Item	Security Management System Events
1	Server Communication Failure (with Server ID notification)
2	Workstation Communication Failure (with WS ID notification)

f. Operations Monitoring Module

The system shall provide an Integrated Operations Monitoring Module, whereby the standard conditions of operation of Sub-System hardware can be defined, and monitored in real time, and to automatically report any deviation from the standard operating conditions. As an example, it shall be possible to create a standard operating condition (set of rules) for the operation of a access door in which the user can define the period for which the door may remain unlocked (open) before an exception event is generated. In addition to the open time period, the user shall be able to define the number of such events per door, that would constitute an incident, and to automatically report the incident to a senior level within the system.

The logging and reporting of such incidents shall include all details relating to the event, for example, the Time, Date and Operator responsible for opening the door.

It is a specific requirement of this tender that the BMS and the Security Management System (SMS) are fully integrated to enable operational incidents to be monitored and reported in real time.

The system shall allow system users with a suitable security and experience level, to create user defined operational conditions for any security sub-system hardware component.

The system shall enable senior users to configure which alarms and events are to be escalated and to whom they should be reported. The system shall also allow for general notification whereby senior users can be notified of Alarms and events without needing to take any action.

The system shall present the appropriate users with the following information relating to each alarm or event, via their Dashboard overview:

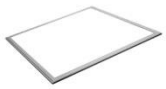
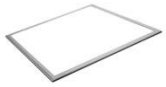
1. Date of the incident
2. Time of incident
3. Category of Incident
4. User responsible for the incident
5. Responsible Users contact details
6. Time elapsed since the incident
7. Description of the Incident
8. Recommended Action to be taken
9. Operations Monitoring Module

g. Dynamic Reporting & Forms

The system shall provide a dynamic Reports and Forms tool, which shall enable users to dynamically create new pages (Tabs) and Input Fields for any additional information capture requirements. The tool set shall negate the need for Hard Coding Development and shall be carried out by a System Administrator.

B18. ELECTRICAL EQUIPMENT SCHEDULE

	Equipment	Description	Areas	Image
1	Type A/Type Au SSO	16A, 3-pin single SSO with two Type J sockets (ZA plug). Mounted at 300mm.	All	
2	Type B/Bu/Type Bu SSO	16A, 3-pin single SSO with two Type J sockets (ZA plug). Mounted on two tier Power Skirting.	All	
6	Type F SSO	16A Single SSO socket mounted on wall in weather proof box.	Exterior of building	
8	Data connection point	RJ45 data socket outlet. Mounted on Power Skirting.	All	
9	Telephone connection point	RJ11 telephone socket outlet. Mounted on Power Skirting.	All	
10	Power Skirting	Two tier Aluminium or PVC power skirting.	All	
11	Isolators	Mounted on walls and in ceiling voids	All	
12	Weatherproof Isolators	IP65 Rated isolator in slide up box	Outdoor Areas	
13	Distribution Boards	Populated as per Schematic	DB Rooms	
14	Uninterrupted Power Supply	Refer to power layout	Various	

15	Isolation Transformer	Refer to Schematic	Various	
16	Server Cabinet	42 Unit	Server Rooms	
17	Solar PV system	Refer to Solar Layout	Roof Clinic	
1	Type A Light	600mm X 600mm ceiling recessed, 40W, 4000K, Natural White, LED luminaire. Aluminium Extruded Frame, Translucent diffuser complete with power supply. Minimum Lumen output of 4100 Lumens. Control Gear: 180 - 250 Volts, with surge protection. Supplied complete with 3m flex cable and 5 amp plug top.	Offices, Passages, Lobby, Restrooms Procedures, Vitals, Kitchen,	
3	Type A(E) Light	As per Type "A" Light with 30-minute emergency back-up battery at 100% output.	Circulation area, Emergency.Room and Procedure Room	
4	Type B Light	300mm recessed, 15W, 4000K, Natural White, Round LED luminaire, adjustable up to 60°. Aluminium Frame, Translucent diffuser complete with power supply. Minimum Lumen output of 1300 Lumens. Control Gear: 180 - 250 Volts, with surge protection. Supplied complete with 3m flex cable and 5 amp plug top.	Server, Garden Store, Male, Main circulation and Female Bathrooms	
6	Type B (E) Light	As per Type "B" Light with 30-minute emergency back-up battery at 100% output.	Main circulation	
9	Type C Light	1200mm x 300mm surface mounted, 40W, 4000K, LED luminaire. Vapour proof. Aluminium Extruded Frame, Polycarbonate diffuser complete with power supply. Minimum Lumen output of 6000 Lumens. Control Gear: 180 - 250 Volts, with surge protection. Supplied complete with 3m flex cable and 5 amp plug top.	Circulation Area, and Electrical Switch Gear Room	

	Type C (E)Light	As per Type "C" Light with 30-minute emergency back-up battery at 100% output.	Circulation Area, and Electrical Switch Gear Room	
10	Type E Light	Slim, 8W, surface mounted exit light, 4000K, cool white, Aluminium Frame LED luminaire with emergency back-up battery. To be supplied complete with 3.6V Ni-MH batteries and signage. Control Gear: 180 - 250 Volts, with surge protection. Supplied complete with 3m flex cable and 5 amp plug top. Construction to be polycarbonate with rear cable entries. Supplied complete with 3m flex cable and 5 amp plug top. Directional Arrow and running man to be verified on site	Exit points	
11	Type D Light	Aluminium, IP65,30W LED Floodlight luminaire. Minimum lumen output of 2800 Lumens. Protector: Glass. To be supplied complete with all necessary accessories and fixtures. Nominal voltage of 200-264V, 50Hz. Light output colour: 4000 Kelvin (Neutral white)	Wall Mounted Exterior of the building	
12	Type H Light	BEKA OMNIBLAST-2-E MIDI 5355, die-cast, aluminium, IP66. 2 x high powered 530W LED mounted on 12m Stepped buried Pole. Minimum lumen output of 72000 Lumens. Protector: Glass. 12m MH , 60 degree mounting, 530W luminaire. To include access door, 2 x MCB's, 12m pole. All fasteners to be stainless steel. Nominal voltage of 198-264V, 50Hz. Light output colour: 72000 Kelvin (Cool white).	Exterior Building	
13	Type F Light	Ceiling mounted, IP54, 4000K LED Medical Procedure/Surgical Luminaire. Minimum central illuminance: 130000lux. Electronic control gear suitable for 220 - 240 volts- 50 hertz AC operating. To be supplied with all necessary equipment. Supplied complete with 3m flex cable and 5 amp plug top.	Exterior Building	
41	Wireways	P9000 Trunking for lighting circuits	Ceiling Voids	
42	Wireways	P8000 Trunking for power circuits	Ceiling Voids	

43	Wireways	300mm Cable Tray for LV Cable	Ceiling Voids	
45	Wireways	300mm Wire basket for access control	Ceiling Voids	
46	Fire Panel	4 Loop Control Panel	Server Room	
51	Medical Bedhead Unit	To include gas lines and electrical power points for medical equipment	Consultation Rooms, Emergency Room and Procedure Room	
52	Kiosks	Moss Green	Site	
53	Generator in Enclosure	260kVA Generator	Site	
55	PTZ Dome Cameras	Ceiling Mounted	Various	
56	External Cameras	Wall Mounted	Exterior of building	
57	Network Video Recorder	90 day Storage capacity	Server Room	
58	Access Control Unit	Biometrics, Card Reader and Speaker combination.	Various	

59	No Touch Sensors	At Selected Exits	Various	
60	Metal Detector Arch	Refer to Security Layout	Security Reception & Search	
61	X-Ray Bag Scanner	Refer to Security Layout	Security Reception & Search	
62	Speaker System	Wall Mounted Speakers on anti-vandal mounting. acoustics as to ensure fit for purpose.	Main waiting & Play Area	
63	Microphones	Desktop Gooseneck Microphones. Mounted on Lectern unit with anti-vandal bracket. Connected to Audio Management system.	Emergency Room, Procedure Room & Reception	
65	Smart Board	Smart Interactive Whiteboard.	Board Rooms	
66	Motorised Projector Screen	Motorized Projector screen in Auditorium. sized in accordance to room dimensions as to ensure fit for purpose.	Board Room	
67	Projector Unit	Ceiling Mounted projector unit including bracket in Auditorium, 2xHDMI & 2xVGA inputs. Remote Power on and off.	Board Room	
70	Nurse Indicator light	Wall mounted 35mm Red LED indicator lamps		

71	Bathroom nurse call latching unit	Bathroom Latching pull call Unit		
72	Patient Pear Push Unit	Pear push unit on RCA Jack, 1.8m cord with call and reset an LED indicator.		
73	Nurse Call Button	Bed Head mounted on 100x100 plate inline moulded RCA socket for patient pear push unit. To Include latching circuits & power supply		
74	Nurse call panel	Wall mounted 300x300 Nurse call indication Panel including Screen with representation of simulation rooms, Tone generator, Power supply	Passages, Reception Emergency and Procedure Room	

Cables schedule report

Client: Client

Technical Specifications

Project Title: Thulasizwe Clinic (ZNB 5766/2024-H)

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Cable ID	Voltage	From	To	L (m)	Make-up	Type	Method	Classification
c-d-1	400V AC	Generator	TS	30	2x4Cx120mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. D - In underground ducts	
c-d-1	400V AC	TRANSFORMER SUPPLY	TS	420	3x4Cx300mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. D - In underground ducts	
c-d-1	400V AC	TS	SWITCHING PANEL	6	3x4Cx150mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. E - In enclosed trench 450mm x 300mm	
c-d-6	400V AC	SWITCHING PANEL	MAIN DISTRIBUTION PANEL	8	2x4Cx150mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. C - Clipped direct	
c-d-2	400V AC	MAIN DISTRIBUTION PANEL	DB-1.1(C-D)	35	4Cx16mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. C - On an unperforated cable tray	
c-d-3	400V AC	MAIN DISTRIBUTION PANEL	UPS	102	4Cx35mm² + E(armour) SWA/XLPE90(70)/Cu	Multicore 90°C XLPE armoured (Run to 70 °C) - Cu	Ref. C - Clipped direct	
c-d-2	400V AC	MAIN DISTRIBUTION PANEL	DB-1.2(E-F)	84	4Cx50mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. C - Clipped direct	
c-d-2	400V AC	MAIN DISTRIBUTION PANEL	DB-1.3(G)	89	4Cx25mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. C - Clipped direct	
c-d-2	400V AC	MAIN DISTRIBUTION PANEL	DB-1.4(H)	75	4Cx35mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. C - Clipped direct	
c-d-2	400V AC	MAIN DISTRIBUTION PANEL	DB-1.5(AM)	85	4Cx35mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. C - Clipped direct	
c-f-9	230V AC	DB-1.1(C-D)	P(9)1	28	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.1(C-D)	P(11)1	29	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.1(C-D)	P(12)1	44	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	

Cables schedule report

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durhan 3629
Designer	

Cable ID	Voltage	From	To	L (m)	Make-up	Type	Method	Classification
c-f-9	230V AC	DB-1.1(C-D)	P(13)1	420	2x3Cx240mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.1(C-D)	P(14)1	44	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.1(C-D)	P15(1)	27	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-1	230V AC	DB EXT	P1(1-8)	58	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P2(1-5)	36	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P3(1-2)	32	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P4(1-6)	48	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P5(1-4)	36	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P6(1-3)	32	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P7(1-4)	48	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P8(1-4)	48	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-d-9	400V AC	UPS	DB-UPS	15	4Cx25mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. E - Infloor troughs	
c-d-3	230V AC	DB-UPS	DB-1.1(UPS)	36	2Cx16mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. E - On a perforated cable tray	

Project Title: Thulasizwe Clinic (ZNB 9706/2024 H)

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Cable ID	Voltage	From	To	L (m)	Make-up	Type	Method	Classification
c-d-3	230V AC	DB-UPS	DB-1.2(UPS)EF	36	2Cx16mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. E - On a perforated cable tray	
c-d-3	230V AC	DB-UPS	DB-1.3(UPS)G	89	2Cx16mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. E - On a perforated cable tray	
c-d-3	230V AC	DB-UPS	DB-1.4(UPS)H	89	2Cx16mm² + E(armour) XLPESWAECC/M/Cu	Multicore XLPE SWA with Earth Continuity Conductor in Wire Armour - Cu	Ref. E - On a perforated cable tray	
c-f-9	230V AC	DB-UPS	RACK	120	3Cx16mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-25	230V AC	DB EXT	P1(1-4)	22	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. B - In conduit in a wall	
c-f-25	230V AC	DB EXT	P21-7)	65	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. B - In conduit in a wall	
c-f-25	230V AC	DB EXT	P3(1-7)	65	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. B - In conduit in a wall	
c-f-25	230V AC	DB EXT	P4(1)	45	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. B - In conduit in a wall	
c-f-25	230V AC	DB EXT	P3(1-2)	44	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. B - In conduit in a wall	
c-f-25	230V AC	DB EXT	P4(1-3)	48	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. B - In conduit in a wall	
c-f-25	230V AC	DB EXT	P1(1-3)	44	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. B - In conduit in a wall	
c-f-25	230V AC	DB EXT	P1(1-5)	44	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-9	230V AC	DB-1.2(E-F)	P(6)1	20	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P(7)1	34	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P(8)1	22	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	

Cables schedule report

Project Title: Thulasizwe Clinic (ZND 3706/2024 H)

Company: GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

Designer:

Cable ID	Voltage	From	To	L (m)	Make-up	Type	Method	Classification
c-f-9	230V AC	DB-1.2(E-F)	P(9)1	37	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P(10)1	33	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P(11)1	33	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P(12)1	27	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P(13)1	32	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P(14)1	19	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P15(1)	18	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P16(1)	18	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P17(1)	18	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P18(1)	35	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P19(1)	26	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.2(E-F)	P20(1)	18	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	

Cables schedule report

Project Title: Thulasizwe Clinic (ZNB 9780/2024 H)

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Cable ID	Voltage	From	To	L (m)	Make-up	Type	Method	Classification
c-f-1	230V AC	DB EXT	P1(1-5)	48	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P2(1-7)	54	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P3(1-3)	23	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P4(1-4)	43	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P5(1-7)	45	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-9	230V AC	DB-1.3(G)	P(5)1	20	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.3(G)	P(6)1	8	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.3(G)	P(7)1	27	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.3(G)	P(8)1	16	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.3(G)	P(9)1	20	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.3(G)	P(10)1	20	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-1	230V AC	DB EXT	P1(1-5)	28	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	

Cables schedule report

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Cable ID	Voltage	From	To	L (m)	Make-up	Type	Method	Classification
c-f-1	230V AC	DB EXT	P2(1-3)	54	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P3(1-4)	30	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P4(1-3)	36	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-9	230V AC	DB-1.4(H)	P(5)1	18	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.4(H)	P(6)1	8	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.4(H)	P(7)1	25	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.4(H)	P(8)1	25	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.4(H)	P(9)1	24	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.4(H)	P(10)1	20	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-1	230V AC	DB EXT	P1(1-5)	28	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P2(1-5)	26	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P3(1-5)	30	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	

Cables schedule report

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Cable ID	Voltage	From	To	L (m)	Make-up	Type	Method	Classification
c-f-1	230V AC	DB EXT	P4(1-3)	30	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-9	230V AC	DB-1.5(AM)	P(6)1	36	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.5(AM)	P(7)1	26	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.5(AM)	P(7)1	8	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.5(AM)	P(8)1	25	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.5(AM)	P(9)1	33	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.5(AM)	P(10)1	20	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.5(AM)	P(11)1	19	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.5(AM)	P(12)1	16	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.5(AM)	P(13)1	33	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.5(AM)	P(14)1	33	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.5(AM)	P(15)1	37	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	

Cables schedule report

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Cable ID	Voltage	From	To	L (m)	Make-up	Type	Method	Classification
c-f-9	230V AC	DB-1.5(AM)	P(16)1	37	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-9	230V AC	DB-1.5(AM)	P(17)1	33	3Cx4mm² (E cable core) PVC70/M/Cu	Multicore 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray	
c-f-1	230V AC	DB EXT	P2(1-3)	28	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P3(1-3)	26	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P4(1-5)	23	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	
c-f-1	230V AC	DB EXT	P5(1-5)	30	2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	Single-core 70°C PVC non-armoured - Cu	Ref. C - On an unperforated cable tray flat touching	

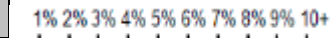
Voltage drop analysis report : TS

Technical Specifications

Company (ZNB 5766/2024-H)

Designer GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

Way	Phase	Description	Conductor	Ib (A)	1Ph AC or DC @ Operating temperature R mΩ/m	X mΩ/m	cosφ	Ct	Voltage drop (%)@ 400/230V Supply	Circuit	Total	Split Limit	Max Limit
	R	TS	30m, 2x4Cx120mm² + E(armour) XLPESWAECC/M/Cu	257	0.1	0.04	1	0.89	0	0.29	0.29	1.5	8
	Y			257	0.1	0.04	1		0	0.29	0.29		
	B			257	0.1	0.04	1		0	0.29	0.29		
1	R	SWITCHING PANEL	6m, 3x4Cx150mm² + E(armour) XLPESWAECC/M/Cu	257	0.05	0.02	1	0.92	0.29	0.03	0.32	1.5	8
1	Y	SWITCHING PANEL	6m, 3x4Cx150mm² + E(armour) XLPESWAECC/M/Cu	257	0.05	0.02	1	0.92	0.29	0.03	0.32	1.5	8
1	B	SWITCHING PANEL	6m, 3x4Cx150mm² + E(armour) XLPESWAECC/M/Cu	257	0.05	0.02	1	0.92	0.29	0.03	0.32	1.5	8

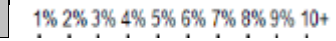


Voltage drop analysis report : SWITCHING PANEL

Company: (ZNB 5766/2024-H) GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

Designer:

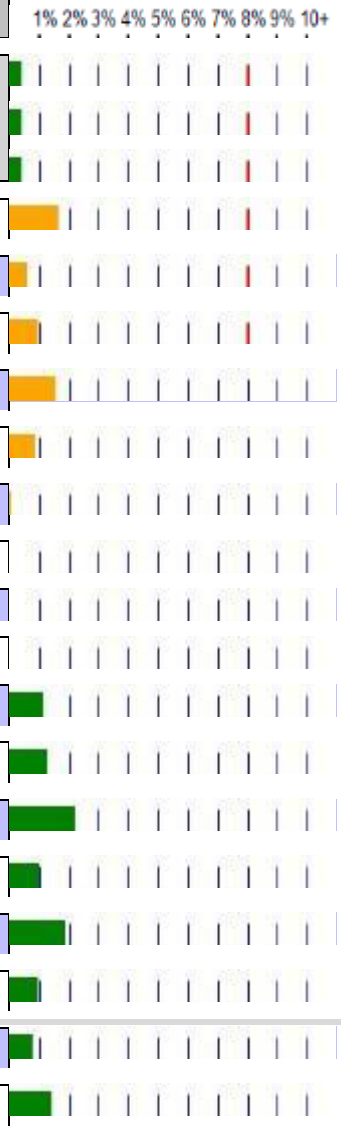
Way	Phase	Description	Conductor	Ib (A)	1Ph AC or DC @ Operating temperature R mΩ/m	X mΩ/m	cosφ	Ct	Voltage drop (%)@ 400/230V Supply	Circuit	Total	Split Limit	Max Limit
	R	SWITCHING PANEL	6m, 3x4Cx150mm² + E(armour) XLPESWAECC/M/Cu	257	0.05	0.02	1	0.92	0.29	0.03	0.32	1.5	8
	Y			257	0.05	0.02	1		0.29	0.03	0.32		
	B			257	0.05	0.02	1		0.29	0.03	0.32		
1	R	MAIN DISTRIBUTION PANEL	8m, 2x4Cx150mm² + E(armour) XLPESWAECC/M/Cu	257	0.08	0.04	1	0.89	0.32	0.06	0.39	1.5	8
1	Y	MAIN DISTRIBUTION PANEL	8m, 2x4Cx150mm² + E(armour) XLPESWAECC/M/Cu	257	0.08	0.04	1	0.89	0.32	0.06	0.39	1.5	8
1	B	MAIN DISTRIBUTION PANEL	8m, 2x4Cx150mm² + E(armour) XLPESWAECC/M/Cu	257	0.08	0.04	1	0.89	0.32	0.06	0.39	1.5	8



Voltage drop analysis report : MAIN DISTRIBUTION PANEL

Company	(ZNB 5766/2024-H) DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Way	Phase	Description	Conductor	Ib (A)	1Ph AC or DC @ Operating temperature: R mΩ/m	X mΩ/m	cosφ	Ct	Voltage drop (%)@ 400/230V: Supply	Circuit	Total	Split Limit	Max Limit
	R	MAIN DISTRIBUTION PANEL	8m, 2x4Cx150mm² + E(armour) XLPESWAECC/M/Cu	257	0.08	0.04	1	0.89	0.32	0.06	0.39	1.5	8
	Y			257	0.08	0.04	1		0.32	0.06	0.39		
	B			257	0.08	0.04	1		0.32	0.06	0.39		
1	R	DB-1.1(C-D)	35m, 4Cx16mm² + E(armour) XLPESWAECC/M/Cu	47.83	1.44	0	1	0.84	0.39	1.24	1.62	1.5	8
1	Y	DB-1.1(C-D)	35m, 4Cx16mm² + E(armour) XLPESWAECC/M/Cu	26.09	1.44	0	1	0.84	0.39	0.2	0.59	1.5	8
1	B	DB-1.1(C-D)	35m, 4Cx16mm² + E(armour) XLPESWAECC/M/Cu	33.91	1.44	0	1	0.84	0.39	0.57	0.95	1.5	8
2	R	UPS	102m, 4Cx35mm² + E(armour) SWA/XLPE90(70)/Cu	28.46	0.64	0.08	1	0.87	0.39	1.17	1.55	1.5	8.23
2	Y	UPS	102m, 4Cx35mm² + E(armour) SWA/XLPE90(70)/Cu	19.31	0.64	0.08	1	0.87	0.39	0.47	0.86	1.5	8.23
2	B	UPS	102m, 4Cx35mm² + E(armour) SWA/XLPE90(70)/Cu	3.75	0.64	0.08	1	0.87	0.39	-0.38	0.01	1.5	8.23
3	R	empty	-	-	-	-	-	-	-	-	-	-	-
3	Y	empty	-	-	-	-	-	-	-	-	-	-	-
3	B	empty	-	-	-	-	-	-	-	-	-	-	-
4	R	DB-1.2(E-F)	84m, 4Cx50mm² + E(armour) XLPESWAECC/M/Cu	65.22	0.5	0.08	1	0.84	0.39	0.73	1.12	N/A	8.14
4	Y	DB-1.2(E-F)	84m, 4Cx50mm² + E(armour) XLPESWAECC/M/Cu	65.22	0.5	0.08	1	0.84	0.39	0.86	1.24	N/A	8.14
4	B	DB-1.2(E-F)	84m, 4Cx50mm² + E(armour) XLPESWAECC/M/Cu	90.44	0.5	0.08	1	0.84	0.39	1.79	2.18	N/A	8.14
5	R	DB-1.3(G)	89m, 4Cx25mm² + E(armour) XLPESWAECC/M/Cu	26.09	0.92	0.08	1	0.82	0.39	0.62	1	N/A	8.165
5	Y	DB-1.3(G)	89m, 4Cx25mm² + E(armour) XLPESWAECC/M/Cu	38.26	0.92	0.08	1	0.82	0.39	1.49	1.88	N/A	8.165
5	B	DB-1.3(G)	89m, 4Cx25mm² + E(armour) XLPESWAECC/M/Cu	26.09	0.92	0.08	1	0.82	0.39	0.55	0.94	N/A	8.165
6	R	DB-1.4(H)	75m, 4Cx35mm² + E(armour) XLPESWAECC/M/Cu	26.09	0.66	0.08	1	0.82	0.39	0.36	0.74	1.5	8.095
6	Y	DB-1.4(H)	75m, 4Cx35mm² + E(armour) XLPESWAECC/M/Cu	41.74	0.66	0.08	1	0.82	0.39	1.02	1.41	1.5	8.095



Voltage drop analysis report : MAIN DISTRIBUTION PANEL

Company: (ZNB 5766/2024-H)
Designer: GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

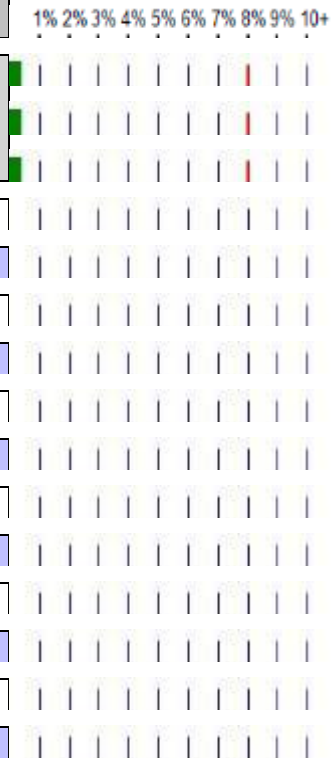
Way	Phase	Description	Conductor	Ib (A)	1Ph AC or DC @ Operating temperature: R mΩ/m	X mΩ/m	cosφ	Ct	Voltage drop (%)@ 400/230V: Supply	Circuit	Total	Split Limit	Max Limit
	R	MAIN DISTRIBUTION PANEL	8m, 2x4Cx150mm² + E(armour) XLPESWAECC/M/Cu	257	0.08	0.04	1	0.89	0.32	0.06	0.39	1.5	8
	Y			257	0.08	0.04	1		0.32	0.06	0.39		
	B			257	0.08	0.04	1		0.32	0.06	0.39		
6	B	DB-1.4(H)	75m, 4Cx35mm² + E(armour) XLPESWAECC/M/Cu	26.09	0.66	0.08	1	0.82	0.39	0.29	0.68	1.5	8.095
7	R	DB-1.5(AM)	85m, 4Cx35mm² + E(armour) XLPESWAECC/M/Cu	65.22	0.66	0.08	1	0.84	0.39	1.44	1.83	N/A	8.145
7	Y	DB-1.5(AM)	85m, 4Cx35mm² + E(armour) XLPESWAECC/M/Cu	52.17	0.66	0.08	1	0.84	0.39	0.79	1.18	N/A	8.145
7	B	DB-1.5(AM)	85m, 4Cx35mm² + E(armour) XLPESWAECC/M/Cu	66.09	0.66	0.08	1	0.84	0.39	1.55	1.94	N/A	8.145
8	R	empty	-	-	-	-	-	-	-	-	-	-	-
8	Y	empty	-	-	-	-	-	-	-	-	-	-	-
8	B	empty	-	-	-	-	-	-	-	-	-	-	-
9	R	empty	-	-	-	-	-	-	-	-	-	-	-
9	Y	empty	-	-	-	-	-	-	-	-	-	-	-
9	B	empty	-	-	-	-	-	-	-	-	-	-	-
10	R	empty	-	-	-	-	-	-	-	-	-	-	-
10	Y	empty	-	-	-	-	-	-	-	-	-	-	-
10	B	empty	-	-	-	-	-	-	-	-	-	-	-
11	R	empty	-	-	-	-	-	-	-	-	-	-	-
11	Y	empty	-	-	-	-	-	-	-	-	-	-	-
11	B	empty	-	-	-	-	-	-	-	-	-	-	-
12	R	empty	-	-	-	-	-	-	-	-	-	-	-
12	Y	empty	-	-	-	-	-	-	-	-	-	-	-
12	B	empty	-	-	-	-	-	-	-	-	-	-	-

Voltage drop analysis report : MAIN DISTRIBUTION PANEL

Company: (ZNB 5766/2024-H) GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

Designer:

Way	Phase	Description	Conductor	Ib (A)	1Ph AC or DC @ Operating temperature R mΩ/m	X mΩ/m	cosφ	Ct	Voltage drop (%)@ 400/230V Supply	Circuit	Total	Split Limit	Max Limit
	R	MAIN DISTRIBUTION PANEL	8m, 2x4Cx150mm² + E(armour) XLPESWAECC/M/Cu	257	0.08	0.04	1	0.89	0.32	0.06	0.39	1.5	8
	Y			257	0.08	0.04	1		0.32	0.06	0.39		
	B			257	0.08	0.04	1		0.32	0.06	0.39		
13	R	empty	-	-	-	-	-	-	-	-	-	-	-
13	Y	empty	-	-	-	-	-	-	-	-	-	-	-
13	B	empty	-	-	-	-	-	-	-	-	-	-	-
14	R	empty	-	-	-	-	-	-	-	-	-	-	-
14	Y	empty	-	-	-	-	-	-	-	-	-	-	-
14	B	empty	-	-	-	-	-	-	-	-	-	-	-
15	R	empty	-	-	-	-	-	-	-	-	-	-	-
15	Y	empty	-	-	-	-	-	-	-	-	-	-	-
15	B	empty	-	-	-	-	-	-	-	-	-	-	-
16	R	empty	-	-	-	-	-	-	-	-	-	-	-
16	Y	empty	-	-	-	-	-	-	-	-	-	-	-
16	B	empty	-	-	-	-	-	-	-	-	-	-	-



Voltage drop analysis report : DB-1.1(C-D)

Project: Thulasizwe Clinic (ZNB 5766/2024-H)

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Way	Phase	Description	Conductor	Ib (A)	R mΩ/m (1Ph AC or DC @ Operating temperature)	X mΩ/m (1Ph AC or DC @ Operating temperature)	cosφ	Ct	Supply (Voltage drop (%)@ 400/230V)	Circuit (Voltage drop (%)@ 400/230V)	Total (Voltage drop (%)@ 400/230V)	Split Limit (Voltage drop (%)@ 400/230V)	Max Limit (Voltage drop (%)@ 400/230V)
	R	DB-1.1(C-D)	35m, 4Cx16mm² + E(armour) XLPESWAECC/M/Cu	47.83	1.44	0	1	0.84	0.39	1.24	1.62	1.5	8
	Y			26.09	1.44	0	1		0.39	0.2	0.59		
	B			33.91	1.44	0	1		0.39	0.57	0.95		
1	R	DB EXT	-	-	-	-	-	-	-	-	-	-	-
1.1	R	P1(1-8)	58m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	6.96	9	0	1	0.88	1.62	2.76	4.39	6.6855	8.185
1.2	R	P2(1-5)	36m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	4.35	9	0	1	0.87	1.62	1.07	2.69	6.5755	8.076
1.3	R	P3(1-2)	32m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	1.74	9	0	1	0.87	1.62	0.38	2	6.5555	8.056
1.4	R	P4(1-6)	48m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	5.22	9	0	1	0.87	1.62	1.71	3.33	6.6355	8.136
1.5	R	P5(1-4)	36m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	3.48	9	0	1	0.87	1.62	0.85	2.48	6.5755	8.076
1	Y	DB EXT	-	-	-	-	-	-	-	-	-	-	-
1.1	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
1.2	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
1.3	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
1.4	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
1.5	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
1	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
2	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
2	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
2	B	DB EXT	-	-	-	-	-	-	-	-	-	-	-
2.1	B	P6(1-3)	32m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	2.61	9	0	1	0.87	0.95	0.57	1.52	6.5555	8.056
2.2	B	P7(1-4)	48m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	3.48	9	0	1	0.87	0.95	1.14	2.09	6.6355	8.136

Voltage drop analysis report : DB-1.1(C-D)

Project: Thulasizwe Clinic (ZNB 5766/2024-H)

Company GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

Designer

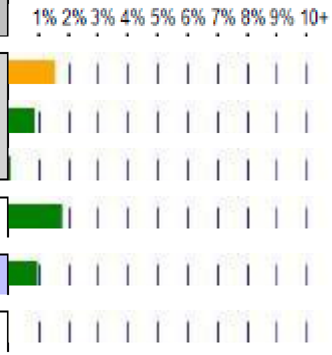
Way	Phase	Description	Conductor	Ib (A)	R mΩ/m (1Ph AC or DC @ Operating temperature)	X mΩ/m (1Ph AC or DC @ Operating temperature)	cosφ	Ct	Supply (Voltage drop (%)@ 400/230V)	Circuit	Total	Split Limit	Max Limit
	R	DB-1.1(C-D)	35m, 4Cx16mm² + E(armour) XLPESWAECC/M/Cu	47.83	1.44	0	1	0.84	0.39	1.24	1.62	1.5	8
	Y			26.09	1.44	0	1		0.39	0.2	0.59		
	B			33.91	1.44	0	1		0.39	0.57	0.95		
2.3	B	P8(1-4)	48m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	1.74	9	0	1	0.87	0.95	0.57	1.52	6.635	8.136
2.4	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
2.5	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
3	R	P(9)1	28m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.63	1.54	3.17	6.535	8.035
3	Y	P(11)1	29m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	0.59	1.6	2.19	6.54	8.04
3	B	P(12)1	44m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	0.96	2.43	3.38	6.615	8.115
4	R	P(13)1	420m, 2x3Cx240mm² (E cable core) PVC70/M/Cu	13.04	0.05	0.04	1	0.91	1.63	0.21	1.83	7	8.5
4	Y	P(14)1	44m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	0.59	2.43	3.02	6.615	8.115
4	B	P15(1)	27m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	0.96	1.49	2.44	6.53	8.03
5	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
5	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
5	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
6	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
6	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
6	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
7	R	SPD	-	-	-	-	-	-	-	-	-	-	-
7	Y	SPD	-	-	-	-	-	-	-	-	-	-	-
7	B	SPD	-	-	-	-	-	-	-	-	-	-	-

Voltage drop analysis report : UPS

Project: Thulasizwe Clinic (ZNB 5766/2024-H)

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Way	Phase	Description	Conductor	Ib (A)	R mΩ/m (1Ph AC or DC @ Operating temperature)	X mΩ/m	cosφ	Ct	Supply (Voltage drop (%)@ 400/230V)	Circuit	Total	Split Limit	Max Limit
	R	UPS	102m, 4Cx35mm² + E(armour) SWA/XLPE90(70)/Cu	28.46	0.64	0.08	1	0.87	0.39	1.17	1.55	1.5	8.23
	Y			19.31	0.64	0.08	1		0.39	0.47	0.86		
	B			3.75	0.64	0.08	1		0.39	-0.38	0.01		
1	R	DB-UPS	15m, 4Cx25mm² + E(armour) XLPESWAECC/M/Cu	26.09	0.92	0.08	1	0.82	1.55	0.21	1.77	N/A	8.305
1	Y	DB-UPS	15m, 4Cx25mm² + E(armour) XLPESWAECC/M/Cu	17.39	0.92	0.08	1	0.82	0.86	0.09	0.95	N/A	8.305
1	B	DB-UPS	15m, 4Cx25mm² + E(armour) XLPESWAECC/M/Cu	2.61	0.92	0.08	1	0.82	0.01	-0.08	-0.07	N/A	8.305



Voltage drop analysis report : DB-UPS

(ZNB 5766/2024-H)

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

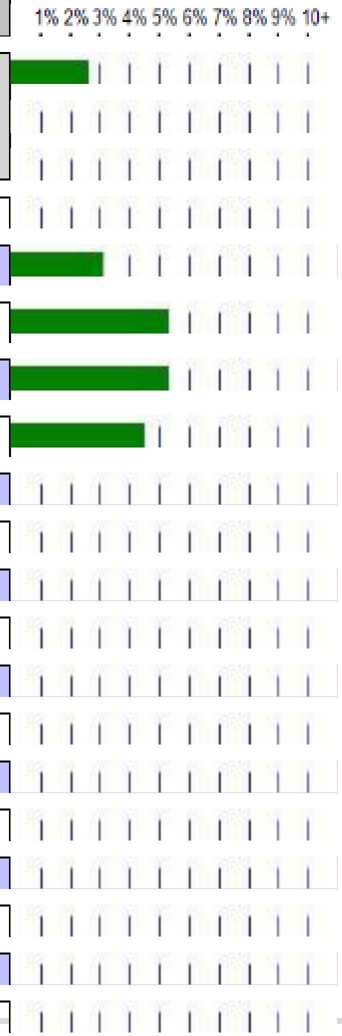
Way	Phase	Description	Conductor	Ib (A)	R mΩ/m (1Ph AC or DC @ Operating temperature)	X mΩ/m (1Ph AC or DC @ Operating temperature)	cosφ	Ct	Supply (Voltage drop (%)@ 400/230V)	Circuit	Total	Split Limit	Max Limit
	R	DB-UPS	15m, 4Cx25mm² + E(armour) XLPESWAECC/M/Cu	26.09	0.92	0.08	1	0.82	1.55	0.21	1.77	N/A	8.305
	Y			17.39	0.92	0.08	1		0.86	0.09	0.95		
	B			2.61	0.92	0.08	1		0.01	-0.08	-0.07		
1	R	DB-1.1(UPS)	36m, 2Cx16mm² + E(armour) XLPESWAECC/M/Cu	21.74	1.45	0	1	0.82	1.77	0.81	2.58	N/A	8.485
1	Y	DB-1.2(UPS)EF	36m, 2Cx16mm² + E(armour) XLPESWAECC/M/Cu	4.35	1.45	0	1	0.81	0.95	0.16	1.11	N/A	8.485
1	B	DB-1.3(UPS)G	89m, 2Cx16mm² + E(armour) XLPESWAECC/M/Cu	2.61	1.45	0	1	0.81	-0.06	0.24	0.17	1.5	8.5
2	R	DB-1.4(UPS)H	89m, 2Cx16mm² + E(armour) XLPESWAECC/M/Cu	4.35	1.45	0	1	0.81	1.77	0.4	2.16	1.5	8.5
2	Y	RACK	120m, 3Cx16mm² (E cable core) PVC70/M/Cu	13.04	1.4	0	1	0.87	0.95	1.66	2.61	N/A	8.5
2	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
3	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
3	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
3	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
4	R	SPD	-	-	-	-	-	-	-	-	-	-	-
4	Y	SPD	-	-	-	-	-	-	-	-	-	-	-
4	B	SPD	-	-	-	-	-	-	-	-	-	-	-

Voltage drop analysis report : DB-1.1(UPS)

(ZNB 5766/2024-H)

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Way	Phase	Description	Conductor	Ib (A)	R mΩ/m (1Ph AC or DC @ Operating temperature)	X mΩ/m (1Ph AC or DC @ Operating temperature)	cosφ	Ct	Supply (Voltage drop (%)@ 230V)	Circuit (Voltage drop (%)@ 230V)	Total (Voltage drop (%)@ 230V)	Split Limit (Voltage drop (%)@ 230V)	Max Limit (Voltage drop (%)@ 230V)
	R	DB-1.1(UPS)	36m, 2Cx16mm² + E(armour) XLPESWAECC/M/Cu	21.74	1.45	0	1	0.82	1.77	0.81	2.58	N/A	8.485
1	R	DB EXT	-	-	-	-	-	-	-	-	-	-	-
1.1	R	P1(1-4)	22m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	3.48	9	0	1	0.87	2.58	0.52	3.1	7	8.5
1.2	R	P21-7)	65m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	6.09	9	0	1	0.88	2.58	2.71	5.29	7	8.5
1.3	R	P3(1-7)	65m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	6.09	9	0	1	0.88	2.58	2.71	5.29	7	8.5
1.4	R	P4(1)	45m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	6.09	9	0	1	0.88	2.58	1.88	4.45	7	8.5
1.5	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
2	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
3	R	DB EXT	-	-	-	-	-	-	-	-	-	-	-
3.1	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
3.2	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
3.3	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
3.4	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
3.5	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
4	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
5	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
6	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
7	R	SPD	-	-	-	-	-	-	-	-	-	-	-



Voltage drop analysis report : DB-1.2(UPS)EF

Project: Thulasizwe Clinic (ZNB 5766/2024-H)

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Way	Phase	Description	Conductor	Ib (A)	R mΩ/m (1Ph AC or DC @ Operating temperature)	X mΩ/m (1Ph AC or DC @ Operating temperature)	cosφ	Ct	Supply (Voltage drop (%)@ 230V)	Circuit (Voltage drop (%)@ 230V)	Total (Voltage drop (%)@ 230V)	Split Limit (Voltage drop (%)@ 230V)	Max Limit (Voltage drop (%)@ 230V)
	Y	DB-1.2(UPS)EF	36m, 2Cx16mm² + E(armour) XLPESWAECC/M/Cu	4.35	1.45	0	1	0.81	0.95	0.16	1.11	N/A	8.485
1	Y	empty	-	-	-	-	-	-	-	-	-	-	-
2	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
3	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
4	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
5	Y	DB EXT	-	-	-	-	-	-	-	-	-	-	-
5.1	Y	P3(1-2)	44m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	1.74	9	0	1	0.87	1.11	0.52	1.63	N/A	8.5
5.2	Y	P4(1-3)	48m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	2.61	9	0	1	0.87	1.11	0.85	1.96	N/A	8.5
5.3	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
5.4	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
5.5	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
6	Y	DB EXT	-	-	-	-	-	-	-	-	-	-	-
6.1	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
6.2	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
6.3	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
6.4	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
6.5	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
7	Y	SPD	-	-	-	-	-	-	-	-	-	-	-

Voltage drop analysis report : DB-1.3(UPS)G

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

(ZNB 5766/2024-H)

Way	Phase	Description	Conductor	Ib (A)	1Ph AC or DC @ Operating temperature R mΩ/m	X mΩ/m	cosφ	Ct	Voltage drop (%)@ 230V Supply	Circuit	Total	Split Limit	Max Limit
	B	DB-1.3(UPS)G	89m, 2Cx16mm² + E(armour) XLPESWAECC/M/Cu	2.61	1.45	0	1	0.81	-0.06	0.24	0.17	1.5	8.5
1	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
2	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
3	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
4	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
5	B	DB EXT	-	-	-	-	-	-	-	-	-	-	-
5.1	B	P1(1-3)	44m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	2.61	9	0	1	0.87	0.17	0.78	0.95	N/A	8.5
5.2	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
5.3	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
5.4	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
5.5	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
6	B	SPD	-	-	-	-	-	-	-	-	-	-	-

1% 2% 3% 4% 5% 6% 7% 8% 9% 10+

Voltage drop analysis report : DB-1.4(UPS)H

Company	(ZNB 5766/2024-H) GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

					1Ph AC or DC @ Operating temperature					Voltage drop (%)@ 230V				
Way	Phase	Description	Conductor	Ib (A)	R mΩ/m	X mΩ/m	cosφ	Ct	Supply	Circuit	Total	Split Limit	Max Limit	1% 2% 3% 4% 5% 6% 7% 8% 9% 10+
	R	DB-1.4(UPS)H	89m, 2Cx16mm² + E(armour) XLPESWAECC/M/Cu	4.35	1.45	0	1	0.81	1.77	0.4	2.16	1.5	8.5	
1	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
2	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
3	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
4	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
5	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
6	R	DB EXT	-	-	-	-	-	-	-	-	-	-	-	
6.1	R	P1(1-5)	44m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	4.35	9	0	1	0.87	2.16	1.3	3.47	N/A	8.5	
6.2	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
6.3	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
6.4	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
6.5	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
7	R	SPD	-	-	-	-	-	-	-	-	-	-	-	

Voltage drop analysis report : DB-1.2(E-F)

Company: (ZNB 5766/2024-H) DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

Designer:

Way	Phase	Description	Conductor	Ib (A)	1Ph AC or DC @ Operating temperature: R mΩ/m	X mΩ/m	cosφ	Ct	Voltage drop (%)@ 400/230V: Supply	Circuit	Total	Split Limit	Max Limit
	R	DB-1.2(E-F)	84m, 4Cx50mm² + E(armour) XLPESWAECC/M/Cu	65.22	0.5	0.08	1	0.84	0.39	1.79	1.12	N/A	8.14
	Y			65.22	0.5	0.08	1		0.39	0.86	1.24		
	B			90.44	0.5	0.08	1		0.39	1.79	2.18		
1	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
1	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
1	B	P(6)1	20m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	2.18	1.1	3.29	N/A	8.24
2	R	P(7)1	34m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.12	1.88	3	N/A	8.31
2	Y	P(8)1	22m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.25	1.21	2.46	N/A	8.25
2	B	P(9)1	37m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	2.18	2.04	4.22	N/A	8.325
3	R	P(10)1	33m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.12	1.82	2.94	N/A	8.305
3	Y	P(11)1	33m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.25	1.82	3.07	N/A	8.305
3	B	P(12)1	27m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	2.18	1.49	3.67	N/A	8.275
4	R	P(13)1	32m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.12	1.77	2.89	N/A	8.3
4	Y	P(14)1	19m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.25	1.05	2.29	N/A	8.235
4	B	P15(1)	18m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	2.18	0.99	3.18	N/A	8.23
5	R	P16(1)	18m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.12	0.99	2.12	N/A	8.23
5	Y	P17(1)	18m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.25	0.99	2.24	N/A	8.23
5	B	P18(1)	35m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	2.18	1.93	4.11	N/A	8.315
6	R	P19(1)	26m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.12	1.43	2.56	N/A	8.27
6	Y	P20(1)	18m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.25	0.99	2.24	N/A	8.23

Voltage drop analysis report : DB-1.2(E-F)

Company: (ZNB 5766/2024-H) GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

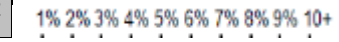
Designer:

Way	Phase	Description	Conductor	Ib (A)	1Ph AC or DC @ Operating temperature: R mΩ/m	X mΩ/m	cosφ	Ct	Voltage drop (%)@ 400/230V: Supply	Circuit	Total	Split Limit	Max Limit
	R	DB-1.2(E-F)	84m, 4Cx50mm² + E(armour) XLPESWAECC/M/Cu	65.22	0.5	0.08	1	0.84	0.39	1.79	1.12	N/A	8.14
	Y			65.22	0.5	0.08	1		0.39	0.86	1.24		
	B			90.44	0.5	0.08	1		0.39	1.79	2.18		
6	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
7	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
7	Y	DB EXT	-	-	-	-	-	-	-	-	-	-	-
7.1	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
7.2	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
7.3	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
7.4	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
7.5	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
7	B	DB EXT	-	-	-	-	-	-	-	-	-	-	-
7.1	B	P1(1-5)	48m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	4.35	9	0	1	0.87	2.18	1.42	3.6	6.8805	8.38
7.2	B	P2(1-7)	54m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	6.09	9	0	1	0.87	2.18	2.25	4.42	6.9105	8.41
7.3	B	P3(1-3)	23m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	2.61	9	0	1	0.87	2.18	0.41	2.58	6.7555	8.256
7.4	B	P4(1-4)	43m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	6.09	9	0	1	0.87	2.18	1.79	3.97	6.8555	8.356
7.5	B	P5(1-7)	45m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	6.09	9	0	1	0.87	2.18	1.87	4.05	6.8655	8.366
8	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
8	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
8	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
9	R	SPARE	-	-	-	-	-	-	-	-	-	-	-

Voltage drop analysis report : DB-1.2(E-F)

Company	(ZNB 5766/2024-H) GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Way	Phase	Description	Conductor	Ib (A)	R mΩ/m	X mΩ/m	cosφ	Ct	Supply	Circuit	Total	Split Limit	Max Limit
				1Ph AC or DC @ Operating temperature					Voltage drop (%)@ 400/230V				
	R	DB-1.2(E-F)	84m, 4Cx50mm² + E(armour) XLPESWAECC/M/Cu	65.22	0.5	0.08	1	0.84	0.39	1.79	1.12	N/A	8.14
	Y			65.22	0.5	0.08	1		0.39	0.86	1.24		
	B			90.44	0.5	0.08	1		0.39	1.79	2.18		
9	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
9	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
10	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
10	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
10	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
11	R	SPD	-	-	-	-	-	-	-	-	-	-	-
11	Y	SPD	-	-	-	-	-	-	-	-	-	-	-
11	B	SPD	-	-	-	-	-	-	-	-	-	-	-



Voltage drop analysis report : DB-1.3(G)

Company: (ZNB 5766/2024-H) GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

Designer:

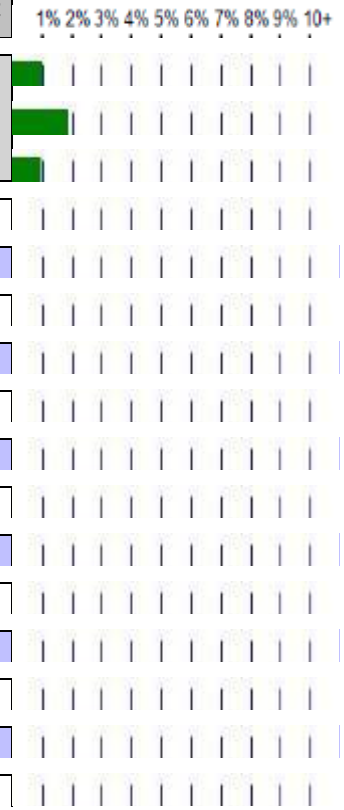
Way	Phase	Description	Conductor	Ib (A)	1Ph AC or DC @ Operating temperature R mΩ/m	X mΩ/m	cosφ	Ct	Voltage drop (%)@ 400/230V Supply	Circuit	Total	Split Limit	Max Limit
	R	DB-1.3(G)	89m, 4Cx25mm² + E(armour) XLPESWAECC/M/Cu	26.09	0.92	0.08	1	0.82	0.39	1.49	1	N/A	8.165
	Y			38.26	0.92	0.08	1		0.39	1.49	1.88		
	B			26.09	0.92	0.08	1		0.39	0.55	0.94		
1	R	P(5)1	20m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.01	1.1	2.11	N/A	8.265
1	Y	P(6)1	8m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.88	0.44	2.33	N/A	8.205
1	B	P(7)1	27m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	0.94	1.49	2.43	N/A	8.3
2	R	P(8)1	16m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.01	0.88	1.89	N/A	8.245
2	Y	P(9)1	20m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.88	1.1	2.99	N/A	8.265
2	B	P(10)1	20m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	0.94	1.1	2.04	N/A	8.265
3	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
3	Y	DB EXT	-	-	-	-	-	-	-	-	-	-	-
3.1	Y	P1(1-5)	28m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	4.35	9	0	1	0.87	1.88	0.83	2.71	6.8055	8.306
3.2	Y	P2(1-3)	54m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	2.61	9	0	1	0.87	1.88	0.96	2.84	6.9355	8.436
3.3	Y	P3(1-4)	30m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	2.61	9	0	1	0.87	1.88	0.53	2.41	6.8155	8.316
3.4	Y	P4(1-3)	36m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	2.61	9	0	1	0.87	1.88	0.64	2.52	6.8455	8.346
3.5	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
3	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
4	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
4	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
4	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
5	R	SPARE	-	-	-	-	-	-	-	-	-	-	-

Voltage drop analysis report : DB-1.3(G)

Company (ZNB 5766/2024-H) (GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

Designer

Way	Phase	Description	Conductor	Ib (A)	1Ph AC or DC @ Operating temperature R mΩ/m	X mΩ/m	cosφ	Ct	Voltage drop (%)@ 400/230V Supply	Circuit	Total	Split Limit	Max Limit
	R	DB-1.3(G)	89m, 4Cx25mm² + E(armour) XLPESWAECC/M/Cu	26.09	0.92	0.08	1	0.82	0.39	1.49	1	N/A	8.165
	Y			38.26	0.92	0.08	1		0.39	1.49	1.88		
	B			26.09	0.92	0.08	1		0.39	0.55	0.94		
5	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
5	B	DB EXT	-	-	-	-	-	-	-	-	-	-	-
5.1	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
5.2	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
5.3	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
5.4	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
5.5	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
6	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
6	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
6	B	empty	-	-	-	-	-	-	-	-	-	-	-
7	R	SPD	-	-	-	-	-	-	-	-	-	-	-
7	Y	SPD	-	-	-	-	-	-	-	-	-	-	-
7	B	SPD	-	-	-	-	-	-	-	-	-	-	-



Voltage drop analysis report : DB-1.4(H)

Company: (ZNB 5766/2024-H)
Designer: GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

Way	Phase	Description	Conductor	Ib (A)	1Ph AC or DC @ Operating temperature: R mΩ/m	X mΩ/m	cosφ	Ct	Voltage drop (%)@ 400/230V: Supply	Circuit	Total	Split Limit	Max Limit
	R	DB-1.4(H)	75m, 4Cx35mm² + E(armour) XLPESWAECC/M/Cu	26.09	0.66	0.08	1	0.82	0.39	1.02	0.74	1.5	8.095
	Y			41.74	0.66	0.08	1		0.39	1.02	1.41		
	B			26.09	0.66	0.08	1		0.39	0.29	0.68		
1	R	empty	-	-	-	-	-	-	-	-	-	-	-
1	Y	empty	-	-	-	-	-	-	-	-	-	-	-
1	B	P(5)1	18m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	0.68	0.99	1.67	6.685	8.185
2	R	P(6)1	8m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	0.75	0.44	1.19	6.635	8.135
2	Y	P(7)1	25m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.41	1.38	2.79	6.72	8.22
2	B	P(8)1	25m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	0.68	1.38	2.06	6.72	8.22
3	R	P(9)1	24m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	0.75	1.32	2.07	6.715	8.215
3	Y	P(10)1	20m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.41	1.1	2.52	6.695	8.195
3	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
4	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
4	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
4	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
5	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
5	Y	DB EXT	-	-	-	-	-	-	-	-	-	-	-
5.1	Y	P1(1-5)	28m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	4.35	9	0	1	0.87	1.41	0.83	2.24	6.7355	8.236
5.2	Y	P2(1-5)	26m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	4.35	9	0	1	0.87	1.41	0.77	2.18	6.7255	8.226
5.3	Y	P3(1-5)	30m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	4.35	9	0	1	0.87	1.41	0.89	2.3	6.7455	8.246
5.4	Y	P4(1-3)	30m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	2.61	9	0	1	0.87	1.41	0.53	1.94	6.7455	8.246

Voltage drop analysis report : DB-1.4(H)

Company (ZNB 5766/2024-H)
Designer (GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

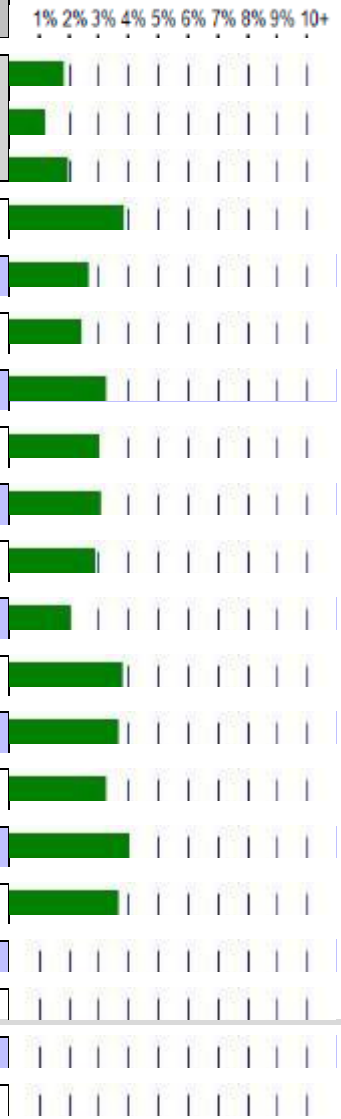
					1Ph AC or DC @ Operating temperature					Voltage drop (%)@ 400/230V				
Way	Phase	Description	Conductor	Ib (A)	R mΩ/m	X mΩ/m	cosφ	Ct	Supply	Circuit	Total	Split Limit	Max Limit	1% 2% 3% 4% 5% 6% 7% 8% 9% 10+
	R	DB-1.4(H)	75m, 4Cx35mm² + E(armour) XLPESWAECC/M/Cu	26.09	0.66	0.08	1	0.82	0.39	1.02	0.74	1.5	8.095	
	Y			41.74	0.66	0.08	1		0.39	1.02	1.41			
	B			26.09	0.66	0.08	1		0.39	0.29	0.68			
5.5	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-	
5	B	DB EXT	-	-	-	-	-	-	-	-	-	-	-	
5.1	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
5.2	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
5.3	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
5.4	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
5.5	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
6	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
6	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-	
6	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
7	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
7	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-	
7	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
8	R	SPD	-	-	-	-	-	-	-	-	-	-	-	
8	Y	SPD	-	-	-	-	-	-	-	-	-	-	-	
8	B	SPD	-	-	-	-	-	-	-	-	-	-	-	

Voltage drop analysis report : DB-1.5(AM)

Company: (ZNB 5766/2024-H) DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

Designer:

Way	Phase	Description	Conductor	Ib (A)	1Ph AC or DC @ Operating temperature: R mΩ/m	X mΩ/m	cosφ	Ct	Voltage drop (%)@ 400/230V: Supply	Circuit	Total	Split Limit	Max Limit
	R	DB-1.5(AM)	85m, 4Cx35mm² + E(armour) XLPESWAECC/M/Cu	65.22	0.66	0.08	1	0.84	0.39	1.55	1.83	N/A	8.145
	Y			52.17	0.66	0.08	1		0.39	0.79	1.18		
	B			66.09	0.66	0.08	1		0.39	1.55	1.94		
1	R	P(6)1	36m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.83	1.99	3.82	N/A	8.325
1	Y	P(7)1	26m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.18	1.43	2.62	N/A	8.275
1	B	P(7)1	8m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.95	0.44	2.39	N/A	8.185
2	R	P(8)1	25m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.83	1.38	3.21	N/A	8.27
2	Y	P(9)1	33m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.18	1.82	3	N/A	8.31
2	B	P(10)1	20m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.95	1.1	3.05	N/A	8.245
3	R	P(11)1	19m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.83	1.05	2.88	N/A	8.24
3	Y	P(12)1	16m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.18	0.88	2.06	N/A	8.225
3	B	P(13)1	33m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.95	1.82	3.77	N/A	8.31
4	R	P(14)1	33m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.83	1.82	3.65	N/A	8.31
4	Y	P(15)1	37m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.18	2.04	3.22	N/A	8.33
4	B	P(16)1	37m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.95	2.04	3.99	N/A	8.33
5	R	P(17)1	33m, 3Cx4mm² (E cable core) PVC70/M/Cu	13.04	5.5	0	1	0.88	1.83	1.82	3.65	N/A	8.31
5	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
5	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
6	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
6	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-



Voltage drop analysis report : DB-1.5(AM)

Company (ZNB 5766/2024-H)
Designer (GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629

					1Ph AC or DC @ Operating temperature					Voltage drop (%)@ 400/230V				
Way	Phase	Description	Conductor	Ib (A)	R mΩ/m	X mΩ/m	cosφ	Ct	Supply	Circuit	Total	Split Limit	Max Limit	1% 2% 3% 4% 5% 6% 7% 8% 9% 10+
	R	DB-1.5(AM)	85m, 4Cx35mm² + E(armour) XLPESWAECC/M/Cu	65.22	0.66	0.08	1	0.84	0.39	1.55	1.83	N/A	8.145	
	Y			52.17	0.66	0.08	1		0.39	0.79	1.18			
	B			66.09	0.66	0.08	1		0.39	1.55	1.94			
6	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
7	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
7	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-	
7	B	DB EXT	-	-	-	-	-	-	-	-	-	-	-	
7.1	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
7.2	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
7.3	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
7.4	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
7.5	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
8	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
8	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-	
8	B	DB EXT	-	-	-	-	-	-	-	-	-	-	-	
8.1	B	P2(1-3)	28m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	2.61	9	0	1	0.87	1.94	0.5	2.44	6.7855	8.286	
8.2	B	P3(1-3)	26m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	2.61	9	0	1	0.87	1.94	0.46	2.4	6.7755	8.276	
8.3	B	P4(1-5)	23m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	4.35	9	0	1	0.87	1.94	0.68	2.62	6.7605	8.26	
8.4	B	P5(1-5)	30m, 2x1Cx2.5mm² + 1x2.5mm² E PVC70/S/Cu	4.35	9	0	1	0.87	1.94	0.89	2.83	6.7955	8.296	
8.5	B	SPARE	-	-	-	-	-	-	-	-	-	-	-	
9	R	SPARE	-	-	-	-	-	-	-	-	-	-	-	
9	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-	

Voltage drop analysis report : DB-1.5(AM)

Project Title: Thulasizwe Clinic (ZNB 5766/2024-H)

Company	GRID DNA CONSULTING ENGINEERS - No 4, Derby Place Westville, Durban 3629
Designer	

Way	Phase	Description	Conductor	Ib (A)	R mΩ/m	X mΩ/m	cosφ	Ct	Supply	Circuit	Total	Split Limit	Max Limit
				1Ph AC or DC @ Operating temperature					Voltage drop (%)@ 400/230V				
	R	DB-1.5(AM)	85m, 4Cx35mm² + E(armour) XLPESWAECC/M/Cu	65.22	0.66	0.08	1	0.84	0.39	1.55	1.83	N/A	8.145
	Y			52.17	0.66	0.08	1		0.39	0.79	1.18		
	B			66.09	0.66	0.08	1		0.39	1.55	1.94		
9	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
10	R	SPARE	-	-	-	-	-	-	-	-	-	-	-
10	Y	SPARE	-	-	-	-	-	-	-	-	-	-	-
10	B	SPARE	-	-	-	-	-	-	-	-	-	-	-
11	R	SPD	-	-	-	-	-	-	-	-	-	-	-
11	Y	SPD	-	-	-	-	-	-	-	-	-	-	-
11	B	SPD	-	-	-	-	-	-	-	-	-	-	-