



higher education
& training
Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA



EKURHULENI EAST TVET COLLEGE

"Committed to Excellence"

INSTITUTION: EKURHULENI EAST TVET COLLEGE, ASDC & BRAKPAN CAMPUSES

ELECTRICAL SPECIFICATION

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ELECTRICAL SPECIFICATION

LIST OF ABBREVIATIONS AND ACRONYMS

ASIB – Automatic Sprinkler Inspection Bureau

BS – British Standard

CD – compact disk

CFOT – Certified Fiber Optic Technician

DB – Distribution Board

DC – Direct Current

ECA – electrical Contracting Association of South Africa

ECC – Earth Continuity Conductor

EN – European Standards

IEC – International Electrotechnical Commission

IP – Ingress Protection

ISO – International Organization for Standardization

IT – information technology

LAN – Local Area Network

LCD – Liquid Crystal Display

LED – Light-Emitting diode

MCB – Miniature Circuit Breaker

OTDR – Optical Time Domain Reflectometer

PA – Public Address

PVC – Polyvinyl Chloride

SABS - South African Bureau of Standards

SANS – South African national standards

SWA – Steel Wire Armoured

UPS – Uninterruptible Power Supply

VdS - Vertrauen durch Sicherheit



ELECTRICAL SPECIFICATION

LIST OF SYMBOLS

μ - Micro

m - Metre

Ω – Ohm

\varnothing – Diameter



ELECTRICAL SPECIFICATION

DOCUMENTS FORMING PART OF THIS SPECIFICATION

Documents forming part of this installation specification:

DOC NO.	TITLE
D34375.00-BOQ-003-01	Bill of Quantities



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DRAWINGS FORMING PART OF THIS SPECIFICATION

Drawings forming part of this installation specification:

Table1: Drawing Register

No.	Rev.	Description
D34375.00-301-01	T0	Site Reticulation Layout
D34375.00-312-119	T0	DB Schematics Layout
D34375.00-312-120	T0	DB Schematics Layout
D34375.00-312-121	T0	DB Schematics Layout
D34375.00-312-122	T0	DB Schematics Layout
D34375.00-312-123	T0	DB Schematics Layout
D34375.00-312-124	T0	DB Schematics Layout
D34375.00-312-125	T0	DB Schematics Layout
D34375.00-312-126	T0	DB Schematics Layout
D34375.00-312-127	T0	DB Schematics Layout
D34375.00-312-128	T0	DB Schematics Layout
D34375.00-312-129	T0	DB Schematics Layout
D34375.00-312-130	T0	DB Schematics Layout
D34375.00-350-43	T0	Lightning & Earthing Protection
D34375.00-350-44	T0	Lightning & Earthing Protection
D34375.00-350-45	T0	Lightning & Earthing Protection
D34375.00-350-46	T0	Lightning & Earthing Protection
D34375.00-350-47	T0	Lightning & Earthing Protection
D34375.00-370-53	T0	Electrical Small Power Layout
D34375.00-370-54	T0	Electrical Small Power Layout
D34375.00-370-55	T0	Electrical Small Power Layout
D34375.00-380-57	T0	Electrical Lighting Layout
D34375.00-380-58	T0	Electrical Lighting Layout
D34375.00-380-59	T0	Electrical Lighting Layout
D34375.00-380-60	T0	Electrical Lighting Layout
D34375.00-380-61	T0	Electrical Lighting Layout
D34375.00-380-62	T0	Electrical Lighting Layout
D34375.00-380-63	T0	Electrical Lighting Layout
D34375.00-380-64	T0	Electrical Lighting Layout
D34375.00-350-48	T0	Lightning & Earthing Protection
D34375.00-350-49	T0	Lightning & Earthing Protection



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D34375.00-350-50	T0	Lightning & Earthing Protection
D34375.00-350-51	T0	Lightning & Earthing Protection
D34375.00-350-52	T0	Lightning & Earthing Protection
D34375.00-370-56	T0	Electrical Small Power Layout
D34375.00-370-57	T0	Electrical Small Power Layout
D34375.00-370-58	T0	Electrical Small Power Layout
D34375.00-370-59	T0	Electrical Small Power Layout
D34375.00-370-60	T0	Electrical Small Power Layout
D34375.00-370-61	T0	Electrical Small Power Layout
D34375.00-370-62	T0	Electrical Small Power Layout
D34375.00-370-63	T0	Electrical Small Power Layout
D34375.00-370-64	T0	Electrical Small Power Layout
D34375.00-380-69	T0	Electrical Lighting Layout
D34375.00-380-70	T0	Electrical Lighting Layout
D34375.00-380-71	T0	Electrical Lighting Layout
D34375.00-380-72	T0	Electrical Lighting Layout
D34375.00-380-73	T0	Electrical Lighting Layout
D34375.00-380-74	T0	Electrical Lighting Layout
D34375.00-380-75	T0	Electrical Lighting Layout



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I. SCOPE OF WORK

This specification covers the manufacture, supply, delivery, offloading, installation, testing, commissioning and handing over of all the electrical works for Benoni Campus.

The attention of the Tenderer is drawn to the Bill of Quantities that forms an integral part of the specification and especially the following clauses:

Where the term "or other approved" is used in connection with proprietary materials or articles, it is to be understood that approval shall be at the sole discretion of the Engineer. Where brand or trade names are referred to in the Drawings and Bill of Quantities, these shall indicate the quality and type of material or fitting required and no substitution of materials so specified will be permitted, unless the authority of the Engineer has been obtained, in writing, before tenders close.

The drawings listed in the index form an integral part of this specification, but are issued for TENDER PURPOSES ONLY and are not intended to be used for construction without the prior written approval of the Client's Representative.

The positioning of all equipment, light fittings, light switches, socket outlets etc. on the drawing, is schematic only and in some cases may not correspond to the actual layout of the buildings. The successful Tenderer shall be responsible for indicating the correct position of all electrical equipment on their working drawings to enable the Client's Representative to produce "as built" drawings.

a. Work included

The successful Tenderer shall provide all labour, materials, equipment, tools and supervision to transport, assemble, erect, install, connect, test and place into service the complete electrical works. The works shall consist of, but are not limited to:

The supply and install new:

- Electrical Distribution Boards as detailed in the BOQ.
- Lighting, light switches, motion sensors and photocells.
- Plug sockets, power-skirting, trunking and wireways.
- Lightning & earthing protection systems.
- Uninterrupted power supplies.
- 1 x 300KVA closed set Generator similar or equivalent to a Scania/Volvo including the following:



ELECTRICAL SPECIFICATION

- Diesel engine coupled with a brushless alternator, all on a fabricated steel base via anti-vibration mounts.
- Direct injection engine with water cooling and four cycle with mechanical governor.
- 300KVA at 0.8PF with 400/230V, three phase four wire, 50Hz running at 1500RPM with an overload capacity of 10%.
- Alternator to be single bearing brushless with 2/3 pitch winding and class H insulation. Voltage regulation plus 1.5% with low harmonic distortion and IP21 degree protection.
- 800L base tank including fuel gauge, filler cap, dished bottom with drain and plug.
- Automatic Mains Failure Control Panel equipped with the following:
 - Incoming Isolator
 - Alternator circuit breaker with adjustable thermal and magnetic overload.
 - Mechanically and electrically interlocked change over system 4 pole switching.
 - One set of three current transformers
 - 1 x 3A automatic battery charger with short circuit protection.
 - Emergency stop button.
 - Control circuit breakers and relays all wired to terminals.
 - PLC type generator control with metering and monitoring systems with commands to start, changeover and stop.
 - Viewable functions must include battery voltage, mains and alternator voltage, phase and frequency.
 - Maintenance free lead calcium battery.
 - Exhaust including residential silencer.
 - Weatherproof canopy.
 - Concrete plinth to cater for the specified load and dimension of the gen-set.



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- Full load test certificate and operator's manual with final commissioning.
- 1 x 150KVA closed set Generator similar or equivalent to a Scania/Volvo including the following:
 - Diesel engine coupled with a brushless alternator, all on a fabricated steel base via anti-vibration mounts.
 - Direct injection engine with water cooling and four cycle with mechanical governor.
 - 150KVA at 0.8PF with 400/230V, three phase four wire, 50Hz running at 1500RPM with an overload capacity of 10%.
 - Alternator to be single bearing brushless with 2/3 pitch winding and class H insulation. Voltage regulation plus 1.5% with low harmonic distortion and IP21 degree protection.
 - 800L base tank including fuel gauge, filler cap, dished bottom with drain and plug.
 - Automatic Mains Failure Control Panel equipped with the following:
 - Incoming Isolator
 - Alternator circuit breaker with adjustable thermal and magnetic overload.
 - Mechanically and electrically interlocked change over system 4 pole switching.
 - One set of three current transformers
 - 1 x 3A automatic battery charger with short circuit protection.
 - Emergency stop button.
 - Control circuit breakers and relays all wired to terminals.
 - PLC type generator control with metering and monitoring systems with commands to start, changeover and stop.
 - Viewable functions must include battery voltage, mains and alternator voltage, phase and frequency.
 - Maintenance free lead calcium battery.
 - Exhaust including residential silencer.



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- Weatherproof canopy.
- Concrete plinth to cater for the specified load and dimension of the gen-set.
- Full load test certificate and operator's manual with final commissioning.

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Tenderers are to allow for ALL work and materials indicated and implied on the drawings, whether indicated in the specification or not, to deliver a complete and operational project.

b. Special Conditions

All work shall be done by an electrical contractor registered with the Electrical Contracting Association of South Africa (ECA) and Department of Labour.

The electrical contractor shall provide certified copies as proof of accreditation and registration with the ECA and Department of Labour prior to commencement at the site hand-over meeting and prior to commencement of any work.

Lightning protection soil resistivity tests, risk assessment, detail designs and installation work shall be done by a certified person and who are able to provide proof of successfully completed projects with contact details and references.

Electronic systems, detail designs and installation work shall be done by a competent certified person and who are able to provide proof of successfully completed projects with contact details and references.

Service Provider needs to be Commscope Certified.

c. Site Establishment

The successful Tenderer shall provide all the facilities required to enable him to undertake the Contract Works.



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d. Standards and Codes of Practice

All installation work shall comply with the following Specifications, Legal Requirements and Codes of Practice:

Table 2: Standards and Codes of Practice

LEGISLATION, STANDARDS AND CODES OF PRACTICE – ELECTRICAL RELATED	
NUMBER	TITLE
OHSA	Occupation Health & Safety Act (act 85 of 1993), with Regulations included
BS 1363-2	13 A plugs, socket-outlets, adaptors and connection units – Specification for 13 A switched and un-switched socket-outlets
ISO 9001 – 9004	Quality Management Systems
ISO 3046-1	Part 1: Standard reference conditions, declarations of power, fuel and lubricating oil consumptions, and test methods
ISO 3046-3	Part 3: Test measurements
ISO 3046-4	Part 4: Speed governing
ISO 3046-5	Part 5: Torsional vibrations
ISO 3046-6	Part 6: Over speed protection
ISO 3046-7	Part 7: Codes for engine power
NRS 048-4	Quality of supply
NRS 0424-1	Diesel alternator set Part1: Diesel alternator sets for fixed installations-Preferred requirements for application their organisations by the DC and standby equipment representative user group.
SANS 10086-1	The installation, inspection and maintenance of equipment used in explosives atmospheres Part 1: Installations including surface installations on mines.
SANS 204	Energy efficiency in buildings
SANS 10108	The classification of hazardous locations and the selection of apparatus for use in such locations.
SANS 1012	Electric light dimmers
SANS 10142-1	The wiring of premises. Part 1: Low-voltage installations
SANS 1019	Standard voltages, currents and insulation levels for electricity supply
SANS 10198-1-14	The selection, handling and installation of electric power cables of rating not exceeding 33 kV. Parts 1 to 13
SANS 10199	The design and installation of earth electrodes
SANS 1029	Miniature substations
SANS 10292 (SABS 0292)	Earthing of low-voltage (LV) distribution systems.
SANS 10313	The protection of structures against lightning
SANS 1063	Earth rods, couplers and connections
SANS 1065-1 & 2	Metal conduits and fittings (screwed-end)



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SANS 1085	Wall outlet boxes for the enclosure of electrical accessories
SANS 1195	Busbars.
SANS 10114-1	Interior lighting Part 1: Artificial lighting of interiors
SANS 10114-2	Interior lighting Part 2: Emergency lighting
NUMBER	TITLE
SANS 1213	Mechanical cable glands
SANS 1239	Plugs, socket-outlets and couplers for industrial purposes
SANS 1339	Electric cables – Cross-linked polyethylene (XLPE) insulated cables for voltages 3,8/6,6 kV to 19/33 kV
SANS 1411-1	Materials of insulated electric cables and flexible cords – Part 1: Conductors
SANS 1418-1	Aerial bundled conductor systems – Part 1: Cores.
SANS 1433-1	Electrical terminals and connectors – Part 1: Terminal blocks having screw and screw less terminals.
SANS 1433-2	Electrical terminals and connectors – Part 2: Flat push-on connectors.
SANS 1473-1	Low-voltage switchgear and control gear assemblies – Part 1: Type-tested, partially type-tested and specially tested assemblies with a rated short-circuit withstand strength above 10 kea
SANS 1507-1 Parts 1-6	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)
SANS 156	Moulded-case circuit-breakers
SANS 1574-3	Electric flexible cores, cords and cables with solid extruded dielectric insulation – Part 3: PVC-insulated cores and cables.
SANS 1574-5	Electric flexible cores, cords and cables with solid extruded dielectric insulation – Part 5: Rubber-insulated cores and cables.
SANS 1632-1	Batteries Part 1: General information-Definitions, abbreviations and symbols
SANS 164-0 parts 1 - 6	Plug and socket-outlet systems for household and similar purposes for use in South Africa
SANS 1665	Metal-clad switchgear for rated a.c. voltages above 1 kV and up to and including 36 kV – General requirements and methods of test
SANS 1765	Low-voltage switchgear and control gear assemblies (distribution boards) with a rated short-circuit withstand strength up to and including 10 kA
SANS 1777	Photoelectric control units for lighting (PECUs)
SANS 1799	Watt-hour meters – AC electronic meters for active energy
SANS 1874	Metal-enclosed ring main units for rated a.c. voltages above 1 kV and up to and including 24 kV.
SANS 1973-1	Part 1 Type tested Assemblies with Stated deviations and a rated short circuit withstand strength over 10kA
SANS 1973-3	Low-voltage switchgear and control gear ASSEMBLIES – Part 3: Safety of ASSEMBLIES with a rated prospective short-circuit current of up to and including 10 kA
SANS 1973-8	Low-voltage switchgear and control gear ASSEMBLIES – Part 8: Safety of minimally tested ASSEMBLIES (MTA) with a rated short-circuit current above 10 kA and a rated busbar current of up to and including 1 600 A a.c. and d.c
SANS 337	Stove couplers
SANS 529	Heat-resisting wiring cables
SANS 556-1	Low-voltage switchgear – Part 1: Circuit-breakers



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SANS 60044-1 to 5	Instrument transformers – Part 1 to 5
SANS 60079 (all parts)	Electrical apparatus for explosive gas atmospheres
SANS 60137	Insulated bushings for alternating voltages above 1 000 V
SANS 60265-1	High-voltage switches – Part 1: Switches for rated voltages above 1 kV and less than 52 kV
SANS 60269-1	Low-voltage fuses
SANS 60282-1	High-voltage fuses – Part 1: Current-limiting fuses
NUMBER	TITLE
SANS 60282-2	High-voltage fuses – Part 2: Expulsion fuses
SANS 60309-1	Plugs, socket-outlets and couplers for industrial purposes – Part 1: General requirements
SANS 60439-1 to 5	Low-voltage switchgear and control gear Assemblies Parts1 to 5
SANS 60502-4	Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 4: Test requirements on accessories for cables with rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV).
SANS 60529	Degrees of protection provided by enclosures (IP Code).
SANS 60669-1	Switches for household and similar fixed electrical installations – Part 1: General requirements.
SANS 60669-2-1/	Switches for household and similar fixed electrical installations – Part 2-1: Particular requirements – Electronic switches.
SANS 60896-21	Stationary Lead Acid Batteries Part 21: Valve regulated types- Methods of Test
SANS 60896-22	Stationary Lead Acid Batteries Part 21: Valve regulated types-Requirements
SANS 60947-2	Low-voltage switchgear and control gear – Part 2: Circuit-breakers
SANS 60947-3	Low-voltage switchgear and control gear – Part 3: Switches, disconnectors, switch-disconnectors and fuse combination units.
SANS 60947-4-1	Low-voltage switchgear and control gear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters
SANS 60947-4-2	Low-voltage switchgear and control gear – Part 4-2: Contactors and motor-starters – AC semiconductor motor controllers and starters.
SANS 60947-4-3	Low-voltage switchgear and control gear – Part 4-3: Contactors and motor-starters – AC semiconductor controllers and contactors for non-motor loads
SANS 60947-5-5	Low-voltage switchgear and control gear – Part 5-5: Control circuit devices and switching elements Electrical emergency stop device with mechanical latching function
SANS 60947-6-1	Low-voltage switchgear and control gear – Part 6-1: Multiple function equipment – Transfer switching equipment.
SANS 61000-3-4	Electromagnetic compatibility - Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16 A
SANS 61000-4-7	General guide on harmonics and inter-harmonics measurements and instrumentation, for power supply systems and equipment connected thereto
SANS 61008-1	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) – Part 1: General rules.
SANS 61084-1	Cable trunking and ducting systems for electrical installations – Part 1: General requirements.
SANS 61238-1	Compression and mechanical connectors for power cables for rated voltages up to 30 kV (Um = 36 kV) – Part 1: Test methods and requirements



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SANS 61312-3	Protection against lightning electromagnetic impulse – Part 3: Requirements of surge protective devices (SPDs).
SANS 61347-2-2	Lamp control gear – Part 2-2: Particular requirements for d.c. or a.c. supplied electronic step-down convertors for filament lamps
SANS 61386-1	Conduit systems for cable management – Part 1: General requirements.
SANS 61386-21	Conduit systems for cable management – Part 21: Particular requirements – Rigid conduit systems
SANS 61386-22	Conduit systems for cable management – Part 22: Particular requirements – Pliable conduit systems.
SANS 61386-23	Conduit systems for cable management – Part 23: Particular requirements – Flexible conduit systems
SANS 61558-1	Safety of power transformers, power supplies, reactors and similar products – Part 1: General requirements and tests.
SANS 61641	Arc Testing

NUMBER	TITLE
SANS 61643-1	Low-voltage surge protective devices – Part 1: Surge protective devices connected to low-voltage power distribution systems – Requirements and tests.
SANS 61643-12	Low-voltage surge protective devices – Part 12: Surge protective devices connected to low-voltage power distribution systems – Selection and application principles
SANS 62053-11	Electricity metering equipment (a.c.) – Particular requirements – Part 11: Electromechanical meters for active energy (classes 0,5, 1 and 2).
SANS 62053-21	Electricity metering equipment (a.c.) – Particular requirements – Part 21: Static meters for active energy (classes 1 and 2).
SANS 62271 All Parts	High-voltage switchgear and control gear
SANS 62305-1	Protection of structures against lightning Part 1: General principles
SANS 62305-1	Protection against lightning – Part 1: General principles.
SANS 62305-2	Protection against lightning – Part 2: Risk management.
SANS 62305-3	Protection against lightning – Part 3: Physical damage to structures and life hazard
SANS 62305-4	Protection against lightning – Part 4: Electrical and electronic systems within structures
SANS 767-1	Earth leakage protection units – Part 1: Fixed earth leakage protection circuit-breakers.
SANS 780	Distribution transformers
SANS 950	Un-plasticized polyvinyl chloride rigid conduit and fittings for use in electrical installations
SANS 60044-1	Instrument transformers Part 1: Current transformers
SANS 60044-2	Instrument transformers Part 2: Inductive voltage transformers
SANS 60265-1	High-voltage switches Part 1: Switches for rated voltages above 1 kV and less than 52 kV
SANS 62271-200	A.C. metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV
SANS 60439-1	Low-voltage switchgear and control gear assemblies Part 1: Type tested and partially type-tested assemblies



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SANS 60529	Degrees of protection provided by enclosures (IP code)
SANS 60947-1	Low-voltage switchgear and control gear Part 1: General rules
SANS 60947-2	Low-voltage switchgear and control gear Part 2: Circuit-breakers
SANS 60947-4	Low-voltage switchgear and control gear Part 4: Contactors and motor-starters
SANS 60947-5	Low-voltage switchgear and control gear Part 5: Control circuit devices and switching elements
SANS 60947-6	Low-voltage switchgear and control gear Part 6: Multiple function equipment
SANS 61439-1	LV Control-Gear and assemblies
SANS 60076 1-21	Power Transformers
SANS 10400	Code of Practice for the Application of the National Building Regulations (as amended)
	DPW requirements
	Electricity Regulation Act, No 4 of 2006 (as amended)
	The National Building Regulations and Building Standards Act 1996 (Act 29 of 1996) (as amended)
	Local Municipal By-Laws and any special requirements of the local supply authority
	Energy Code of Conduct for all Government Buildings
	National and Local Authority Fire Regulations and SANS 10400-T: 2011 (Ed 3)
NUMBER	TITLE
	ICASA Regulations
	Construction Regulations 2003
	The Local Government Act 1998 (Act 10 of 1998 (Gauteng), municipal by-laws and any special requirements of the local supply authority
	The Fire Brigade Services Act 2000 (Act 14 of 2000)
	The Post Office Act 1998 (Act 124 of 1998)
	The Electricity Act 1996 (Act 88 of 1996)
	The Regulations of the local Gas Board where applicable
	The National Water Act 1998 (Act no. 36 of 1998)
	The Water Services Act 1997 (Act no. 108 of 1997)
	The General Authorizations (Water act)
	The Environmental Conservation Act 1998 (Act no. 73 of 1989)
	The National Environmental Management Act 1998 (Act no. 107 of 1998)

e. Client Standards

In line with accepted practice, the Client has, from time to time, standardised on the supply of various items of equipment. The Tenderer shall undertake, and by the submission of his tender confirms that he has undertaken, to inform himself of the status of such standardisation requirements ruling at the time of tender, and any deviations from such standards shall be corrected by the successful Tenderer at his expense.



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f. Maintenance of installations

With effect from the date of the issue of the Completion (First Delivery Certificate) the successful Tenderer shall, at his own expense, undertake the regular servicing of the installation during the maintenance period and shall make all adjustments necessary for the correct operation thereof.

The maintenance period shall be 12 months.

If during the said period the installations are not in working order, due to the fault of the successful Tenderer, or if the installations develop defects, the successful Tenderer shall immediately upon being notified thereof take steps to remedy the defects and make any necessary adjustments.

Should such stoppages however become so frequent as to become troublesome, or should the installations otherwise prove unsatisfactory the successful Tenderer shall, if called upon by the Client, at his own expense, replace the affected part or the whole of the installations or such parts thereof as the Client may deem necessary with apparatus specified by the Client.

g. Balancing Of Loads

The successful Tenderer is required to balance the load as equally as possible over the multiphase supply where applicable.

1. LOW VOLTAGE PVC INSULATED CABLES (600-1000V)

Low voltage power cables shall be two, three or four core stranded plain annealed copper conductor, polyvinyl chloride (PVC) insulated, PVC bedded, galvanised steel wire armoured (SWA), PVC sheathed, PVC/PVC/SWA-ECC/PVC type cable 600/1000V to SANS 1574 as amended.

All low voltage power cables shall be manufactured in strict accordance to SANS 1507 and shall bear the SABS mark on the outer sheath.

The insulation material shall comprise of PVC in accordance to SANS 1411: Part II as amended.

The bedding shall consist of a continuous impermeable of PVC extruded sheath to fit the core or cores closely and to fill the interstices between the cores of multi-core cables.

Where armouring is specified, the armouring shall consist of one layer of round galvanized steel wire in accordance with SANS 1411: Part IV. Aluminium strip or tape armouring is not acceptable.



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Unless otherwise specified specifically, all multi-core cables shall include earth continuity conductor (ECC) in the armouring. Where required additional bare earth copper conductor shall be installed as specified.

All cable connections from 16mm² conductor sizes and larger shall be of the hexagonal crimp method using correct size and type of lugs, ferrule and matching crimp head dices. Smaller conductor sizes shall be done with indent crimp method with tools having the ratchet facility to ensure a full depth crimp.

All routine tests specified by SANS 1507 as amended shall be carried out on production runs of the cable. Two test certificates will be provided for each cable drum delivered to site.

Wooden cables drums shall be clearly marked on both sides in accordance with SANS 1507 as amended. Both ends of the cable on the wooden drum must be sealed to prevent penetration of moisture. Both ends of the cable shall furthermore be fixed to the flange of the drum to avoid loose coiling and mechanical damage. Cable drums shall be placed on firm, well-drained surfaces.

Cable ducting and trenches shall be in accordance with SANS 2001 PD3.

2. LOW VOLTAGE CABLE INSTALLATION

All low voltage cables shall be in accordance with the standard and detail specifications.

Cables shall be loaded, transported and off-loaded on wooden cable drums manufactured and supplied for the purpose by the cable manufacturer.

The transportation, loading, off-loading and installation of the cables shall be in strict accordance with the requirements of the cable manufacturer, this specification and relevant standards which shall be continuously supervised and controlled by a competent person who is well experienced in the handling and installation of cables.

Cables that are not terminated shall at all times be capped and sealed to protect the ends from the ingress of moisture and dirt.

Cables shall be installed in the routes specified. Cable lengths are nominal and shall not be used for ordering purposes. The Contractor shall be remunerated on actual lengths of cable installed. All wastage shall be for the account of the successful Tenderer.

All cables shall be rolled from the wooden cable drum such that the cable will not be subjected to twisting or tensions values exceeding the values specified by the manufacturer.



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Cables laid in the same trench shall be laid parallel to each other and shall not cross over one another.

All cables shall be run in single un-spliced lengths and shall be drawn up and terminated in the distribution kiosk, distribution boards, plant or equipment as required. When complete, all cabling and wiring shall present a neat and tidy appearance.

No joints shall be allowed in cables unless specifically called for in the Bill of Quantities or unless the cable lengths exceed the maximum standard drum lengths supplied by the manufacturer or without the prior approval of the Engineer.

The minimum radius of bends in all cables shall be as per the manufacturer recommendation to ensure that the minimum bending radii of the cables are maintained at all times during and after installation. Failure to adhere to this requirement may result in the rejection of the particular cable.

Special care shall be taken during installation to avoid any damage to the sheaths of the cable. Rollers and pulling socks or other suitable means approved by the Engineer shall be used for installing the cables in trenches. The rollers shall be free of sharp edges and shall be spaced to prevent the cable from touching the ground during the pulling process. Corner rollers shall be used at each corner and where required bond pulling shall be used.

Where communication, instrument or signal type service cables run with power cables in the same trench, the minimum separation shall be 500mm. Where "signal" and power services cross, they shall be separated vertically by 500mm.

LV cables no less than 600mm below final ground level measured to the top of the cable.

The cables shall be laid in such a manner that the beginning of a drum shall be laid from the end of the previous drum to ensure that the lay of the cores remain the same. Low voltage cables shall overlap by at least 500mm.

All cables shall be fitted with the appropriate size lugs at the termination. Lugs and ferrules equal or greater the 16mm² shall be crimped with a hydraulic crimper only using a hexagon die.

All glands, lugs, fixers, nuts, bolts and other consumables are, where not specifically detailed in the Bill of Quantities, are to be included within the price for cable terminations.

Where cables cross under roadways, walkways, parking areas, paved areas and other services, and where cables enter buildings, the cables shall be installed in 110mm diameter Class 9 u-PVC pipes or as indicated on the drawings.



ELECTRICAL SPECIFICATION

Every cable shall be marked on both ends by means of an approved type cable tag label on which the size of cable and its source or destination and cable number is punched. The label shall be installed around the outer PVC sheath immediately below the cable termination and gland.

3. CABLES IN TRENCHES

All cable trenches shall be routed as indicated on the drawings attached to this specification. Deviations shall only be permitted by prior consent of the Electrical Engineer or the issuing of revised drawings.

Trenches shall be straight and be cut as square as possible and the bottom made flat and free from stones or other hard projections. Where this is not possible, a 50mm layer of stone free sand shall be laid at the bottom of the trench to accommodate the cables. It must be presumed that, where trenching occurs within soft/hard rock, the trenching rate shall include for the stone free layer of soil. After installation, the cables shall be covered with a 100mm layer of fine, stone free soil prior to backfilling. The backfill shall be adequately compacted in layers of 250mm to the approval of the Electrical Engineer.

The minimum width of trenches shall be 300mm for one cable and 500mm for up to three unless otherwise specified.

Cables shall be laid at a minimum depth of 600mm (to top of cable) for cables rated 600/1000V, and 1 000mm (to top of cable) for cables rated greater than 1000V, below the adjoining final ground level, except where intersections take place with other services, adequate clearance between the services shall be allowed.

A cable marking tape shall be run 300mm above each cable. Where multiple services are installed within the same trench, two marker tapes shall be installed marking the width extremities of the trench. For cables rated greater than 1 000V, protective cable tiles shall be laid at 600mm above each main cable for the entire length of the cable trench.

The Tenderer shall excavate by hand due to limited access or the proximity of other services.

Special care shall be taken at intersections with other services. Any damage to other services shall be made good and paid for by the Contractor.

No excavated material shall be left closer than 300mm from the side of the excavation. The excavated material shall take up as small an area as possible with the safety of the workmen and Works taken into consideration.

The Tenderer shall maintain the excavation in a good condition, free of water, mud, loose ground, rocks, stones, gravel and other strange material until the cables are installed and the excavation is backfilled and completed.



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The cable shall, after the completion of the trench, be laid with the minimum of delay so that the trench can be backfilled. Timeous arrangements shall be made that all cables be inspected by the Electrical Engineer prior to backfilling and closing trenches. The Tenderer shall be responsible for informing the Electrical Engineer timeously, and non-inspected closed trenches may be required to be opened up for test inspections or may be rejected.

All open cable trenches shall be effectively barricaded so as to prevent people from falling into the trenches. Cable trenches within demarcated and fenced construction areas shall be barricaded with danger tape and maintained to be clearly visible to all construction activities.

4. CABLES IN SLEEVES

Pulling socks or other suitable means approved by the Engineer shall be used for the installation of cables in sleeves. Care shall be taken to ensure that the maximum allowed mechanical forces on the cables are not exceeded and that the sheaths are not damaged during installation. Furthermore, the Contractor shall ensure that the cables are not kinked or excessively bent while maintaining the minimum bending radius as specified by the manufacturer.

The Contractor shall use necessary precautions to ensure that all cables are not damaged at the mouth of cable sleeves.

The Contractor shall inspect the sleeves before installation of the cables to ensure and confirm that there are no sharp edges present that could cause damage to the sheaths.

Cables found with scratch marks or other forms of damage will be rejected and shall be replaced at the Contractor's cost.

Should long runs of cables in sleeves be encountered, it may be required to grease the cable with petroleum jelly or other non-aggressive compound to facilitate the installation. This will however be discussed with the Engineer prior to installation.

5. CABLES ON CABLE RACKING

Cables to be installed on cable racking shall be secured to the cable racking at intervals not exceeding 1m.

Cables with diameters larger than 50mm and cables in trefoil arrangement shall be secured by means of stainless steel bandit straps (over a PVC strap for the protection of sheath). Smaller cables shall be secured by means of PVC cable ties.

All cables shall be individually strapped, except for cables installed in trefoil format.



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6. CABLE NUMBERING AND CORE IDENTIFICATION

Each cable shall be numbered by means of an approved type cable tag attached to both ends below each termination and gland. Each tag shall indicate the designation connected at the other end, cable size, number of cores, length, earth wire size and be easily readable after installation.

7. DISTRIBUTION BOARDS

The successful Tenderer shall be responsible for the design and installation of the distribution boards so as to ensure that they fit comfortably in the positions specified on the drawings, are easily maintained and the doors of the distribution boards can be fully opened.

The layouts and construction of all distribution boards shall be to the approval of the Engineer prior to ordering and manufacturing.

The distribution boards shall be of the flush / floor standing / surface mounting type/s. The distribution board tray shall be constructed of 1.6mm minimum thickness hot dip galvanised steel or folded 3CR12 sheet metal. Pre-punched knockouts for conduit shall be incorporated in the upper and lower sides of the distribution board tray prior to galvanising. The size of tray shall be determined by the number of circuits actually installed allowing for 30% additional circuit space and spare conduits installed from the distribution board to the ceiling void where the distribution board (DB) is built into a wall.

The architrave frame shall be constructed with square edges from minimum 1.6 mm thick 3CR12 steel and be powder coated. The architrave frame shall form a 25 mm border around the bonding tray and shall be fixed to the bonding tray in such a manner as to allow for adjustment for the inequalities in the wall finish. A minimum of 75 mm shall be allowed between the inside of the architrave frame and the equipment.

The distribution board cover shall be constructed of minimum 1.6mm thick folded 3CR12 steel and be powder coated. The distribution board cover shall have machine cut openings for the specified electrical equipment and as indicated on the single line diagrams. The distribution board cover shall furthermore be fitted with suitable handles to facilitate safe the removal of the cover.

Distribution boards shall be equipped with single/double hinged doors. The doors shall be constructed of 2 mm minimum thick 3CR12 steel and be powder coated. Where required, the doors shall be reinforced to ensure rigidity. The door shall be mounted flush in the architrave frame and will comply with the requirements detailed on the drawings.

The distribution boards shall be equipped with suitably sized tinned solid copper neutral and earth bars as required for earth leakage protected circuits and for the balancing of the circuits. Only one neutral conductor shall terminate in each clamp. 30% extra terminals shall be provided above those circuits actually installed.



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Wiring shall be done by means of PVC insulated copper conductors with sizes to suit the relevant switchgear. The ends of the conductors shall be provided with suitably sized lugs, firmly crimped for connection to busbars.

The main/incoming isolator/circuit breaker shall be mounted at the left hand side of the distribution board. The isolators and circuit breakers shall comprise the list as shown on the single line diagram. Should the distribution board comprise of rows of equipment, then sufficient vertical space shall be allowed for between equipment for the bending and termination of conductors and cables. The earth leakage circuit breakers/isolators shall be 30mA sensitivity with a tolerance of +0 to -50%.

All metal doors shall be earthed bonded to the distribution board tray by means of an insulated copper strap, tooth washers, bolts and nuts.

Every circuit on each distribution board shall be clearly and legibly labelled. The legend shall be typed and circuit breaker numbering shall be of the engraved type.

All unequipped spaces in the distribution boards shall be fitted with dummy miniature circuit breakers (MCBs) or approved cover plates.

uPVC sleeves installed shall cater for the cable size and the minimum bending radius on the sleeve with minimum 6 times the diameter of the sleeve.

Distribution boards shall be painted and labelled in accordance with the details as specified below:

Table 3: DB Descriptions

	Normal Supply	Essential Supply	UPS Supply
Colour of Indoor Distribution Board	White or Beige	White or Beige but preferably Red	White or Beige but preferably Blue
Colour of Outdoor Distribution Board	Electric Orange colour B26 of SANS 10140 (Part II)	Electric Orange colour B26 of SANS 10140 (Part II)	Electric Orange colour B26 of SANS 10140 (Part II)
Colour of Face Plate	White or Beige (Indoor) Electric Orange (Outdoor)	Signal Red colour B26 of SANS 1091	Blue colour F06 of SANS 1091
Label Type	Black letters on White Ivorene label	White engraved letters on red Ivorene label	White engraved letters on blue Ivorene label
Label Fixing	Ivorene label to be glued with super glue or pop riveted to face plate or frame		
Distribution Board Label Details	Distribution Board name e.g. DB A	Distribution Board name e.g. DB AE	Distribution Board name e.g. DB AU



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	Normal Supply	Essential Supply	UPS Supply
Face Plate Label Details	Distribution Board Name; Indication of Feeder source; Size of Feeder cable; Fault level; Rating of Distribution Board; Phase rotation		
Letter Font	Arial		
Letter Size	Distribution Board label 6mm Face Plate label 3mm		
Labelling of Cables	All incoming and outgoing cables must be labelled with Ivorene labels indicating the designation and size of the cable		

8. CONDUIT AND ACCESSORIES (PVC)

The conduit and wiring system shall include all conduit, draw boxes (where required), joints, elbows and other accessories required for the completion of the Contract Works. Consumables, including saddles, fixers, screws, conduit bushes, etc., are deemed to be included within the rates quoted. A minimum number of joints shall be permitted in any length of conduit run between draw boxes, switch socket outlets, luminaries, distribution boards, etc.

All the conduiting shall be done on the roof trusses (attached by means of saddles onto the bottom of the trusses) or on top of the ring beams or chased into walls or cast in concrete where applicable. The conduit work shall cater for face brick external wall finishes and plastered/face brick internal finishes to all buildings. No surface conduit shall be allowed and the successful Tenderer shall build conduits into the walls. Where services exit in face brick walls, the successful Tenderer is to ensure that the conduit box or switch box is symmetrical with the nearest brick course.

The successful Tenderer shall be responsible for the conduit routing. Draw-boxes are to be provided in accordance with the Wiring Code and wherever necessary to facilitate easy wiring.

The successful Tenderer shall have a representative in attendance at all times when the casting of concrete slabs takes place, to ensure that no movement or damage to conduit occurs.

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

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

The bonding of PVC tubing to connectors, elbows or termination boxes shall be carried out using a good quality adhesive, rendering the pipe work completely watertight.



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The loop in system shall be used throughout the installation. This means that all wiring shall be possible from below the ceiling and that no inspection or draw boxes shall be allowed in the ceiling space.

For light and socket outlet circuits, the conduit used shall have an external diameter of 20mm.

For telephone and local area network (LAN) circuits, the conduit used shall have an external diameter of 25 or 32mm. In all other instances the sizes of conduit shall be in accordance with the Wiring Code for the specified number and size of conductors. For a single outlet point, a 25mm conduit must be installed and a 32mm to power skirting for every 5 or less outlet points.

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

Under no circumstances will conduit having a wall thickness of less than 1.6mm be allowed in screeding laid on top of concrete slabs.

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

Flexible connections between conduit and appliance or other equipment shall be by means of flexible conduit.

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 Engineer to any claim submitted by the successful Tenderer that may result from a lack of knowledge in regard to the requirements of the supply authority.

The Contractor shall make himself familiar with the positions of all fittings, such as blackboards, pinning boards, cupboards, shelving, work-tops, etc, before commencing the conduit installation. The position of switches and socket outlets as indicated on the drawings are approximate only. The Contractor must verify that the final position of these will not be covered by the installation of the fittings referred to above, or come midway between the junction of any dadoes and upper wall finishes.

No extras will be entertained for moving switches or socket outlets as a result of the Contractor's failure to verify the final positions of the fittings or type of wall finish.



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9. CONDUIT IN ROOF SPACES

Conduit in roof spaces shall be installed parallel or at right angles to the roof members and shall be secured at intervals not exceeding 1.5m by means of saddles screwed to the underside of the roof timbers.

Nails or crampets will not be allowed.

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

Under flat roofs, in false ceilings or where there is less than 1m 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.

10. SURFACE MOUNTED CONDUIT

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

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

Conduit will be secured on heavy duty approved spaced saddles rigidly secured to the mounting surface.

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

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

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

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

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

Only approved plugging materials such as aluminium inserts, fibre plugs, plastic plugs, etc, and round-head screws shall be used for fixing saddles, switches,



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socket outlets, etc., to walls. Wood plugs and the plugging in joints in brick walls are not acceptable.

No extras will be entertained for moving switches or socket outlets as a result of the Contractor's failure to verify the final positions of the fittings or type of wall finish.

11. WIRING

In general, all wiring used in installations shall be of at least 600/1000V grade in accordance with SABS 1507 and PVC insulated, subject to volt drop calculation results.

Light, ceiling fan and extractor fan circuits shall be wired with 2.5mm² 7 strand copper conductor PVC insulated wire, subject to volt drop calculation results.

Switched socket outlets and power points shall be wired with 4mm² 7 strand copper conductor PVC insulated wire, subject to volt drop calculation results.

Geyser, air conditioner and heater circuits shall be wired with 4mm² 7 strand copper conductor PVC insulated wire, subject to volt drop calculation results.

Stove and oven cooker circuits shall be wired with 6mm² 7 strand copper conductor PVC insulated wire, subject to volt drop calculation results.

Wiring for circuits not specified shall be according to SANS 10142-1.

Associated with every circuit, a stranded copper earth conductor shall be run and connected to the terminal of the appliance or outlet and on the installed earth bar within the distribution board. Wire sizes shall be as follows:

6mm ² conductor	:	4mm ² earth wire
4mm ² conductor	:	2.5mm ² earth wire
2.5mm ² conductor	:	2.5mm ² earth wire
1.5mm ² conductor	:	2.5mm ² earth wire

Where circuits are run in metal conduit, bare earth conductor shall be used and PVC insulated earth conductor shall be used for circuits run in PVC conduit.

12. POWER SKIRTING

The power skirting shall provide for all the services detailed on the layout diagrams, and shall be in accordance with the type specified in the legend, or equal approved. Wiring shall conform to the standards detailed within this specification. The power skirting shall be of the type detailed on the layout diagrams complete with all bends and end caps.



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The per meter rate quoted for the supply of the power skirting shall include for all necessary covers, fitting mechanisms, fixers and consumables, but shall not include for switched socket, telephone or computer LAN outlets plus cover plates and other hardware fitted into the power skirting.

Conduits linking between sections of power skirting and between the power skirting and the relevant distribution boards shall be provided as per the requirements for plug, telephone and computer LAN circuits.

13. LIGHTING

13.1 LIGHTING CONDUIT WORK

Lighting circuits are to be conduited using 20mm conduit, and all lighting circuits are to be routed via the ceiling, either cast into the ceiling slab or saddled to roof trusses and branding in the ceiling void. A separate circuit shall be run from the distribution board for each of the light circuits as indicated on the layout diagrams.

Light points are to consist of 60mm round boxes 32mm deep with side/back entry. Where a light point is to be cast into a ceiling slab a deep conduit box with extension ring shall be used to provide a 61mm deep conduit box.

For external wall mounted lighting the conduit shall be attached to the fitting in such a manner as to provide a weatherproof and vermin proof seal. Where a luminaire is to be installed on a face brick wall, conduit shall be chased into the inner skin or routed in the wall cavity, and shall only protrude at the position of the mounting, terminating in a conduit box over which the luminaire shall be mounted.

The light switch point shall consist of a galvanised pressed steel conduit box of dimensions 100mm x 50mm x 50mm deep recessed into the brickwork to allow for a flush mounting.

The successful Tenderer is to co-operate closely with the building contractor to ensure that luminaires are symmetrically positioned with regards to the ceiling pattern. The exact positioning of lights and switches is to be confirmed with the Client's Representative.

13.2 LIGHTING GENERAL

Lighting shall comply with the SABS standards where applicable. The luminaires specified are detailed in the Bill of Quantities and drawings and luminaire schedule. Where alternative luminaires and lamps are offered, the details shall be submitted with the tender. All alternatives shall be subject to the approval of the Client's Representative. Earth conductors shall be connected to the earthing terminal of all luminaires and in accordance with SANS 10142-1.

All luminaires shall be supplied complete with a first working fitting of the appropriate lamp in each lamp holder. Each lighting circuit on the Distribution



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Board shall consist of a 10A single pole MCB of 6kA rupturing capacity, unless specified otherwise on the single line diagram.

Unless otherwise specified in the Bill of Quantities or the drawings, the light switches shall be of Clipsal Series 2000, Crabtree Diamond or other approved. The correct PVC cover plate shall be provided with the light switch and included in the rate for the light switch.

The colour coding of light switches shall be in accordance with the details as specified below:

Table 4: Colour Coding of Switches

	Normal Supply	Essential/Emergency Supply	UPS Supply
Colour of Cover Plate	White		
Colour of Switch Toggle	White	Red	Blue
Label Type	Black letters on White Ivorene label or engraved directly on the cover plate with Black infill	Red letters on White Ivorene label or engraved directly on the cover plate with Red infill	Blue letters on White Ivorene label or engraved directly on the cover plate with Blue infill
Label Fixing	Ivorene label to be glued with super glue or pop riveted to cover plate		
Cover Plate Label Details	Distribution Board name and circuit number feeding the switch e.g. DBA L1	Distribution Board name and circuit number feeding the switch e.g. DBAE LE1	Distribution Board name and circuit number feeding the switch e.g. DBAU LU1
Letter Font	Arial		
Letter Size	3mm		

13.2 LIGHT EMITTING DIODE (LED) LUMINAIRES

LED linear light fittings are to be of the PioLed manufacture or other approved. Performance requirements of LED luminaires shall be according to SANS 475. Luminaires shall also bear the SANS mark of approval and the SANS 1464 safety mark.

NB: NO ALTERNATIVE LIGHT FITTINGS WILL BE ACCEPTED AFTER TENDER AWARD.

14. SWITCHED SOCKET OUTLETS (PLUGS)

Plug circuits are to be conduited using 25mm conduit, and all plug circuits are to be cast into the floor slab, unless circumstances specific to the installation require otherwise. A separate circuit shall be run from the distribution board for each of the plug circuits as indicated on the layout diagrams.



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The plug point shall consist of a galvanised pressed steel flush/surface mounted conduit switch box of dimensions 100mm x 100mm x 50mm deep recessed into the brickwork to allow for a flush mounting.

Unless otherwise specified in the Bill of Quantities or the drawings, the socket outlets shall be of the round pin 16A rating euro socket outlet type where indicated, similar in design and construction to the Clipsal Series 2000, Crabtree Diamond or other approved. The correct cover plate shall be provided with the switched socket outlet and included in the rate for the plug.

The colour coding of switched socket outlets shall be in accordance with the details as specified below:

Table 5: Colour Coding of Switched Socket Outlets

	Normal Supply	Essential/Emergency Supply	UPS Supply
Colour of Cover Plate	White		
Colour of Switch Toggle	White	Red	Blue
Label Type	Black letters on White Ivorene label or engraved directly on the cover plate with Black infill	Red letters on White Ivorene label or engraved directly on the cover plate with Red infill	Blue letters on White Ivorene label or engraved directly on the cover plate with Blue infill
Label Fixing	Ivorene label to be glued with super glue or pop riveted to cover plate		
Cover Plate Label Details	Distribution Board name and circuit number feeding the socket outlet e.g. DB A/P1-1 Each socket outlet on a circuit shall be labelled	Distribution Board name and circuit number feeding the switch e.g. DB AE/PE1-1 Each socket outlet on a circuit shall be labelled	Distribution Board name and circuit number feeding the switch e.g. DB AU/PU1-1 Each socket outlet on a circuit shall be labelled
Letter Font	Arial		
Letter Size	3mm		
Earth Pin	Round		
Colour of Female Insert	White		

All switched socket outlets fed from circuits equipped with Earth Fault Monitoring equipment shall be equipped with double pole switches.

Dedicated switched socket outlets for computer equipment only, shall comply generally with those fed from the normal supply, but shall have red cover plates,



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switch toggles and female inserts, and shall only accept plugs with D-shaped earth pins.

All switched socket outlets shall comply with SABS 164 and shall be rated at 16A.

Not more than six 16A double switched socket outlets shall be connected to any one circuit without the approval of the Client's Representative.

Each power circuit on the distribution board shall consist of a 20A single pole MCB of the correct kA rupturing capacity as specified on the single line diagram.

Spurs and additions to any switched socket outlet circuit will not be accepted.

15. AIR CONDITIONER CIRCUITS

Air conditioner circuits are to be conduited using 25mm conduit, and all air conditioner circuits are to be routed via the ceiling, either cast into the ceiling slab or saddled to roof trusses and brandering in the ceiling void. The circuit shall terminate in a 60mm round conduit box installed flush on the external wall and in such a manner as to provide a weatherproof and vermin proof seal. The conduit box shall be located at a point within 1.5m of the position at which the air conditioner condenser unit is to be mounted. A separate circuit shall be run from the distribution board for each of the air conditioner circuits as indicated on the layout diagrams. Unless specified otherwise in the Bill of Quantities, the successful Tenderer shall not be responsible for the supply and installation of the air conditioner units, but shall be responsible for the electrical connection to the air conditioner units.

Each air conditioner circuit on the Distribution Board shall, depending on the size of the air conditioning unit, consist of either a 30A 2 pole or a 30A 3 pole MCB of 5kA rupturing capacity, unless specified otherwise on the single line diagram.

A 30A 2 pole or 30A 3 pole weatherproof Ingress Protection 65 (IP65) enclosed type corrosion proof PVC encased isolating switch shall be mounted over the position of the external conduit box. The isolator shall have a 5kA rating, unless specified otherwise on the single line diagram.

Unless otherwise specified in the Bill of Quantities or the drawings, the isolator outlets shall be similar in design and construction to the Clipsal Series 2000, Crabtree Diamond or other approved. The correct PVC cover plate shall be provided with the isolator outlet and included in the rate.

16. EXTRACTOR FAN CIRCUITS

For extractor fans to be mounted in walls or windows, a 16A front entry two pole cord grip isolator shall be installed not further than 1.5m away from each extractor fan. The isolator shall be flush mounted on the wall adjacent to the fan.



ELECTRICAL SPECIFICATION

For extractor fans mounted in ceilings, the 5A, 3 pin socket outlet mounted in a 63mm diameter round conduit box shall be installed not further than 1.5m away from the extractor fan. The extractor fan shall be fitted with a 5A, 3 pin plug.

For ducted extraction systems mounted in ceilings, a 16A two pole isolator shall be installed in a 100 x 100 x 50 conduit box not further than 1.5m from the fan motor. The fan motor shall be connected to the isolator using a flexible conduit connector.

Where indicated on the layout diagram, each extractor fan shall be wired into the light circuit of the room in which it is to be installed.

Unless otherwise specified in the Bill of Quantities or the drawings, the isolator outlets shall be similar in design and construction to the Clipsal Series 2000, Crabtree Diamond or other approved. The correct PVC cover plate shall be provided with the isolator outlet and included in the rate.

17. EQUIPMENT ISOLATORS

The colour coding of isolators located adjacent to items of fixed equipment as prescribed in SANS 10142-1 or elsewhere in this specification or drawings, shall be in accordance with the details as specified below:

Table 6: Colour Coding of Isolators

	Normal Supply	Essential/Emergency Supply	UPS Supply
Colour of Cover Plate	White		
Colour of Isolator Toggle	White	Red	Blue
Label Type	Black letters on White Ivorene label or engraved directly on the cover plate with Black infill	Red letters on White Ivorene label or engraved directly on the cover plate with Red infill	Blue letters on White Ivorene label or engraved directly on the cover plate with Blue infill
Label Fixing	Ivorene label to be glued with super glue or pop riveted to cover plate		
Cover Plate Label Details	Distribution Board name and circuit number feeding the isolator e.g. DBA I1	Distribution Board name and circuit number feeding the isolator e.g. DBAE IE1	Distribution Board name and circuit number feeding the isolator e.g. DBA U/IU1-1
Letter Font	Arial		
Letter Size	3mm		

Where Blue isolator toggles are not obtainable and written approval was obtained from the Engineer, an isolator switch incorporating a Red or Blue neon or LED indicator may be used. Alternatively, a White isolator toggle may be used but the isolator toggle must be tagged with a non-removable Red or Blue sticker.



ELECTRICAL SPECIFICATION

Unless otherwise specified in the Bill of Quantities or the drawings, the isolator outlets shall be similar in design and construction to the Clipsal Series 2000, Crabtree Diamond or other approved. The correct PVC cover plate shall be provided with the isolator outlet and included in the rate.

18. EARTHING AND LIGHTNING PROTECTION

General

All workmanship and materials used shall be of the highest standard and shall be carried out in accordance with the best modern practice, as determined by the Engineer.

The entire installation shall comply in every respect with the latest amended publication of the relevant specifications.

Definitions

Lightning Protection System

The whole system of conductors used to protect a structure from the effects of lightning.

Air Terminal

The part of a lightning protection system that is intended to intercept lightning discharges directly.

Down Conductor

A conductor that connects the air terminal (s) to the earth terminals (s).

Earth Terminal

The part of a lightning protection system that is intended to discharge lightning currents into the general mass of the earth.

Earthing Electrode

The part of an earth terminal which makes direct electrical contact with the earth.

Bond

A conductor that provides electrical connection between the lightning protection system and the metal work of the structure to be protected or between various parts of this metal work.

Joint



ELECTRICAL SPECIFICATION

A mechanical junction between two conductors for purpose of providing electrical continuity between two parts of the lightning protection system.

Testing Joint

A joint in a down-conductor or in a bond connecting two sections of the lightning protection system so designed and situated as to enable measurements to be made of the resistance to earth or of electrical continuity of parts of the lightning protection system.

Detailed scope

The contractor shall have a specialist who will undertake the soil resistivity tests and submit a detail design based on soil resistivity results indicating the expected earth reading to the engineer for approval prior to commencement of the installation.

Each transformer shall have an earth mat that is connected to the earth point of the transformer.

The earth mat shall be provided by the successful Tenderer as close as possible to the distribution board. The earth electrode shall consist of 10mmØ solid copper conductor and treaded copper coated earth spikes bearing the SABS mark of approval. A minimum of 250µm copper coated mild steel threaded on both ends driven into the ground to a depth where the reading obtained on equipment as specified does not exceed 2Ω. The distribution board earth bar shall be connected to the earth by means of a bare stranded copper conductor of size equivalent to that of the main incoming cable.

Earth continuity between any point and an exterior earth connection shall be proven by a Meggar reading of zero, i.e. full continuity.

All light fittings, fixed appliances such as stoves, geysers, etc., switched socket outlets and steel or copper water pipes shall be suitably bonded to a good earth.

Should non-conductive water piping be used in buildings for hot or cold water, the geyser or heat pump earth must be bonded to the main earth in each distribution board and to the main water supply piping.

No exothermic weld connections are allowed.

The lightning protection system shall consist of an aluminium roof conductor system in the case of non-metallic roofs and metallic roofs with which do not conform with minimum SANS62305-3:2011 (as amended), linked via a series of aluminium down conductors to buried earth spikes and 10mmØ solid copper trench earths. In the case of metallic roofs, that conform with minimum SANS requirements, the roof shall be bonded to the buried earth spikes and trench earths by means of down conductors. The down conductors shall be spaced at a maximum of 20m apart around the entire building.



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All conductors shall be in accordance with the requirements of BSS 1474 or American Standards Specification 6063. All aluminium conductors shall have a cross-section area of not less than 50mm² (domestic dwelling only) or 70mm² for all other applications. The dimensions of flat section conductors shall be a minimum of 20mm x 3mm. Where conductors are mounted in stand-off guides, the cross-sectional area of the conductor shall be not less than 70mm² to give adequate mechanical strength.

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

The conductor system shall be supported in guides so that an air gap exists at all times between the aluminium and the surface of the structure, the guides being seated upon plastic or other similar insulating material. Should conductors be installed directly upon the surface of concrete or cement plaster, an insulating strip is to be installed over their entire length to prevent contact between the two surfaces. Guides shall be installed to support the conductor at intervals not exceeding 1.2m horizontally or 1.5m vertically.

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

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

Where external down-conductors are installed in areas which are readily accessible to the public, the lower ends of the conductors shall be enclosed in a semi-rigid insulating material. In the case of a circular section conductor this shall comprise a 2m length of 20mm diameter conduit. The conduit shall be securely attached to the wall by means of galvanized heavy duty steel saddles fixed with stainless steel screws and plugs, spaced at intervals not exceeding 1m. The ends of the conduit shall not be sealed.

Standard Procedure to be followed by the Specialist Contractor

- a. Conduct a risk assessment on various structures and equipment, as required by the SANS Code of Practice.
- b. Conduct resistance test measurements at areas where existing earthing has been installed and measure earth termination points connected and disconnected.



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- c. Conduct soil resistivity surveys where new installations are intended by means of the Wenner and fall of potential method.
- d. Analyse from the surveys whether the ground conditions are in any way corrosive as per the SANS Code of Practice.
- e. Block plan/site plan drawing to be provided so that required earthing can be marked up to upgrade wherever necessary.
- f. Once the survey has been conducted and drawings marked up, etc., to provide quotation to upgrade wherever necessary.
- g. Supply and install materials to structures and equipment wherever upgrading or new system may be installed to SANS requirements.
- h. Conduct final resistance test measurements in presence of authorized personnel and issue an Earthing & Lightning Protection Report and Certificate/s.
- i. Provide detail design of the complete earthing system complete with SANS10313 Lightning Protection System Installation Safety Report for acceptance by the Engineer.

The acceptance letter will be submitted by the Engineer.

All test procedures and recommendations will fully comply with the SANS Code of Practice 10313: 2010 in conjunction with SANS 62305-1-2-3-4: 2011 and IEC 62305-1-2-3-4: 2010.

18.1 JOINTS ABOVE GROUND

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

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

Down-conductors are to be terminated approximately 200mm above finished ground level. Circular section aluminium is to be jointed to a 70mm² (50mm² in the case of domestic dwellings) stranded copper conductor by securely crimping in place two



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heavily tinned lugs and bolting these together using 10mm diameter copper, brass or bronze nuts, bolts and washers.

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

18.2 JOINTS BELOW GROUND

A joint in the stranded copper conductor which forms part of the earthing system shall be made by using a crimped copper ferrule clamp (not lugs), two copper line taps of suitable dimensions. The copper earth conductor shall be joined to an earth rod by clamping, using a standard earth rod clamp or copper line tap. No exothermic weld connections are allowed.

Joints made between dissimilar metals (i.e. copper conductor to galvanized steel water main), shall be thoroughly cleaned before assembly. They shall be rendered watertight using waterproof adhesive tape or a suitable compound for a minimum distance of 200mm in all directions from the joint.

18.3 BONDS

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

18.4 AIR TERMINALS FOR NON-METALLIC PITCHED ROOFS

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

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

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

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



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- a. Where the maximum distance from the ground level to the eaves of the building is less than 4m and the pitch of the roof is more than 1 in 2 (27° from the horizontal).
- b. Where the maximum distances from ground level to the eaves is less than 7m and the pitch of the roof is more than 1 in 1.5 (34° from the horizontal).
- c. Where the distance from the ground level to the eaves is more than 7m and the pitch of the roof is more than 1 in 1 (i.e. the included angle at the apex of the roof is less than 90°).

Under these circumstances eaves conductors need not be installed.

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

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

18.5 AIR TERMINALS FOR METALLIC PITCHED ROOFS

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

18.6 AIR TERMINALS FOR NON-METALLIC FLAT OR MONO-PITCHED ROOFS

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

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

18.7 AIR TERMINALS FOR METALLIC FLAT OR MONO PITCHED ROOFS

Metallic flat or mono pitched roofs do not require separate air terminal conductors, providing that there is electrical continuity between the metallic roofing sheets. A metallic roof surrounded by a non-metallic parapet wall shall have conductors



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installed at the top of the parapet wall and these shall be bonded to the metallic roof at intervals not exceeding 20m. If the parapet wall is clad with metal over its upper surface, or a handrail is installed which affords good electrical continuity, separate air terminal conductors need not be installed. Under these circumstances the metal handrail or cladding shall be bonded to the metal roof covering at intervals not exceeding 20m.

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

18.8 DOWN CONDUCTORS FOR NON-METALLIC STRUCTURES

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

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

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

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

18.9 DOWN CONDUCTORS FOR REINFORCED CONCRETE FRAMED STRUCTURES

The steel reinforcement of this type of structure may be used in place of down conductors. Where the reinforcing system is used, the air terminal system shall be



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bonded to it at a maximum of 30m intervals using steel clamps. This bond may be achieved by clamping, with a steel clamp, a steel conductor to a selected reinforcing bar, the opposite end of this conductor shall terminate at a corrosion resistant metallic terminal such as Grade 316 stainless steel.

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

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

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

18.10 DOWN CONDUCTORS FOR STEEL FRAMED STRUCTURES

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

18.11 EARTHING BY MEANS OF VERTICALLY INSTALLED ROD TYPE ELECTRODES

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

The minimum horizontal separating distance between rod-type electrodes bonded together shall not be less than their installed depth. The upper ends of installed rod-type electrodes are to be terminated approximately 500mm below finished surface level. A 50mm^2 copper bonding conductor shall be installed to run between each earthing electrode system and the lower ends of the adjacent down conductors. A joint is to be made between each of these bonding conductors and the down conductors at a position approximately 200mm above finished ground level. These bonding conductors shall be installed in PVC conduit securely affixed to the wall. The length of this PVC conduit shall be approximately 600mm and shall be installed



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so that approximately 200mm protrudes above ground level, the remainder being buried into the soil.

18.12 EARTHING BY MEANS OF METALLIC WATER MAINS

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

18.13 EARTHING BY MEANS OF TRENCH TYPE ELECTRODES

Where the soil conditions prevent the satisfactory installation of rod-type electrodes, a trench earth system shall be installed. This method is to comprise a 70mm² stranded copper conductor installed horizontally into a trench at a depth of 500mm below finished ground level. The conductor is to follow the general outline of the structure to be protected and be installed 1m away from the outside walls. Where the building stands on rocky ground, the trench earth may be attached to the lower part of the wall in areas where rock protrudes through the soil. The conductor shall, however, be buried wherever possible as described above.

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

Trench earth systems shall have a maximum earth resistance of 30Ω. An isolated length of trench earth mat shall be bonded to the down conductor system in such a way as to reduce the length of dead-ends to the minimum.

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

The maximum useful length of a dead-ended trench earth is 80m.

18.14 TESTS ON COMPLETION

The lightning protection of the installation shall comply with and shall be tested in accordance with SANS 10313. The installation shall be done by an approved and recognised specialist in the field of lightning protection and earthing.

The submitted price for the lightning protection system shall include all requirements for the detail design and entire installation, compliance with SANS 10313 and shall include all testing and the issue of safety and test certificates. Any additional cost required to enhance the earthing and lightning protection installation shall be paid direct from the project upon Clients approval or Clients representative.



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19. TESTING AND INSPECTION

The successful Tenderer shall comply with the relevant requirements concerning registration of electricians, registration of the works, testing and inspection.

The successful Tenderer shall ensure that all equipment is installed and tested in full compliance with the requirements of the manufacturers of the equipment so as to ensure that the guarantees offered by the manufacturers are not compromised. The successful Tenderer shall familiarise himself in detail with the manufacturer's requirements prior to the installation of the equipment, and, where necessary, the installation work shall be carried out under the supervision of the manufacturer/supplier.

The successful Tenderer shall carry out continuity, earth leakage, earth loop impedance and insulation tests to ensure that the installation is functional and safe.

A full functional test will be carried out on the installation for a period to determine the satisfactory working thereof after completion of the works and before first delivery is taken. During this period the installations will be inspected and the successful Tenderer shall make good, to the satisfaction of the Engineer, any defects that may arise.

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

The successful Tenderer shall on completion of the tests, submit, in terms of the OHS Act No.85 of 1993 (as amended), a completed and signed Certificate of Compliance for Electrical Installations to the Clients Representative.

On completion of the Contract Works, the successful Tenderer shall remove all dirt and debris arising from the Contract Works from site, paying particular attention to roof spaces.

Only Tenderers registered with the Electrical Contracting Board of South Africa in accordance with Regulation 5 of the Occupational Health and Safety Act will be accepted and permitted to do work under this Contract. The requirements of Regulation 5(2) will be strictly enforced, and are repeated for convenience purposes:

"5(2) The Electrical Contracting Board of South Africa shall, free of charge, register as an electrical contractor and enter into a register kept for that purpose the name of any person who applies therefore in terms of sub-regulation (1) and who

- (a) has a fixed address and has a telephone listed in his name; and
- (b) employs an accredited person on a full-time basis, or is himself an accredited person."



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An "accredited person" is defined in the Regulations as ".....a person registered in terms of Regulation (9) (of the Act) as an electrical tester for single phase, an installation electrician or a master installation electrician, as the case may be". If, for any reason whatsoever, the successful Tenderer fails to comply with these statutory requirements during the Contract period, after having been accepted initially to do work under this Contract, the services of the successful Tenderer will be terminated in accordance with Clause 56 of the Conditions of Contract.

20. DRAWINGS AND DOCUMENTATION

The successful Tenderer shall provide four sets of "as built" drawings and operational manuals for all equipment installed in terms of this specification, the drawings and Bill of Quantities. One set shall be provided to the Clients Representative and three to the Employer.

The maintenance and operational manuals must be complete with an index and be bound in a suitable hard cover binder such as Bantex A4 Ring Binders. The files must be provided with stiff dividers on which the relevant sections are indicated and are to be in printed or typed format. Drawings shall be housed in plastic pockets in the file, and only one (1) drawing per pocket will be allowed.

In addition all "as built" drawings must be stored on Compact Disk (CD) in .dwg format and must also be submitted with the manuals.

All schematic electrical "as built" drawings of distribution boards must be laminated and attached to the inside of the doors with double sided tape.

The main distribution board/electrical panel schematic diagram in the low voltage plant room or in other plant rooms as well as the schematic site reticulation layout, if applicable, must be suitably framed with Perspex and be mounted in the plant room in a position as indicated on site.

The maintenance and operational manuals must consist of the following sections where applicable to the project:

- Operations section, covering description of the system and functioning thereof, all starting up and stopping procedures, fault-finding procedures, pre-start checks and equipment running checks.
- Comprehensive data log sheets to be kept by the user of the system.
- General system description and general information schedules of plant and equipment, such as description of equipment, model number, capacity, electrical requirements of equipment, name and address of supplier, name of manufacturer.
- Design information: Design data sheet containing all design and selection parameters, calculations, selection curves, etc. Settings and values recorded during commissioning. Manufacturers' brochures, pamphlets, pump curves, etc.



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- Maintenance data and schedules: The lapse of time between services and the description of service requirements for each part, piece of equipment or item installed under the Contract. This section must also include the detailed daily, weekly, monthly, three monthly, six monthly and yearly preventative maintenance instructions and checklists.
- Manufacturers' literature indication lubrication points, lubricants to be used and other data referred to above.
- Commissioning data of all equipment and systems with all set points listed in table format relating to the specific piece of equipment and/or system.
- All other data relating to other components forming part of the system/reticulation such as valves, diffusers, medical gas outlet points, etc.
- Critical spare parts list for all equipment.
- All test certificates (any certificates required in terms of the installations as pertaining to the project), compliance certificates, lightning protection certificates, certificates of construction of electrical panels.
- Schematic wiring diagrams and equipment ratings of all electrical panels and distribution boards.
- All "As-Built" drawings of mechanical and electrical installations pertaining to the project. "As-Built" drawings must be the true reflection of the installation as on site and must include the actual particulars of the equipment as installed on site and must be signed and dated by the responsible consultant and must be marked "AS BUILT".
- All "As-Built" drawings, including wiring diagrams, must be produced in Autocad format and be stored on CD as listed above.

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