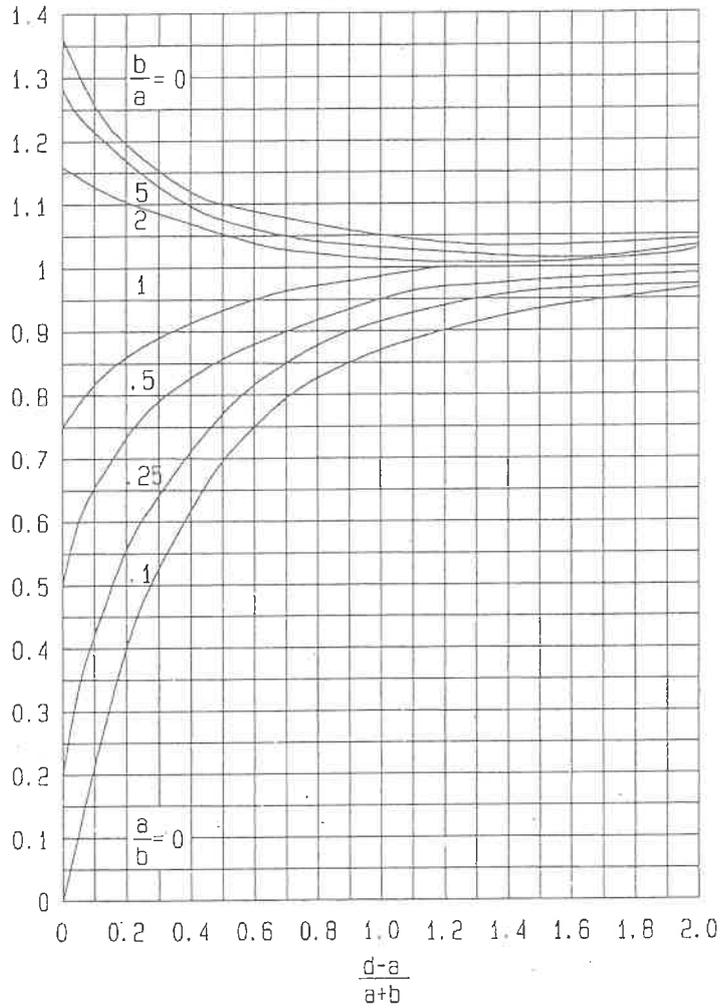
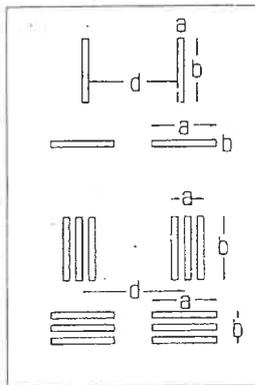


PART 3

FIG. C15.1



k-space factor for rectangular bars



SECTION C16**C.16 EARTHING ELECTRODES****1. GENERAL**

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

2. CATEGORY AND TYPE

2.1 Only the following type of earth rods shall be used:

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

2.2 Bare aluminium is not acceptable as an electrode material.

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

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

3. COUPLINGS AND CONDUCTOR CLAMPS

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

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

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

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

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

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

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

SECTION C17**C.17 SWITCHBOARDS (UP TO 1 KV)****1. GENERAL****1.1 SCOPE**

This section covers the manufacturing and testing of flush mounted, surface mounted and floor standing switchboards for general installations in normal environmental conditions and for system voltages up to 1 kV.

1.2 SIZE

All switchboards shall be of ample size to accommodate the specified switchgear and provide space for future switchgear. For every 4 (or part of 4) 5kA circuit-breakers on a switchboard, space for an additional 5kA circuit breaker shall be allowed unless future space requirements are clearly specified. For circuit breakers above 5kA, this factor shall be 15%. The clearance between adjoining switchgear openings shall be as specified in par. 6.2.

1.3 EXTERNAL DIMENSIONS

The maximum allowable height of free standing switchboards is 2,2m. Cubicle type boards may be up to 2,4m high if they can be fully dismantled into individual cubicles. Where, due to space restrictions, a board exceeds 2,4m in height, equipment not normally requiring access, shall be installed in the top section, enabling equipment normally requiring access to be installed lower down in the board. All other specified external dimensions for switchboards shall be strictly adhered to. If the clearances specified in par. 6.2 cannot be adhered to as a result of restricting external dimensions, the Contractor shall obtain the approval of the Department before manufacturing the switchboards.

1.4 MOISTURE AND VERMIN

All switchboards shall be rendered moisture proof and vermin proof and shall be adequately ventilated. Refer to par. 4.10 and 4.11.

1.5 LOAD BALANCE

The load shall be balanced as equally as possible across multiphase supplies.

2. CONSTRUCTION OF FLUSH MOUNTED SWITCHBOARDS**2.1 STANDARD**

Flush mounted switchboards shall comply fully with SANS 1765. Unless the depths of the switchboards are specified, the depths shall be determined in accordance with par. 6.

2.2 EXPANDED METAL

Where switchboards are to be built into 115mm thick walls, expanded metal shall be spot-welded to the rear of the bonding trays. The expanded metal shall protrude at least 75mm on each tray side to prevent plaster from cracking.

2.3 KNOCK-OUTS

Knock-outs shall be provided in the top and bottom ends of each switchboard tray to allow for the installation of conduits for the specified and future circuits. Knock-outs shall be provided for an equal number of 20mm and 25mm dia. conduits.

2.4 PANEL

Front panels shall have machine punched slots for housing the specified and future flush mounted switchgear. The distance between the inside of the closed doors and the panel shall not be less than 20mm. No equipment may be mounted on the panel unless the panel is permanently hinged to the switchboard frame.

2.5 FIXING OF FRONT PANELS

The front panel shall be secured to the architrave frame by means of 6mm studs and chromium-plated hexagonal domed nuts, hank nuts or captive fasteners. Alternatively the panel may be secured to the architrave frame by means of two pins at the bottom and a latch or lock at the top of the panel. Self-tapping screws will not be allowed. All front panels shall be provided with a minimum of one chrome plated handle.

2.6 DOOR HANDLES AND CATCHES

Switchboard doors shall be equipped with handles and catches. Locks shall only be provided when specified. In all cases where lockable doors are required and in all cases where the switchboard doors are higher or wider than 450mm, handles consisting of a push-button-and-handle combination with spring loaded catch or rotary handle-and-catch combination shall be installed. Switchboard doors smaller than 450mm in height and width may be equipped with spring loaded flush mounted ring type latches. Square key operated catches are not acceptable unless specified.

3. CONSTRUCTION OF SURFACE MOUNTED SWITCHBOARDS

3.1 STANDARD

Surface mounted switchboards shall comply with SANS 1765.

3.2 SWITCHBOARD TRAY

Surface mounted switchboards shall be equipped with a 1,6mm minimum sheet steel reinforced tray suitably braced and stiffened to carry the chassis, door and equipment. Lugs to secure the switchboard to a vertical surface shall be provided.

3.3 CONSTRUCTION

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

3.4 CHASSIS

A sheet steel chassis for the mounting of equipment shall be bolted to the tray and shall comply with the requirements of par. 6.1 and 6.3.

3.5 FRONT PANEL AND DOOR

The front panel and door shall comply with par. 2.4 to 2.6 above. Doors shall fit flush in the tray when closed.

3.6 DIMENSIONS

Unless the depth of the switchboards is specified, the dimensions shall be determined in accordance with the requirements of par. 6.2 and 6.3.

4. CONSTRUCTION OF FREE STANDING SWITCH BOARDS

4.1 FRAMEWORK

A metal framework for free standing switchboards shall be manufactured from angle iron, channel iron or 2mm minimum folded metal. A solid U-channel base frame, sufficiently braced to support all equipment and span floor trenches and access holes shall be provided. Switchboards shall be of cubicle design with 2mm side panels forming divisions between cubicles. The maximum allowable cubicle width is 1,5m. (Refer also to par. 4.7). Joints shall be non-continuously butt-welded. Welds shall be ground smooth and the joint wiped with plumber's metal in order to provide a smooth finish. Switchboards wider than 2m shall be fitted with

screwed eye-bolts attached to the framework to facilitate loading and transportation of the board.

4.2 REAR AND SIDE PANELS

The rear panels shall be removable and shall be manufactured from 2mm minimum sheet steel. The panels shall have returned edges which are recessed in the frame or which fit over lips on the switchboard frame. The panels shall be secured to the frame by means of studs and chromium-plated hexagonal domed brass nuts or hank nuts or captive fasteners equal or similar to "DZUS" or "CAMLOC". Where switchboards are intended for installation in vertical building ducts or against walls, the rear and side panels may consist of a single folded sheet which is either bolted or welded to the frame or which forms part of the folded metal frame.

4.3 FRONT PANELS

- 4.3.1 The front panels of floor standing switchboards shall preferably be hinged except where flush mounted equipment prevents this. Alternatively, panels shall be secured by means of the methods described in par. 2.5. The panels shall be arranged in multi-tiered fashion to allow for the logical grouping of equipment in accordance with par. 6.
- 4.3.2 The hinged front panels shall have a dished appearance with 20mm upturns which fit over a lip on the switchboard frame. Alternatively the hinged panels shall have folded edges and shall be fitted flush or slightly recessed in the switchboard frame. The latter method shall be used where doors are required. (Also refer to par. 4.6). Corners shall be welded and smoothed.
- 4.3.3 The panels shall be of 2mm minimum sheet steel with machine punched slots to allow for the flush mounting of instrumentation, switchgear toggles and operating handles. A minimum clearance of 50mm shall be maintained between the rear of equipment mounted on the panels (taking into account terminals or other projections) and the frame and chassis of the switchboard. Separate panels shall preferably be provided for the mounting of instrumentation and for covering flush mounted switchgear. Enclosed switchgear with front panels e.g. combination fuse-switch units, may be flush mounted in the board in lieu of separate hinged panels.
- 4.3.4 Hinged panels shall be suitably braced and stiffened to carry the weight of flush mounted equipment and to prevent warping.
- 4.3.5 Hinged panels with flush mounted equipment and panels higher than 600mm shall be supported by hinges of adequate strength to ensure smooth and reliable operation. 16mm pedestal or similar heavy duty hinges with single fixing bolts may be used on panels smaller than 600mm. On the larger panels long pedestal type hinges with two fixing bolts per hinge are preferred. Piano hinges are not acceptable for this application.
- 4.3.6 A tubular chromium-plated handle shall be fitted on each panel. The handle may be omitted if "DZUS" or "CAMLOC" fasteners are used.
- 4.3.7 Blanking plates shall be fitted over slots intended for future equipment. These plates shall be fixed in a manner which does not require the drilling of holes through the front panel. Dummy circuit-breakers may be fitted where applicable.
- 4.3.8 Front panels containing live equipment such as instrumentation or control switches, shall be bonded to the switchboard frame with a braided copper earth trap with an equivalent cross-sectional area of at least 4mm².

4.4 SECURING OF FRONT PANELS

Hinged panels shall be secured in position by means of square key operated non-ferrous fasteners designed to draw the panels closed or similar quick-release fasteners. Self-tapping screws are not acceptable. Where non-hinged removable panels are specified, they shall be secured in position by means of 6mm studs and hexagonal chromed brass dome nuts and washers or hank nuts. Non-hinged removable panels may alternatively be secured in position by means of two pins at the bottom and a latch or lock at the top.

4.5 CHASSIS

A suitably braced chassis for the mounting of switchgear and equipment shall be firmly secured to the frame of the switchboard. The chassis shall be designed so that the switchgear can be installed in accordance with

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par. 6. Circuit-breakers and isolating switches which are not of the moulded-case air-break type and the insulators of busbars for ratings of 200 A and more may be secured directly to the framework. (Refer to par. 6.1).

4.6 DOORS

- (a) Doors need only be provided when specified. Doors shall be arranged in multi-tiered fashion to allow for the logical grouping of equipment in accordance with par. 6.
- (b) Doors shall have a dished appearance with a minimum of 20mm upturns which fit over a lip on the switchboard frame or shall fit flush in the switchboard frame. Corners shall be welded and smoothed.
- (c) Doors shall be of aluminium sheet steel with machine punched slots to allow for the flush mounting of instrumentation, control and protection equipment. Switchgear shall be flush mounted in the front panels behind the doors unless specified to the contrary. A minimum clearance of 50mm shall be allowed between the rear of equipment mounted on doors (including terminals and projections) and the frame, front panel and chassis.
- (d) Doors shall be suitably braced and stiffened to carry the weight of the equipment and to prevent warping.
- (e) Hinges for doors shall be provided as described in par. 4.3.5. At least three hinges shall be provided on doors higher than 1,2m.
- (f) Doors shall be fitted with handles consisting of a pushbutton-and-handle combination with springloaded catch or a rotary handle-and-catch combination. Flush mounted ring type handles or square key operated latches are not acceptable. The same key shall fit all locks on the switchboard in cases where locks are required.
- (g) Doors shall be fitted with hypalon or neoprene seals.
- (h) Doors containing any electrical equipment shall be bonded to the switchboard frame with a braided copper earth wire with an equivalent cross-sectional area of at least 4mm².

4.7 SECTIONS

For ease of transportation and to facilitate access to the allocated accommodation, switchboards may be dismantled into cubicles or sections. Each section shall be rigidly manufactured to ensure that damage to the switchgear will not occur during transportation and handling. Where required, switchboards shall have temporary wood or steel bracing to protect switchgear and facilitate handling.

4.8 GROUPING OF SWITCHGEAR

The switchgear shall be logically arranged and grouped as described in par. 6. Depending upon the number and size of components, a common front panel may be installed over one or more groups of equipment. All equipment shall be installed in accordance with the requirements of par. 6.

4.9 CABLE GLAND PLATE

A cable gland plate shall be installed across the full width of each power cubicle at a minimum height of 300mm above the bottom of the switchboard to house the cable glands. A Steel cable channel or other approved support shall be provided to carry the weight of the cable and remove mechanical stress from the cable glands. A minimum distance as required by the bending radius of outgoing cables shall be provided between the lowest terminals of major equipment and the gland plate.

4.10 VENTILATION

Switchboards shall be properly ventilated, especially cubicles containing contactors, transformers, motor starters, lighting dimmers and other heat producing equipment. Louvres shall be fitted to provide adequate upward or cross ventilation. All louvres shall be vermin proofed with 1,5mm brass mesh or perforated steel plate internally spot welded over the louvres. The internal ambient temperature shall not exceed 40°C.

4.11 VERMIN PROOFING

Free standing boards shall be protected against vermin, especially from below, where cables have to pass

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through the gland plate, rubber grommets shall be provided and enough non-hardening compound shall be delivered with the board so that these holes can be sealed properly after installation of the cables.

5. CONSTRUCTION OF MAIN LOW TENSION SWITCHBOARDS

Main low tension switchboards and sub-main low tension switchboards heavily equipped shall comply with par. 4.1 to 4.11 as well as the following exceptions or additions:

- (a) These boards shall be fully extensible with removable busbar cover plates in the side panels.
- (b) Doors shall not be supplied unless specifically called for.
- (c) Switchgear and equipment shall be installed in accordance with the requirements of par. 6.
- (d) Provision for metering equipment shall be made in accordance with requirements of local authorities where applicable.

6. MOUNTING OF EQUIPMENT

6.1 The mounting of equipment shall comply with SANS 1765 where applicable. Equipment to be mounted on the chassis shall be mounted by bolts, washers and nuts or by bolts screwed into tapped holes in the chassis plate. In the latter case the minimum thickness of the chassis plate shall be 2,5mm. The latter method shall not be used where boards will be subject to vibration or mechanical shocks. Self-tapping screws will not be accepted.

6.2 SPACE REQUIREMENTS

In designing the switchboards the following requirements shall be strictly adhered to:-

- (a) A minimum of 50mm between any piece of equipment and the frame or internal partitioning. This minimum space is required on all sides of the equipment. In the case of a single row of single-pole circuit-breakers the spacing on one side row may be reduced to 25mm if the incoming side of the circuit-breakers is busbar connected.
- (a) A minimum of 75mm between horizontal rows of equipment. The maximum outside dimensions of equipment shall be considered.
- (c) Circuit-breakers up to a fault rating of 10 kA may be installed adjacent to each other. For higher ratings a minimum of 40mm shall be allowed between circuit-breakers or isolators.
- (d) Sufficient space shall be provided for wiring allowing for the appropriate bending radius.
- (e) Space for future equipment shall be allowed as described in par. 1.2.

6.3 MOUNTING OF CHASSIS

The chassis of flush mounted and smaller surface mounted boards shall be mounted in accordance with SANS 1765. For all free standing switchboards and surface mounted switchboards where the main switch rating exceeds 100 A (triple-pole), space for wiring shall be provided between the chassis and tray. This space shall be adequate to install the supply cable behind the chassis and terminate on the main switch without sharp bends in the cable cores.

6.4 GROUPING OF EQUIPMENT

6.4.1 Equipment shall be arranged and grouped in logical fashion as follows:

- (a) Main switch - to be installed either at the top or bottom of the board.
- (b) Short circuit protection equipment - fuse gear or fuse-switches.
- (c) Change-over contactors or other contactors controlling the supply.
- (d) Motor supplies.

- (e) Fuse-switches for outgoing circuits.
 - (f) Other circuits and equipment.
- 6.4.2 Where a portion of the equipment on the switchboard is supplied from a standby power source, the change-over contactor and the associated equipment shall be grouped in a separate compartment.
- 6.4.3 Where earth leakage units are required, the associated circuit-breakers shall be installed adjacent to the unit.

6.5 MOUNTING OF CIRCUIT-BREAKERS

All moulded-case circuit-breakers shall be flush mounted with only the toggles protruding. Miniature circuit-breakers may be installed in clip-in trays mounted on the frame. All other circuit-breakers shall be bolted to the chassis. Special provision shall be made for large main switches when designing the framework. Care shall be exercised that the rear studs of circuit-breakers are properly insulated from the steel chassis. Where necessary, insulating material shall be installed between the rear studs and the chassis. Circuit-breakers shall be installed so that the toggles are in the up position when "ON" and down when "OFF".

6.6 INSTRUMENTATION

All metering instruments shall be flush mounted in the front panel or door. The rear terminals of instruments mounted on doors shall be covered with an insulating material to prevent accidental contact. Current transformers for metering shall be mounted so that the rating plate is clearly visible. Fuses for instrumentation shall be mounted in an easily accessible position and clearly marked.

6.7 MOUNTING OF FUSES

- 6.7.1 Fuse holders shall be mounted semi-recessed in the front panel so that fuses can readily be changed without removing the front panel. Busbar mounted fuses for instrumentation shall be used as far as possible.
- 6.7.2 Where equipment requiring fuses is specified on a board (fuse switches etc), a ruling shall be obtained from the Department on the quantity of spare fuses to be provided.

6.8 EQUIPMENT IN MAIN BOARDS

Equipment in main low tension switchboards and sub-main boards shall be grouped in individual compartments. Equipment shall be installed as follows:

- 6.8.1 Rack-out type air circuit-breakers shall be mounted in the bottom section, flush behind the panel with the handle only protruding. If this is not possible, the panel shall be omitted and the air circuit-breakers installed behind a door.
- 6.8.2 If the main switch is a moulded-case circuit-breaker or isolator it shall be flush mounted.
- 6.8.3 Contactors controlling the supply shall be installed behind separate front panels.
- 6.8.4 All metering, protection and indicating equipment shall be clearly visible from the front of the board. Current transformer ratios and multiplication factors shall be clearly marked. Where doors are specified the equipment shall be installed flush in the doors and covered as described in par. 6.6.
- 6.8.5 All circuit-breakers and fuses (with the exception of fuse-switches) may be grouped together behind one or more panels as described in par. 4.8.
- 6.8.6 Fuses or fuse-switches providing back-up protection for circuit breakers, shall be grouped with the associated circuit-breakers. Exposed surfaces effuse-switches shall be of the same finish and colour as the rest of the board where practical.

6.9 STANDBY SUPPLIES

- 6.9.1 Where standby power from a diesel-generator set or other sources is available and has to be connected to some of the equipment on a switchboard, the switchboard shall be divided into separate sections with sheet metal divisions to isolate standby power and mains power sections.

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- 6.9.2 Standby and normal supply shall each have its own incoming isolator or circuit-breaker.
- 6.9.3 The two sections of the switchboard shall be labelled "ESSENTIAL" and "NON-ESSENTIAL" respectively.
- 6.9.4 The front panels of standby and no-break supply sections shall be painted in distinctive colours as follows:
- | | | | |
|-----|-----------------|-----------------|-------------------------|
| (a) | Normal supply | "LIGHT ORANGE", | colour B26 of SANS 1091 |
| (b) | Standby power | "SIGNAL RED", | colour All of SANS 1091 |
| (c) | No-break supply | "DARK VIOLET", | colour F06 or |
| | | "OLIVE GREEN". | colour H05 of SANS 1091 |

7. BUSBARS IN SWITCHBOARDS

7.1 APPLICATION

- 7.1.1 Busbars shall be manufactured of solid drawn high conductivity copper with a rectangular cross-section in accordance with SANS 1473, SANS 1195 and BS 159 and BS 1433, where applicable.
- 7.1.2 Although SANS 1473 refers only to overhead or rising busbars, busbars in switchboards shall comply with applicable sections of this specification especially as far as insulation and clearance values, creepage distance, joints, insulation resistance, dielectric strength, deflection test, absorption resistance and rated short time withstand current are concerned.
- 7.1.3 Busbars shall be supplied for the following applications:
- (a) Distribution of supply voltage.
 - (b) Connection of equipment with ratings exceeding the current rating of 70mm² conductors (par. 8.6).
 - (c) Connection of outgoing circuits with current ratings in excess of that allowed for 70mm² conductors (par. 7.8).
 - (d) Collector bars for parallel cables (par. 8.1).
 - (e) Connection bars for neutral conductors (par. 7.9).
 - (f) Earth busbars (par. 7.10).
 - (g) Connections to miniature circuit-breakers (par. 8.6).

7.2 SEE PART C15 FOR FURTHER DETAILS.

8. WIRING

8.1 CABLING

Cables connected to incoming or outgoing circuits shall be terminated on the gland plate supplied for this purpose. (Refer to par. 4.9). Power cables up to and including 70mm² may terminate on clamp type terminals where the clamping screws are not in direct contact with the conductor. Connection to the equipment can then be made with cables that are similarly connected to the clamp terminal. All power cables larger than 70mm² terminate on busbars that are connected to the associated equipment. Parallel incoming or outgoing cables shall be connected to a collector busbar without crossing the conductors.

8.2 TERMINAL STRIPS

External wiring for low voltage, control, interlocking, alarm, measuring and DC circuits shall terminate on numbered wiring terminals complying with the Department's standard specification for "WIRING TERMINALS", Section C9. The correct terminal size as recommended by the manufacturer for each conductor to be connected shall be used throughout. The terminal numbers shall appear on the wiring

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diagrams of the switchboard. Terminals for power wiring shall be separated from other terminals. Terminals for internal wiring shall not be interposed with terminals for external circuits. All connections to terminals shall be identified as described in par. 8.8. Where switchboards consist of separate sections, the control wiring passing between sections shall be terminated on strips in each section so that control wiring can be readily re-instated when reassembling the board.

8.3 CURRENT RATINGS

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

TABLE 17.3

CURRENT RATING FOR INTERN

Nominal cross- Section mm ²	CONDUCTOR RATING (A)				
	Number of conductors in bunch				
	1	2-3	4-5	6-9	10 and more
2,5	28	25	22	19	16
4	37	33	30	26	22
6	47	42	38	33	28
10	64	54	51	44	38
16	85	76	68	59	51
25	112	101	89	78	67
35	138	124	110	96	88
50	172	154	137	120	103
70	213	191	170	149	127

The above table shall be applied for ambient temperatures up to 30°C. (Refer to table 41.2 in VDE 0100). For higher ambient temperatures the values shall be derated as prescribed by SANS 10142. Table 10.

8.4 INTERNAL WIRING

- (a) Standard 600/1 000 V grade PVC-insulated stranded annealed copper conductors to SANS 1507 shall be employed for the internal power wiring of switchboards. The smallest conductor size to be used for power wiring in switchboards shall be 2.5mm². Flexible cord of minimum size 1,0mm² may be used for control wiring.
- (b) Where heat generating equipment is present and the internal temperature of the board is likely to exceed 50°C, silicon-rubber insulated stranded conductors shall be used.
- (c) Wiring shall be arranged in horizontal and vertical rows and shall be bound with suitable plastic straps or installed in PVC wiring channels. Under no circumstances may PVC adhesive tape be used for the bunching of conductors or for the colour identification of conductors.
- (d) Bunched conductors shall be neatly formed to present a uniform appearance without twisting or crossing the conductors. Conductors leaving the harnesses shall be so arranged that they are adjacent to the chassis.

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- (e) Conductors to hinged panels and doors shall be secured on both the door and the frame and shall be looped between the two points. The loop shall be arranged to produce a twisting motion when the door is opened or closed. A flexible protection sleeve shall be installed over the conductors.
- (f) Where wiring channels are used, they shall be installed horizontally and vertically. Under no circumstances may power and control circuit wiring be installed in the same wiring channels. Channel shall not be more than 40% full.
- (g) All wiring between different Panels within the same switchboard shall be installed in wiring channels.
- (h) Grommets shall be installed in each hole in the metalwork through which conductors pass.
- (i) All wiring shall be installed away from terminals, clamps or other current carrying parts. Wiring shall also be kept away from exposed metal edges or shall be protected where they cross metal edges protected where they cross metal edges.
- (k) Conductors may be jointed at equipment terminals or numbered terminal strips only. No other connections are allowed.
- (l) Where conductors change direction, smooth bends shall be formed with a radius of at least 5 times the outside diameter of the conductor or harness.
- (m) Where screened cables are specified, the screening shall be earthed in the switchboard or control board only unless clearly specified to the contrary. Screened cables entering control boxes through pressed knock-outs, shall terminate in compression glands. Conductors shall as far as possible remain inside the screening at terminations. Where conductors have to separate from the screen, the braiding shall be separated and the conductors drawn through the braid without damaging the braiding. The conductors shall then be connected to their respective terminals and the screening smoothed and connected to the earth terminal.
- (n) Where neutral connections are looped between the terminals of instruments, it is essential that the two conductor ends be inserted into a common lug or ferrule and are crimped or soldered together in order that the neutral connection is not broken when the conductors are removed from one of the instruments.
- (o) Wiring should as far as possible be confined to the front portions of switchboards for ease of access. This requirement is important for wiring between smaller circuit-breakers and the associated main circuit-breaker as well as the wiring from circuit-breakers to lighting and socket-outlet circuits.
- (p) A maximum of two conductors will be allowed per equipment terminal. Where more conductors must be connected to the same equipment terminal (e.g. a main circuit-breaker feeding other circuit-breakers), stub busbars shall be provided for the various conductors. Refer also to par. 8.6.

8.5 LOAD END CONNECTIONS

The supply end connections to all equipment shall under all circumstances be at the top and the load end connections at the bottom.

8.6 WIRING TO CIRCUIT-BREAKERS

Equipment with a rating exceeding the current rating of 70mm² conductors shall be connected by means of busbars to the main busbars. Looped connections may only be installed for a maximum of two outgoing circuits. Where there are more than two outgoing circuits, busbars shall be used and equipment connected individually to the busbars. Where miniature circuit-breakers are mounted in continuous rows and supplied by busbars connected to each MCB, each busbar shall be supplied by a separate conductor. This conductor shall be connected to the busbar by means of a separate lug and not via an MCB terminal.

8.7 CONDUCTOR TERMINATIONS

Conductors connected to terminals complying with the Department's standard specification for "WIRING TERMINALS". Section C9, need not be soldered or ferruled. Connections to circuit-breakers, isolators or contactors shall be made by one of the following methods:

- (a) A ferrule of the correct size,
- (b) soldering the end of the conductor, or
- (c) winding a conductor strand tightly around the end to totally cover the end.

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

8.8 IDENTIFICATION

- 8.8.1 The colour of the conductors for all 220/250 V circuits shall correspond to the colour of the supply phase for that circuit. Neutral conductors shall be black.
- 8.8.2 All other conductors in the board, supplying control circuits, etc. shall be coded in colours other than those specified above. A colour code shall be devised for each board and the colour code shall be shown on the wiring diagrams.
- 8.8.3 All conductors that terminate at wiring terminals and all conductors used for the internal wiring of the switchboard, shall further be identified at both ends by means of durable cable marking ferrules. PVC or other tape is not acceptable.
- 8.8.4 The numbers on the markers shall be shown on the wiring diagrams.

9. PAINT FINISH

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

10. LABELLING

- 10.1 Care shall be taken to ensure that all equipment is fully labelled and that accurate descriptions and safety warning notices appear in both official languages.

10.2 MATERIAL

Engraved plastic or ivory sandwiched strips shall be used throughout. The strips shall bear white lettering on a black background for normal labels and red letters on a white or yellow background for danger notices.

10.3 MAIN SWITCHBOARDS

Main switchboards and sub-main switchboards shall be supplied with the following bilingual labels:

- (a) Number and allocation of switchboard. Example:

CONTROL BOARD A4

BEHEERBORDA4

Lettering: at least 10 mm high prominent position. Label on the outside in a prominent position.

- (b) Designation of busbar sections. Example:

BUSBAR SECTION 2

GELEISTAMSEKSIE2

Lettering: at least 10mm high. Label on the outside in a prominent position.

- (c) Designation of all switchgear including circuit-breakers, isolators, contactors, etc. If the current rating of circuit-breakers is not clearly marked on the equipment, the value shall be indicated on the engraved label. Example:

SUPPLY TO BOARD C3 TOEVOER NA
BORD C3

PUMP SUPPLY
POMPTOEVOER

Letters at least 5mm high. Label on the outside of the switchboard.

- (d) All other equipment including meters, instruments, indicator lights, switches, push-buttons, circuit-breakers, fuses, contactors, control relays, protection relays, etc. shall be identified. The function of the equipment and circuits shall be clearly indicated. The main switch shall be labelled as such and designated :

"SWITCH OFF IN CASE OF EMERGENCY"
"SKAKEL AF IN NOODGEVAL"

Flush mounted equipment within doors or front panels shall be identified with labels fixed to the doors or front panels respectively. The labels for equipment installed behind panels, shall be fixed to the chassis close to the equipment. If this equipment is positioned too close together to accommodate descriptive engraved labels, the equipment may be identified by a code or number on an engraved label which shall be fixed close to the equipment. The code number shall be identified on a legend card which shall be installed on the switchboard behind a plastic or other protective cover.

10.4 OTHER SWITCHBOARDS

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

10.5 FIXING OF LABELS

- 10.5.1 Labels shall not be fixed to components or trunking but to doors, panels, chassis or other permanent structures of the switchboard.
- 10.5.2 Engraved strips shall be secured to facilitate a neat alteration of the designation of the labels. Sufficient fixing points shall be provided to prevent labels from warping. Labels in slotted holders shall be secured in position to prevent unauthorised removal. Labels may be secured by the use of brass bolts and nuts, self-tapping screws, slotted label holders or pop-rivets.

11 TESTS

- 11.1 The Department shall be notified when the mechanical construction of the switchboard, i.e. frame, panels and base frame, is complete in order that it may be inspected at the factory.
- 11.2 Function tests of all equipment, control and interlocking circuits shall be conducted to the satisfaction of the Department. Testing equipment and facilities including instruments, dummy loads and additional switchgear and cables shall be provided by the Contractor at no extra cost. The Department shall be notified in writing two weeks in advance of any test to be conducted, to allow its representative to be present at such tests. A complete report on the tests shall be handed to the Department.

12. DRAWINGS

12.1 DRAWINGS FOR APPROVAL

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

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

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

12.2 FINAL DRAWINGS

A complete set of "as-built" transparent drawings of all switchboards shall be submitted to the Department within two weeks after delivery of the boards. The following information shall be presented:

- (a) Item (a) to (d) of the previous paragraph.
- (b) Terminal strip numbers, numbers and colours of conductors connected to the terminal strips and numbers and colours of the conductors utilised for the internal wiring.
- (c) A separate schedule of all equipment.

12.3 MANUALS

Three sets of manuals for all specified main and sub-main switchboards shall be supplied to the Department at no extra cost. These manuals shall include the following information:

- (a) Complete information on the operation of the equipment.
- (b) Complete information for maintenance of the equipment.
- (c) Brochures and ordering information.
- (d) A complete equipment list indicating quantities and relevant catalogue numbers.

12.4 COMPLETION

The supply contract shall be regarded as incomplete until all tests have been conducted successfully and all drawings and manuals have been handed to the, Department

SECTION C18**C.18 LOW VOLTAGE DISTRIBUTION CUBICLES (KIOSKS)****1. GENERAL**

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

2. SIZE

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

3. MOISTURE AND VERMIN

- 3.1 Kiosks shall be weatherproof. To prevent the ingress of water onto live equipment, the door entry surrounds shall have a channel shape, at least 12mm deep, to accommodate the door edge.
- 3.2 The roof shall be constructed with an overhang above non continuous panelling and shall be provided with a drip-edge.

4. VENTILATION

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

5. FIBREGLASS CANOPIES**5.1 APPLICATION**

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

5.2 CONSTRUCTION

- 5.2.1 The laminate shall be constructed to SANS 141.
- 5.2.2 An outer isophalec resin gelcoat with a minimum thickness of 0,4mm and ultraviolet absorption properties to prevent degradation of the surface from exposure to the sun shall be provided.
- 5.2.3 The gelcoat shall be backed by multiple layers of chopped strand mat glass rendering not less than 1,2kg/m². The strength shall be increased to 1,3 kg/m² on kiosks with panelling larger than 500 x 500mm.
- 5.2.4 The fibreglass shall be thoroughly impregnated with polyester resin. The resin should preferably be clear.
- 5.2.5 The resin to fibreglass ratio shall not be less than 2,5 :1 and not more than 3,0 :1.
- 5.2.6 Air entrapped between the glass mat layers shall be thoroughly worked out. The laminate must be free of air bubbles and voids.
- 5.2.7 All edges shall be reinforced with an additional 700 g/m² of fibreglass.

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- 5.2.8 All large surfaces, wider than 300mm, shall be reinforced or panelled to improve stiffness and rigidity.
- 5.2.9 A resin coat shall be applied to the inside of the kiosk to cover the fibre pattern.
- 5.2.10 Brass or steel backing plates shall be laminated into the fibreglass at hinge points, locking mechanism catch support areas, door restraint fixing points and all other points which will be subjected to mechanical stresses.
- 5.2.11 Doors shall be adequately braced, reinforced, ribbed or double laminated with an air gap between the two layers of laminate to ensure rigidity.
- 5.2.12 The fibreglass canopy shall be fixed to the internal equipment support frame with bolts accessible through the door only.

5.3 FINISH AND COLOUR OF FIBREGLASS KIOSKS

- 5.3.1 The outside surface of the kiosk shall have a glossy, smooth finish to ensure good weathering. To obtain this the manufacturer shall ensure that the mould is smooth, free of voids, hairline cracks, pores or other defects.
- 5.3.2 Compound rubbing or sanding of the outside surface will not be permitted.
- 5.3.3 Pigments shall be added to the outer gelcoat to obtain a matching colour to SANS 1091 "AVOCADO GREEN" colour C12 or "LIGHT STONE", colour C37.
- 5.3.4 Fibreglass kiosks shall not be painted.

6. SHEET STEEL CANOPIES

- 6.1 Where specified the canopy and doors shall be manufactured of either mild steel as 3Cr12 stainless steel to the following requirements:
 - 6.1.1 A metal framework shall be manufactured from solid angle iron, channel iron or 2,5mm minimum folded sheet steel.
 - 6.1.2 Joints shall be non-continuously butt welded. Welds shall be ground smooth and the joint wiped with plumber's metal in order to provide a smooth finish.
 - 6.1.3 Side panels, doors and the roof shall be manufactured from 2mm minimum sheet steel. The panels shall have upturned edges which are recessed in the frame or which fit over lips on the frame. The side panels may be either bolted or welded to the frame or form part of the folded metal frame.
 - 6.1.4 The roof of the cubicle shall be removable and shall be fitted by means of bolts which shall be accessible from inside the cubicle only.
 - 6.1.5 All panels and doors shall be suitably braced and stiffened to ensure rigidity and to prevent warping.
 - 6.1.6 The steel canopy and framework shall be fixed to the base frame by four M16 high tensile steel bolts.

6.2 FINISH AND COLOUR OF SHEET STEEL KIOSKS

- 6.2.1 Metal components of the framework, panels and doors shall be painted in accordance with the Department's "STANDARD PAINTING SPECIFICATION", Section C39.
- 6.2.2. The colour shall be "AVOCADO GREEN", colour C12 or "LIGHT STONE", colour C37 of SANS 1091. A tin of matching touch-up paint (not smaller than 500ml) shall be provided with each consignment.

7. CAST IRON KIOSKS

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

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- 7.1.1 A metal framework shall be manufactured from solid angle iron or channel iron.
- 7.1.2 Cast iron panels shall be bolted to the frame work and shall be replaceable with standard cast iron panels.
- 7.1.3 The panels shall be bolted to the frame from the inside of the cubicle. Bolts or nuts on the outside of the cubicle are not acceptable.
- 7.1.4 The roof of the cubicle shall be one casting and shall be bolted in position from inside the cubicle.
- 7.1.5 The minimum thickness of the cast iron panels and doors shall be 6mm
- 7.1.6 All cast iron panels and doors shall be fettled prior to painting.
- 7.2 FINISH AND COLOUR OF CAST IRON KIOSK:
 - 7.2.1 Metal components of the framework, panels and doors shall be painted in accordance with the Department's "STANDARD PAINTING SPECIFICATION". Section C39.
 - 7.2.2 The colour shall be "AVOCADO GREEN", colour C12 or "LIGHT STONE", colour C37 of SANS 1091. A tin of matching touch-up paint (not smaller than 500ml) shall be provided with each consignment.

8. DOORS

- 8.1 Doors shall be fitted to the front and to the rear of each cubicle. The doors shall provide free access to equipment which has to be operated and shall provide a full view of all meters. Cubicles wider than 700mm shall be provided with double doors.
- 8.2 Doors shall have well returning edges to fit into the channel of the door entry surrounds. Refer to par. 3.1 and 6.1.3.
- 8.3 Doors shall swivel through 135.
- 8.4 Brass hinges shall be used to hang the doors. The hinges shall be bolted to the canopy with brass bolts and nuts. Bolt heads or nuts shall not protrude beyond the outer surface of the kiosk. Nylon, aluminium or piano hinges are not acceptable.
- 8.5 Doors shall be fitted with lever locks with a 135° movement. The locking mechanism shall have a catch on the rear which catches behind the frame or door entry surround. The locking mechanism as well as the catch support area shall be backed with brass or galvanised steel plates. The locking mechanism shall be lockable by padlocks. Padlocks will be provided by the Department.
- 8.6 The locking mechanism shall be made of brass or stainless steel.
- 8.7 Door restraints shall be provided. Cloth or canvas straps are not acceptable. The fixing points of the restraint at both the door and canopy shall be reinforced.
- 8.8 At least three hinges shall be supplied on steel doors higher than 12mm.
- 8.9 Doors shall be fitted with neoprene or equivalent seals.
- 8.10 Metal doors shall be earth bonded to the frame by means of a copper braided strap, tooth washers, bolts and nuts.

9. EQUIPMENT SUPPORT FRAME

- 9.1 A free standing, angle iron or similar type rigid support framework shall be provided.
- 9.2 The frame shall be bolted down on the base by four M16 high tensile steel bolts. The holding-down bolts shall be accessible from the inside of the cubicle only. The frame of sheet steel canopies may be bolted to the canopy framework.
- 9.3 A galvanised steel cable gland plate shall be bolted to the bottom of the frame across the full width of the cubicle to cover the cable entry opening in the base.

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- 9.4 The gland plate shall be suitably punched to accept the number and size of cables specified.
- 9.5 All steelwork shall be hot-dip galvanised in accordance with SANS 32&121.
- 9.6 A panel of resin bound synthetic wood or other suitable dielectric material shall be provided for the mounting of all equipment and busbars. Impregnated hardboard, other treated or untreated wood products are not acceptable.
- 9.7 Alternatively, all equipment and busbars shall be flush mounted within a purpose-made sheet metal frame enclosed by a machine punched removable front panel through which the operating handles of the equipment protrude. Care shall be exercised that the rear studs of circuit-breakers are properly insulated from the steel chassis. Miniature circuit-breakers may be installed in clip-in trays mounted on the frame.

10. CONCRETE BASES AND BASE FRAMES

- 10.1 To ensure stability of the kiosk after installation, it shall be mounted on a base frame which, in turn, shall be bolted to a concrete base cast into the bottom of the cable trench.
- 10.2 The base frame shall be constructed of angle iron, at least 50 x 4mm thick and shall be of welded construction hot-dip galvanised and coated with epoxy resin tar.
- 10.3 The vertical height of the box frame shall be at least 900mm and the construction shall be such as to provide a rigid support for the kiosk.
- 10.4 The base frame shall protrude to a maximum height of 200mm above ground level. Provision shall be made for the protection and concealing of the cables entering the kiosk and to prevent access of animals and vermin.
- 10.5 The base frame shall be secured by at least four M16 bolts to the support frame of the kiosk and four M16 anchor bolts and nuts to the concrete base. The bolts, nuts and washers shall be galvanised and supplied with the kiosk.
- 10.6 All galvanising shall be to SANS 32&121.
- 10.7 The kiosk manufacturer shall supply a detailed drawing of the base frame and the concrete base required.
- 10.8 Alternative designs and materials for the base (or root) of the kiosk will be considered but full details must be submitted for approval by the Department.

11. BUSBARS

See Section C15 for details.

12. WIRING

See Section 17.8 for details

13. MOUNTING OF EQUIPMENT

- 13.1 The mounting of equipment shall comply with SANS 1765 where applicable. Equipment shall be fixed to the support panel with bolts, nuts, washers and spring washers or self locking nuts with washers. Self-tapping screws are not acceptable.
- 13.2 Equipment shall be arranged and grouped in a logical fashion.
- 13.3 All equipment shall be flush mounted behind panels with only circuit-breaker and isolator toggles and meter faces protruding. The front panels shall be secured in position by 6mm studs and hexagonal chromed brass dome nuts and washers or hank nuts fasteners. Self-tapping or similar screws are not acceptable.
- 13.4 Blanking plates shall be fitted over slots intended for future equipment. These plates shall be fixed so that fixing holes do not need to be drilled through the front panel.

14. ACCESS

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

15. LABELLING

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

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

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

15.3.1 Number and allocation of kiosk, e.g. KIOSK B26

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

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

HOUSE 473
HUIS473

PUMP SUPPLY
POMPTOEVOER

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

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

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

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

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

16. NOTICES

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

17. INSPECTION

The Department shall be notified at least two weeks in advance of the completion of the kiosks in order that an inspection may be carried out before delivery.

18. DRAWINGS

18.1 DRAWINGS FOR APPROVAL

18.1.1 A set of three prints of the shop drawings of the cubicles shall be submitted to the Department for approval before the cubicles are manufactured. The following information shall be presented:

(a) Schematic and wiring diagrams of the cubicles.

(b) A complete layout of the arrangement of the cubicles showing all equipment dimensions and constructional details. The positions and method of fixing of busbars shall be shown.

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- (c) All labelling information in both the official languages on a separate sheet.
- (d) The makes, catalogue numbers and capacities of all equipment.
- (e) A detail drawing of the concrete plinth, showing concrete mixes, dimensions, sizes, steel reinforcing details and holding-down bolt fixing details.

18.1.2 The approval of drawing shall not relieve the Contractor of his responsibility to the Department to supply the cubicles according to the requirements of this Specification.

18.2 FINAL DRAWINGS

A complete set of "as built" drawings of the cubicles shall be submitted to the Department within two weeks after delivery of the kiosks. The information contained in par. 18.1.1 shall be provided.

18.3 COMPLETION

The supply contract shall be regarded as incomplete until all drawings have been handed to the Department.

SECTION C19**C.19 METAL CLAD AIR CIRCUIT BREAKERS, WITHDRAWABLE TYPE**

1. This section covers with drawable air circuit breakers for use in power distribution systems up to 1kV, 50 Hz.
2. The circuit breakers shall be metal clad and shall comply with BS 4752 and IEC 157.
3. The circuit breaker shall be horizontally withdrawable and shall be a self-contained unit of the dead front type, allowing maintenance and tests to be carried out without having to remove the circuit breakers from the withdrawal mechanism.
4. The unit shall contain the necessary mechanical interlocks to prevent:
 - (a) Access to "LIVE" terminals when the circuit breaker is withdrawn.
 - (b) The withdrawal or insertion of the unit, when the circuit breaker is in the closed position.
 - (c) Closing of the circuit breaker following an automatic trip condition without resetting the mechanism.
5. Adjustable thermal overload releases shall be provided to suit the required current range. In addition instantaneous magnetic short circuit trips which are adjustable shall be fitted. The tripping devices shall be direct acting. The delay adjustment shall be bypassed with an instantaneous making current release when the circuit breaker is closed to prevent the delay timer from operating when the circuit breaker is closed on a fault.
6. The air circuit breakers shall be of the quick make and quick break type with a stored energy spring assisted operating mechanism provided with:
 - (a) A trip free mechanical hand operated closing mechanism.
 - (b) A manually operated mechanical trip mechanism suitably protected to prevent inadvertent tripping.
 - (c) A positively driven mechanical device to provide ON/OFF/ TRIP indication. This indication shall be clearly visible with the circuit breaker in position.
7. Provision shall exist for the addition, if required, of a supply side under voltage release.
8. Air circuit breakers shall have electrically separate auxiliary contacts as specified. Where none are specified two N/O and two N/C auxiliary contacts shall be provided.
9. Shunt trips and electrical stored energy circuit breakers shall be interlocked to prevent repeated operation of the trips or winding mechanisms when the circuit breaker is in the tripped or closed position.
10. All non current carrying metal parts of air circuit breakers shall be solidly interconnected and connected to an earth contact on the truck which shall engage with a mating contact or copper plate on the cradle which is connected to the earth busbar of the switchboard. The arrangement shall be such that the air circuit breaker frame is earthed in the test position and before the circuit breaker contacts engage the live fixed contacts.
11. The fixed cradle shall be of high mechanical strength.
12. The circuit breaker shall have "RACKED OUT", "TEST" and "ENGAGED" positions that are clearly marked.
13. The air circuit breaker shall bear a clearly legible rating plate indicating the current rating, breaking capacity and voltage rating.
14. The complete circuit breaker and its electrical and mechanical constituents and accessories shall be from a standard product range of a single original supplier.

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15. Extension type operating handles shall be fixed to the air circuit breaker on completion of the installation.
16. A description and illustration of the circuit breaker as well as trip curves, operating manuals and rupturing test certificates shall be provided.
17. The circuit breakers shall be designed to allow the incoming terminals to be at the top or bottom without affecting the operation of the unit.
18. Circuit breakers shall be derated if necessary to compensate for the following environmental factors:
 - (a) Maximum ambient air temperature in excess of 40°C or the daily average ambient air temperature in excess of 30°C. This is especially important with regard to the type of enclosure in which the circuit breaker is to be installed.
 - (b) Height above sea level.
 - (c) Operational duty cycle and estimated loading.

SECTION C20

C.20 MOULDED-CASE CIRCUIT-BREAKERS

1. This section covers single or multi pole moulded case circuit breakers for use in power distribution systems, suitable for panel mounting, for ratings up to 1 000 A, 600 V. 50 Hz.
2. The circuit breakers shall comply with SANS 156.
3. The continuous current rating, trip rating and rupturing capacity shall be as specified.
4. The contacts shall be silver alloy and shall close with a high pressure wiping action.
5. Where specified, the circuit breaker shall be capable of accommodating factory fitted shunt trip or auxiliary contact units or similar equipment.
6. The operating handle shall provide clear indication of "ON", "OFF" and "TRIP" positions.
7. The mechanism shall be of the TRIP-FREE type preventing the unit from being held in the ON position under overload conditions.
8. All moulded case circuit breakers in a particular installation shall as far as is practical be supplied by a single manufacturer.
9. The incoming terminals of single pole miniature circuit breakers shall be suitable for connection to a common busbar.
10. The circuit breaker shall have a rating plate indicating the current rating, voltage rating and breaking capacity.
11. Extension type operating handles shall be provided for units of 600 A rating and above.

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C.21 COMBINATION FUSE-SWITCH UNITS

1. Combination fuse-switch units shall be triple pole devices fitted with neutral links and shall comply fully with SANS 60947 or BS 5419.
2. The fuse-switches shall be of the on load type capable of carrying the rated current continuously, making and breaking rated current and tested to IEC 408 for making and breaking capacity.
3. The units shall be of the double air-break, quick-make, quick-break type with an arc chamber. The mechanism shall be driven by springs on both sides.
4. The unit shall consist of a fixed contact assembly, heavy duty mechanism, moving contact carriage and a retractable operating handle mounted on a rigid frame. The contacts shall be of high quality material, e.g. silver plated.
5. The fixed contacts shall be shrouded.
6. When the fuse-switch is in the open position, the double air-break shall isolate the HRC fuse links, permitting fuse replacement in safety.
7. Interlocks shall be provided to prevent the cover from being opened when the switch is "ON" and to prevent the switch from being operated when the cover is open unless purposely defeated.
8. The cartridge fuses used in the units shall comply with SANS 172 or BS 88 or the equivalent DIN and VDE standards. The category of duty shall be suitable for the voltage level and the fault level at the point where the fuses are installed. Time/current characteristics shall be matched to the equipment supplied and protected by the switch.
9. Fuse-gear carrying the HRC fuses on the cover, the cover also forming the operating lever, is regarded as a fuse isolator and is not acceptable.

SECTION C22**C.22 CARTRIDGE FUSES AND FUSE HOLDERS**

This section covers cartridge fuses and holders used for the protection of distribution and power system equipment up to 600 V.

1. TYPES

- 1.1 The following fuse and fuse holder types are acceptable for use in distribution and power systems:
- (a) A cartridge type fuse link which fits into a fuse carrier together with a fuse base with fixed terminals. The fuse can be removed by taking out the fuse carrier and then removing the fuse from the carrier.
 - (b) A cartridge type fuse link which fits into a fuse base with fixed terminals. In this case a fuse puller is required to disengage the fuse from the base. These fuses are only acceptable on equipment imported with these fuses as a standard item. One puller shall be supplied for each board or box in which these fuses are used.
- 1.2 Rewirable fuses are not acceptable and shall not be used.
- 1.3 Fuses shall normally be installed in moulded plastic fuse holders or rigid isolating barriers shall be installed between the fuses. Sufficient spacing to prevent accidental contact when inserting or withdrawing fuses shall be maintained. The covers or barriers shall be manufactured for the specific fuses to be used.
- 1.4 Striker pin fuses shall be equipped with an alarm contact so that the contact closes and remains closed when the striker pin operates.

2. STANDARDS

All fuses used for distribution systems shall comply with the following standards :

- 2.1 Fuses : SANS 172 or BS 88. Parts 1 and 2
- 2.2 Holders : SANS 172.
- 2.3 Fuses of the types described in par. 1 above and complying with the relevant DIN (49510, 49511, 49515, 49522, 49360, 49367) and VDE (0635.0660) standards are also acceptable.

3. RATINGS

- 3.1 Fuse ratings shall be accurate to within $\pm 5\%$ of the published value for unused fuses and shall not vary significantly after long periods of service.
- 3.2 Fuses shall be derated for ambient temperatures above 25°C in accordance with the manufacturer's recommendation. If no such recommendation exists, a derating factor of 1% per °C above 25°C shall be applied.
- 3.3 Fuses shall be derated for elevations of more than 1 000m above sea level in accordance with the manufacturer's recommendation. If no such recommendation exists, a derating factor of 1% per 300m above 1 000m above sea level shall be applied.
- 3.4 Time/current characteristics shall be chosen to suit the application.
- 3.4.1 Cable protection: The fusing factor shall not exceed 1,5.
 - 3.4.2 Motor circuits: Time lag characteristic so that the starting currents will not cause deterioration of the fuse.
 - 3.4.3 Capacitor circuits: Fuses shall be chosen to withstand a higher than

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normal full load current (1,5 times rated capacitor current) to allow for harmonics and shall not deteriorate due to the high transients at switch on.

- 3.4.4 Distribution systems: The total operating Ft let through by secondary (minor) fuses shall be less than that of primary (major) fuses in any specific branch.
- 3.5 It shall be ensured that the rupturing capacity of a fuse chosen for a specific application shall be adequate, both as far as short circuit current and applied voltage are concerned.

SECTION C23**C.23 DIRECT ACTING INDICATING INSTRUMENTS**

This section covers direct acting indicating instruments suitable for flush mounting in switchboards or instrument panels.

1. GENERAL REQUIREMENTS

- 1.1 Instruments shall be suitably rated for the supply voltage and frequency to be applied, which shall be 400/230 V, 50 Hz unless specified to the contrary.
- 1.2 All the instruments used for a particular application or a specific project shall be from the range of a single reputable supplier and shall have the same face dimensions. The face dimensions shall be square and not less than 96 x 96mm.
- 1.3 All instruments shall comply with BS 89 and/or IEC 51.
- 1.4 Instruments shall be screened against magnetic interference and shall have anti static, impact-resistant glass faces.
- 1.5 Preference will be given to locally manufactured instruments.
- 1.6 Instruments shall be insulated to achieve a 2 kV insulation resistance to earth.
- 1.7 All instruments shall be splash proof and dustproof unless more stringent requirements are specified for hazardous locations.
- 1.8 Instruments shall be sufficiently resistant to vibration that may be encountered in the specific application.
- 1.9 For normal environmental and supply conditions, instruments shall be suitable for use inside the limits specified in Tables III and VI of IEC 51.
- 1.10 All instruments shall be capable of withstanding overloads of continuous or short duration in accordance with section 8.3 of IEC 51.
- 1.11 Instruments shall be provided with studs for rear connection. Shrouds shall be provided to prevent accidental contact where instruments are to be installed in hinged panels of switchboards.

2. VOLTMETERS AND VOLTMETER SELECTOR SWITCHES

- 2.1 Unless specified to the contrary, voltmeters shall be scaled from 0 - 250V in the case of LV applications.
- 2.2 Voltmeters shall be of the moving iron type with class 1,5 accuracy as specified in IEC 51.
- 2.3 A zero adjustment screw shall be provided.
- 2.4 Unless specified to the contrary, a single voltmeter and selector switch shall be provided. The voltmeter switch shall have an "OFF" and three metering positions to indicate readings between neutral and each of the three phases.
- 2.5 The markings shall be indicated clearly on the face plate of the selector switch and the handle position shall be accurate in relation to the markings on the face plate.
- 2.6 The selector switch shall be of the cam-actuated or wiping air break type with two breaks per pole.

3. AMMETERS

- 3.1 Ammeters shall have a moving coil element to indicate instantaneous values.

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- 3.2 Direct reading ammeters up to a maximum rating of 60 A may be used. Current transformer operated ammeters shall be 5 A full scale, calibrated to read actual primary circuit currents. The current transformer ratio shall be indicated on the face plate.
- 3.3 A zero adjustment screw shall be provided.
- 3.4 Where combined maximum demand and indicating ammeters are specified, a bimetallic spiral element shall be provided in the same housing to indicate mean value over a 15 minute period.
- 3.5 The bimetal element shall drive a residual pointer to indicate maximum mean current between resettings. This pointer shall operate on the main scale and shall be of a distinctive colour. The pointer shall be resettable from the face of the meter.
- 3.6 The bimetal element shall be designed to compensate for limits of ambient temperature between - 20°C and 70°C.
- 3.7 Full load or rated current shall be clearly indicated, preferably with a red line. Unless specified to the contrary, a 100% condensed over scale shall be provided for instantaneous reading instruments and no over scale for combined maximum demand ammeters.
- 3.8 The intrinsic error, expressed in terms of the fiducial value in accordance with IEC 51, shall be class 1,5 for the instantaneous readings and class 2,5 for the mean maxima.
- 3.9 Where saturation current transformers are required, these shall form an integral part of the meter. Separate saturation current transformers are unacceptable to the Department.

4. KILOWATT-HOUR METERS

- 4.1 Unless specified to the contrary, kilowatt-hour meters shall be suitable for operation on 220/250 V. 50 Hz systems.
- 4.2 Meter elements shall be of the inductor disc type and designed to carry the rated current continuously.
- 4.3 Kilowatt-hour meters shall comply with the relevant parts of BS 37 and BS 5685.
- 4.4 The integrating period on maximum demand meters shall be 30 minutes unless specified to the contrary.
- 4.5 The registering mechanism shall be of the cyclometer type, providing a six digit readout with the sixth digit indicating one-tenth of a unit.
- 4.6 Unless specified to the contrary, the meters shall conform to accuracy Class 1 as specified in IEC 51.
- 4.7 Kilowatt-hour meters shall be graded and calibrated for the specific application to avoid the application of multiplication factors where possible. Where multiplication factors are unavoidable this shall be clearly indicated in unit form and not as a combination of several factors. Current transformer ratios shall be incorporated in the factor.
- 4.8 The kilowatt-hour meter shall preferably be provided with a magnetic type of bearing for the disc spindle.
- 4.9 Facilities for a security seal shall be provided on the fixing screws of the cover.

5. FREQUENCY METERS

- 5.1 Frequency meters may be of the vibrating reed type or the direct indicating type consisting of a moving coil milli-ammeter and a current/frequency transducer.
- 5.2 Unless specified to the contrary, the indicating range shall be 45 HZ - 55 Hz.
- 5.3 The accuracy class shall be class 0,5 in accordance with IEC 51 unless otherwise specified.
- 5.4 Where required an adjustable speed alarm contact shall be provided, adjustable over the complete scale length.

6. RUNNING HOUR-METERS

- 6.1 Running hour-meters shall be of the electrically operated cyclometer type, suitable for flush mounting.
- 6.2 Numerals shall be clearly defined white on a black background.
- 6.3 The range of hour-meters shall be five digits, the fifth digit indicating one-tenth of an hour, i.e. from 0 to 9999,9 hours.
- 6.4 The accuracy class shall be class 1 in accordance with IEC 51 unless otherwise specified.

SECTION C24

C.24 EARTH LEAKAGE RELAYS

1. Earth leakage relays shall be single or three-phase units with a sensitivity of 30mA with associated circuit breaker or on-load switch for use on 220/250V single phase or 380/433 V three phase, 50 Hz, supplies.
2. The units shall be suitable for installation in switchboards in clip-in trays or bolted to the chassis.
3. The earth leakage relay shall function on the current balance principle and shall comply with SANS 767 as amended, and shall bear the SANS mark. Integral test facilities shall be incorporated in the unit.
4. Circuit breakers with trip coils used integrally with earth leakage units (two pole for single phase units and three pole for three phase units) shall comply with SANS 156.
5. On-load switches used integrally with earth leakage units (two pole for single-phase units and three pole for three phase units) shall comply with SANS 60497.
6. The fault current rating of the unit shall be 2,5kA or 5kA as required, when tested in accordance with SANS 156.

SECTION C25

C.25 MICRO-GAP SWITCHES

1. Micro-gap switches shall be suitable for ratings up to 400 A at 660 V (triple pole) and may be used for main and distribution switches in domestic applications, offices, small factories and similar applications.
2. Double pole switches shall be suitable for voltages up to 230V \pm 10%.
3. The switches shall comply with SANS 60947.
4. Micro-gap switches may be used on AC circuits only.
5. Metal clad and moulded casings are acceptable.
6. Micro-gap switches shall be capable of carrying rated current continuously and making and breaking rated current.
7. Heavy, fully accessible, brass terminals with two screws each shall be provided to facilitate easy wiring. Contacts shall have large contact surfaces, made from high quality material such as solid silver.
8. The "ON" and "OFF" positions and the rating of the switch shall be clearly and indelibly marked.

SECTION C26**C.26 CURRENT TRANSFORMERS****1. GENERAL**

Current transformers shall comply with the requirements of BS 3938 and IEC 185 with the exception of the required impulse test level, par.6 below.

2. RATINGS

Current transformers shall be suitable for the primary currents listed hereunder and their decimal multiples:

10, 12.5, 15, 20, 25, 30, 40, 50, 60 and 75.

The preferred values are:

10,15, 20, 30, 50 and 75.

2.2 Current transformers shall have secondary ratings of 1, 2 and 5A, with 5A being preferred.

2.3 Current transformers shall have standard outputs of 2, 5, 5, 10, 15 or 30 VA as applicable in terms of the burden of the instruments and interconnecting wiring. The current transformer output shall match the actual instrument burden as closely as possible in order not to introduce unnecessary errors.

3. ACCURACY CLASS

3.1 For metering applications, accuracy classes of 0.1, 0.2, 0.5, 1, 3 or 5 are applicable. Where no accuracy class has been specified, the following table may be used as a guide:

Application	Primary Current	Suggested Class
Indicating Instruments	All .	5
Metering Applications	Up to 200 A	1
Metering Applications	250 to 600 A	0.5
Metering Applications	800 A and above	0.2

3.2 Where ring type current transformers are specified, the aperture shall not be unnecessarily large as accuracy is thereby reduced.

3.3 The classes for protection are 5P, 10P, 15P, 20P or 30P with 5P and 10P being standard. Turns compensation shall not be employed on protection current transformers for ratios greater than 150/5.

3.4 Class X current transformers shall be used in differential protection systems.

3.5 Manufacturers shall supply the magnetisation curve details and saturation factors for each different transformer ratio.

4. MARKINGS

All current transformers shall come complete with a label on which the following information is indelibly stamped:

Manufacturer.

Serial No. or Type.

Rated primary and secondary current.

Rated frequency.

Rated output and accuracy class.

Highest system voltage.

Rated insulation level.

5. FAULT CURRENT

Current transformers shall be capable of withstanding the dynamic forces resulting from the maximum through-fault current which may be encountered at the point where they are installed. The short time current rating of current transformers shall be at least equal to that of the associated circuit breaker.

6. IMPULSE LEVEL

Current transformers used in system voltages in excess of 660 V shall withstand an impulse test level of 95 kV. Impulse levels for current transformers used in system voltages up to 660 V shall comply with BS 3938.

7. TESTS

7.1 One protection current transformer of each type used in a contract shall be tested to confirm the estimated characteristics. The following results shall be submitted:

- (a) Magnetisation Curve
- (b) Secondary resistance
- (c) Secondary leakage reactance, if not negligible or if required by the Department.

7.2 The power frequency, secondary to earth and over voltage inter-ium tests in accordance with BS 3938 shall be conducted on all current transformers. Impulse tests shall be conducted on all current transformers intended for use in system voltages in excess of 660 V.

SECTION C27**C.27 INDICATOR LIGHTS**

1. Indicator lights shall be of neon, incandescent (filament) or LED types. Lamp voltages shall suit the supply or control voltage. Lamps shall be derated for continuous duty by using economy resistors or using input voltages at least 20% lower than the rated lamp voltages.
2. Where LED's are used as indicators on main supply voltages a suitable current limiting capacitor and reverse voltage protection diode shall be used. For low AC or DC voltages (+ 24 V) a current limiting resistor will suffice.
3. Indicator lights shall comply with BS 1050 where applicable.
4. Indicator lights shall be suitable for installation in switchboard panels and doors and shall consist of interchangeable lenses, lamp base, suitably rated and accessible terminals and a chromed screw-on retaining ring or other suitable means to secure the units.
5. It shall be possible to replace lamps from the front of the panel without the use of tools.
6. Surface mounted indicator lights shall be housed in purpose-made boxes with suitable cover plates.
7. Indicator lights shall be equipped with standard removable legend plates. Alternatively, the function shall be clearly indicated by means of labels or by engraving on the lenses.
8. All indicator lights for a specific application or switchboard shall be from the range of one manufacturer and shall preferably be of the same size and shall use the same lamp types.
9. The following are the preferred colours for indicator lights:
 - (a) RED : Abnormal state.
 - (b) YELLOW : Attention or caution, (or amber)
 - (c) GREEN : Ready for operation.
 - (d) WHITE : Circuit live or circuit operating (or clear) normally
 - (e) BLUE : Any function not covered by the above colours.

SECTION C28

C.28 TRIPLE POLE ON-LOAD ISOLATORS

1. This section covers switches suitable for panel mounting for use in power distribution systems up to 600 V, 50 Hz. Switches for motor isolation are included.
2. The switches shall be of the triple pole, hand operated type complying with SANS 60947.
3. The switches shall have a high speed closing and opening feature.
4. The switches shall be suitably rated for the continuous carrying, making and breaking of the rated current specified as well as the through-fault current capacity as specified.
5. To distinguish the switches from circuit breakers the operating handles shall have a distinctive colour and/or the switch shall be clearly and indelibly labelled "ISOLATOR".

SECTION C29**C.29 ROTARY CAM SWITCHES**

1. This section covers rotary cam switches used for control functions in switchboards, motor control centres, etc., up to 600 V.
2. The switches shall be rotary cam switches and shall comply with BS 4794, IEC 337 and VOE 0113, where applicable.
3. The switches shall be of the cam actuated type with two breaks per pole. The required number of poles and number of control functions shall be provided by the assembly of switching units on a common spindle.
4. The spindle shall be operated by a control handle suitable for the method of installation of the switch. The control handle shall be located by a key way on the spindle.
5. The switches shall be provided with a suitable face plate of non-conductive material, indicating the angle of throw and the switch positions. The latching mechanism shall ensure positive positioning in accurate relation to the positions indicated on the face plate.
6. The switches shall be suitable for use with the supply voltage level. The contacts shall be silver plated or gold laminated and shall be suitably rated for the switching functions intended.
7. For normal applications the making capacity of the switch shall be at least three times the normal current rating. For AC4 duties (inching, reversing, plugging) the rated current of the switch shall be at least equal to the stalled rotor current of the motor.
8. Special contacts, e.g. late-making, early-breaking, etc. shall be inherent in the design and shall not be improvised by loading or bending contacts, etc.
9. Time-delay units (if required) shall be of the electronic type with an adjustable time delay on energisation from 50 to 600 s. The units shall be suitable for clip-on rail mounting and supply voltage as specified.

SECTION C30**C.30 TIME SWITCHES AND PHOTOCELLS**

1. Time switches shall be of single-pole type, suitable for 220/250 V systems, with contacts rated for the duty to be performed with a minimum rating of 15A. Contacts shall be of high quality material, e.g. silver-plated or solid silver.
2. The clock shall be driven by a self-starting, hysteresis synchronous motor, keeping accurate mains time. All clocks shall be controlled by an electrically wound escapement providing the main spring with a minimum of 15 hours reserve in case of a power failure. The main spring shall be kept fully wound without the use of slipping clutch devices that may wear and fall out of adjustment.
3. The main spring shall have a minimum of 15 hours reserve under full load and if fully discharged, shall be completely rewound within 15 minutes of the restoration of power.
4. An external manual bypass switch shall be provided to permit the circuit to be switched "ON" or "OFF" manually without affecting the operation of the time switch.
5. The time switch shall have a 24 hour dial, with day and night indication, that can be set to switch in 30 minute steps. The dial shall be fitted with 48 tappets corresponding to 48 change-over operations in a 24 hour period.
6. The time switch shall be fitted with a day omission dial comprising a total of 14 tappets which can be set to switch in 12 hour steps.
7. The time switch shall be housed in a dust-tight moulded plastic or metal case, consisting of a plastic clip-on front cover and a moulded plastic or metal base. Time switches to be used for surface mounting on walls shall be provided with a suitably positioned 20mm conduit knock-out.

PHOTOCELLS**1. GENERAL**

- 1.1 The switches shall be used for the control of street lights and shall be provided with switch contacts able to carry at least 5 A. The current during no-load conditions may not exceed 50 mA.
- 1.2 The units shall be suitable for 240 V + 6%, 50Hz, single-phase alternating current.

2. CONSTRUCTION

- 2.1 The units shall be weather and vibration resistant as they are to be mounted on top of streetlight luminaires. The design shall be of such a nature that the units will be able to withstand both hail damage and damage by stone-throwers. If the units do not meet with these requirements, separate wire screens shall be provided for this purpose.
- 2.2 The units shall be provided with a standard NEMA plug and socket. The socket shall have a bracket for mounting on a pole.
- 2.3 All components shall be treated to be corrosion resistant.

3. OPERATING CONDITIONS

- 3.1 The units shall be suitable for operating under dusty conditions between temperatures of -5 EC and 55 EC.

4. TECHNICAL REQUIREMENTS

- 4.1 units shall switch on when the light intensity drops to 15 lux + 20% and shall switch off when the light intensity again reaches 40 lux + 20%.
- 4.2 When the unit is in the "on" position there must be a delay of one minute if it were to switch off in the case of a sudden increase in the light intensity.

SECTION C31**C.31 CONTACTORS**

1. Contactors shall be of the open or totally enclosed, triple- or double-pole, electromechanically operated, air-break type suitable for 380/433 V or 220/250 V supplies and shall comply with SANS 1092.
2. Contactors shall have the following characteristics:
 - (a) Enclosed coil easily replaceable.
 - (b) A permanent air gap in the magnetic circuit to prevent sticky operation.
 - (c) Provision for quick and simple inspection of contacts.
 - (d) Clearly marked main and auxiliary terminals.
3. All parts shall be accessible from the front.
4. Contactors which are not located in switchboards shall be housed in enclosures which comply with IP 54 of IEC 144.
5. The current rating of the contactor shall be as specified for the circuit with a switching duty in accordance with the SANS 1092 or IEC 158-1, utilisation category AC1 for lighting and power circuits and utilisation category AC3 for motor starting.
6. In addition to the required current carrying capacity and switching duty of a contactor, the contactor chosen for a particular application shall be rated for the maximum through fault current allowed by the back-up protection devices at the point where the contactor is installed. Careful co-ordination of short circuit devices shall take place.
7. All laminations of the magnetic system of the contactor shall be tightly clamped. Noisy contactors will not be accepted.
8. Non-current-carrying metallic parts shall be solidly interconnected and a common screwed earth terminal shall be provided. The contactor shall be earthed to the switchboard earth bar.
9. Latched contactors shall be provided with a trip coil and a closing coil. The contactor shall remain closed after de-energising the closing coil and shall only trip on energising the trip coil.
10. Contactor operating coils shall have a voltage rating as required by the control circuitry and shall have limits of operation and temperature rise as specified in Clause 7.5 and Table IV of IEC 158-1. Latched contactors shall be capable of being tripped at 50% of the rated coil voltage.
11. Contactors for normal/standby changeover circuits shall be electrically and mechanically interlocked. Contactors in star-delta starters shall be electrically interlocked.
12. Contactors with provision to add auxiliary contacts and convert auxiliary contacts on site are preferred. Contactors with permanently fixed auxiliary contacts shall have at least 1 x N/O and 1 x N/C spare auxiliary contacts in addition to the contacts specified or control purposes and in addition to contacts required for self-holding operations or economy resistances. Where the number of auxiliary contacts required is greater than the number of contacts that can be accommodated on the contactor, an auxiliary relay or additional contactor shall be provided to supply the additional contacts.
13. It shall be possible to replace main contacts without disconnecting wiring.
14. Auxiliary contacts shall be capable of making, carrying continuously and breaking 6A at 230V AC, unity power factor for contactors used on 380-433/220-250 V systems.
15. Auxiliary contact functions required e.g. "lazy" contacts late-make, late-break, make-before-break, etc. shall be inherent in the contact design. Under no circumstances may these functions be

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improvised by bending contacts, loading contacts, etc. These functions shall be available in all contactors.

16. Spare auxiliary contacts shall be wired to numbered terminal strips in the switchboard and shall appear on the switchboard drawings.
17. All contactors on a specific project shall be from a standard range of one single manufacturer, unless specified to the contrary.

SECTION C32**C.32 PUSH-BUTTONS AND PUSH-BUTTON ASSEMBLIES**

1. Push-buttons and push-button arrangements may be used in switchboards and control boards or in self-contained units for control functions.
2. Push-buttons and push-button assemblies for one specific project shall be supplied from a single reputable supplier's product range.
3. The various types of push-buttons employed shall be specifically selected for the required duty and mounting characteristics, e.g. flush mounted, enclosed, self-contained, illuminated, etc.
4. All push-buttons on a specific switchboard shall be of the same physical dimension (round or square) and shall be fully interchangeable as far as possible. Push-buttons must preferably be interchangeable with indicator lamps, key switches, etc.
5. Push-buttons shall be designed for long life, low contact bounce and constant contact resistance. Mechanisms may be of the mechanical type with spring control and a clutch or catch frame or of the solid state type operating on the principle of a non contacting, inductive proximity switch.
6. All push-buttons shall be provided with replaceable lenses with a variety of symbols. Legend plates shall be interchangeable.
7. Push-button terminals shall be suitable for the application with regard to spacing, conductor capacity, etc. Terminals shall be suitable for conductor sizes to be used. Push-button assemblies mounted on doors of control boards shall be enclosed to prevent inadvertent contact with the terminals and when the doors are open.
8. Push-buttons shall be suitable for the environmental conditions to be encountered, e.g. moisture, excessive temperatures, mechanical shock, vibration, etc.
9. Contact duty shall be chosen to suit the application. Wiping contacts shall be used for low voltages and currents and snap action contacts for high voltages and currents. Contacts shall be constructed of high quality material such as silver-tipped or gold laminated contacts.
10. Illuminated push-buttons may employ neon, incandescent or LED lamps. Lamp voltages shall suit system control voltages. Lamps shall be derated when used for continuous duty, e.g., using 20 V supply on 28 V rated lamps. External resistors shall be used with LED lamps to avoid excessive current.
11. Push-buttons may be grouped together in purpose-made stations, suitable for the environment in which they are to be installed.
12. Keylock push-buttons shall be supplied with duplicate keys. The removal action of the key shall suit the application.
13. Push-buttons shall comply with the applicable requirements of BS 4794.
14. The following are the preferred colours for push-buttons:

(a)	RED	:	Stop or emergency stop.
(b)	GREEN	:	Start (preparation)
(c)	GREEN	:	Start (implementation) (or black)
(d)	YELLOW	:	Interrupt a function (action)
(e)	WHITE	:	Any function not covered by the (or pale blue) above colours

SECTION C33

C.33 INDOOR SURGE ARRESTORS

1. Surge arrestors shall comply with the requirements of SANS 61643 or VDE 0675.
2. Surge arrestors shall be suitable for installation at altitudes of up to 1800m above sea level.
3. The unit shall be contained within a thermoplastic or cast resin housing and all internal components shall be fully sealed in.
4. The unit shall be supplied complete with a galvanised steel mounting bracket for convenient mounting onto the metalwork or tray of a switchboard.
5. Alternatively, the unit shall be of the type which can be mounted into the clip-tray of a switchboard.
6. Surge arrestors shall be provided in all cases where a switchboard is supplied directly from an overhead line.
7. In other cases, surge arrestors, if required, will be specified in the Detail Technical Specification.

SECTION C34**C.34 INDOOR METAL CLAD SWITCHGEAR AND ASSOCIATED EQUIPMENT****1. GENERAL**

- 1.1 This section covers the manufacturing and testing of indoor metal-clad switchgear and associated equipment for general installations in normal environmental conditions and for system voltages of 3,3 kV to 11 kV.
- 1.2.1 A switchboard shall comprise metal-clad, pedestal type three-phase single or duplicate busbar extensible switch panels, each panel containing a circuit breaker or switch and the associated auxiliary equipment.

2. STANDARDS

All materials and apparatus shall be new and of the best quality and shall comply with the relevant current specifications of the SANS, BSI or IEC and as stated in this document.

The following standards may be used as a guide but must not be regarded as a complete list.

<u>DESCRIPTION</u>	<u>SANS</u>	<u>BSI</u>	<u>IEC</u>
Air & Oil Switches	1195	5463	265-A-C
Busbar & Busbar Connections		159	
Bushings		223	
Cable Glands & Sealing Boxes		542, 2562	
Circuit Breakers		5311	56
Current Transformers		3938	185
Voltage Transformers		3941	186
HV Fuses		2692	282-1
LV Fuses	172	88	269-1
Electrical Power Switchgear		5227	298
Galvanising	32&121	729	51
Indicating Instruments		89	296
Insulating Oil	555	148	129
Isolators and Earthing Switches		5253	43
Meters		37	255
Protective Relays		142	
Colours for Specific Purposes	1091		

4. SERVICE CONDITIONS

Nominal Voltage	3.3 kV	6.6 kV	11 kV
Rupturing Capacity	25 kA	20 kA	20 kA
Impulse Level	45 kV	75 kV	95 kV
Highest System Voltage	3,6 kV	7.2 kV	12 kV
Rated Short Time Current (3 s) 26.3 kA		21.9 kA	18.3 kA
Frequency	50 Hz		
Phases	3		
Atmospheric Temperature	-5°C minimum +40°C maximum		
Altitude	0 m minimum 1850 maximum		
Lightning & Dust	severe		
Average Power Factor	0,8		
Maximum Humidity	95%		

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The system neutrals will be solidly earthed. However, all switchgear and auxiliary equipment shall be designed to withstand the stresses of an unearthed system.

4. SWITCHGEAR LAYOUT

- 4.1 The switchboard shall be designed as a continuous assembly in a straight line, capable of being extended at either end.
- 4.2 The switchboard will be located in a totally enclosed, naturally ventilated chamber and shall be suitable for installation directly on a finished floor.

5. CIRCUIT BREAKERS

5.1 GENERAL CONSTRUCTION

- 5.1.1 Circuit breakers may be of the low oil content, inert gas (gis) or vacuum type.
- 5.1.2 Circuit breakers shall be of the horizontal draw-out truck mounted type with either vertical or horizontal isolation action.
- 5.1.3 Each circuit breaker shall be installed in a free standing metal clad cubicle and the front of each panel shall be totally enclosed.
- 5.1.4 It shall be possible to remove the circuit breakers from the cubicles without moving the cubicle, without removing parts thereof or without disconnecting any wiring thereto. Secondary wiring may be unplugged.
- 5.1.5 Any circuit breaker shall be interchangeable with any other panel of the board of the same rating. It shall not be possible to insert a circuit breaker into a higher rated circuit.
- 5.1.6 Contact spouts, bushings, covers, busbar insulators, etc. shall be designed to minimise dust collection.
- 5.1.7 Mechanical stops shall be provided to ensure accurate location of the circuit breaker truck prior to racking into the service position. The breaker carriage shall be locked in position on both sides of the cubicle with a robust mechanical lock that will not distort or jam under fault conditions.
- 5.1.8 All openings, joints, etc. in the entire switchboard shall be adequately vermin proofed.
- 5.1.9 All components including screws, nuts, bolts, washers, etc. used in the construction of or fixing of components shall be rendered corrosion proof.

5.2 CIRCUIT BREAKING FEATURES

- 5.2.1 The contacts shall ensure rapid and consistent extinction of the arc with a minimum release of arc energy under all loading and fault conditions and a low power factor.
- 5.2.2 The arcing contacts shall be tipped or coated with an erosion resistant material, preferably a tungsten alloy.
- 5.2.3 The main contacts shall be self-aligning with a high contact pressure and a self-cleaning action.

5.3 BUSBAR AND CIRCUIT SHUTTERS

- 5.3.1 Protective shutters, which automatically cover the contacts of the fixed portion of the switchgear when the circuit breaker or voltage transformer is withdrawn to the isolation position, shall be provided.
- 5.3.2 The busbar and voltage transformer orifices shall be provided with automatic separate shutters.
- 5.3.3 Facilities shall be provided for padlocking the shutters in the closed position.
- 5.3.5 All shutters shall close automatically after being opened by hand and it shall not be possible for the shutters or shutter operating links to be jammed by the circuit breaker.

5.3.5 Shutters shall be painted and designated as follows:

- (a) Busbar shutters: The word "BUSBAR" in black lettering on a red background.
- (b) Circuit shutters: The word "CABLE" in black lettering on a yellow background.
- (c) Earthing shutters: The word "EARTH" in black lettering on a green background.

Lettering shall be a minimum of 40 mm high.

5.4 INTERLOCKS

The switchgear shall be mechanically interlocked in accordance with BS 5227 and all interlocks shall be robust and shall not distort or jam in the event of a maloperation. The minimum safety features provided shall prevent the following actions:

- (a) A closed circuit breaker from being withdrawn from or inserted into the isolating contacts. The circuit breaker shall not trip if an attempt is made to do so.
- (b) The closing of the circuit breaker except when it is correctly located and fully racked in the "service" or "earthing" positions or in the fully lowered position. It must, however, be possible to close the circuit breaker when it is fully withdrawn from the cubicle.
- (c) The lowering of the tank of bulk oil circuit breakers unless the circuit breaker is fully withdrawn and the racking-in of the circuit breaker unless the tank is securely bolted in position.
- (d) The circuit breaker from being closed when the secondary circuits are not fully engaged. It shall also not be possible to remove the secondary circuit plugs unless the circuit-breaker contacts are fully open.
- (e) Electrical tripping of the circuit breaker when the circuit breaker is in the earthed position. Padlocking facilities shall also be provided to lock off the mechanical trip lever on the breaker mechanism.
- (f) The integral earthing switch (where applicable) from closing unless the circuit breaker is in the correct earth position. It must not be possible to close the earth switch onto live busbars.

5.5 EARTHING

- 5.5.1 An earth busbar in accordance with the requirements of par. 7.3 shall be provided.
- 5.5.2 All joints shall be tinned or silver-plated and clamping bolts, nuts, washers and lockwashers of cadmium-plated high tensile steel shall be fitted.
- 5.5.3 Integral earthing facilities through the circuit breaker are preferred, but separate earthing devices or earthing switches mounted on separate trucks are acceptable.
- 5.5.4 Where separate earthing devices or earthing trucks are supplied, the gear shall be suitable for use on all the circuit breakers in a switchboard and shall also be suitable for earthing either the busbar or the cables. A full set of earthing devices or earthing trucks shall be supplied for each switchboard.
- 5.5.5 Earthing equipment shall have a making capacity and a 3s short time current rating equal to the rest of the switchboard.

5.6 CAPACITIES AND FAULT LEVELS

- 5.6.1 The complete primary circuit (OCB's, busbars, etc.) shall be capable of withstanding the rated short time current specified in par. 3 above.
- 5.6.2 The circuit breakers shall have continuous current ratings as specified in the Detail Technical Specification.
- 5.6.3 Circuit breaker tanks and top plates shall be capable of withstanding, without permanent distortion, a hydraulic pressure of 700kPa for 1 minute, unless a lower pressure is approved after reference to actual pressures measured during short circuit tests.

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- 5.6.4 Each circuit breaker shall be clearly and indelibly marked to show the current and voltage ratings and breaking capacities.

5.7 CLOSING MECHANISMS

- 5.7.1 The closing mechanism shall be either of the hand charged, spring or hand operated, spring assisted or motor wound spring charging or solenoid operated types as specified in the Detail Technical Specification.
- 5.7.2 The closing action of the hand operated, spring assisted mechanisms shall ensure that once closing is initiated the action becomes independent of the operator.
- 5.7.3 Motor wound spring charging mechanisms shall be provided with hand cranks for emergency use should the electrical closing circuitry become inoperative.
- 5.7.4 Slow closing facilities shall be provided on all mechanism types for maintenance purposes and these facilities shall only be accessible with the circuit breaker in the "withdrawn" position.
- 5.7.5 All mechanisms shall be of the trip-free type and it shall not be possible for the mechanism to maintain the circuit breaker in a "closed" position during fault conditions or when the "open" signal has been initiated.
- 5.7.6 The electrical closing circuitry shall be open circuited as soon as the closing sequence has been completed to prevent continued electrical loading of the closing circuitry and to deactivate the closing signal until a new sequence is initiated.
- 5.7.7. Where auto-reclosing duties are specified, the mechanisms shall be capable of performing a "BREAK-MAKE-BREAK" operation.
- 5.7.8 All electrically operated closing devices shall be at least suitable for operation at any voltage between 80% - 120% of the nominal control voltage at the device terminal. The nominal control voltages are specified in the Detail Technical Specification.
- 5.7.9 Anti-pumping devices shall be provided on all mechanisms to prevent pumping while the closing circuit remains energised and the circuit breaker either fails to latch or trip during closing due to the operation of the protection system. The arrangement shall be to the approval of the Department.

5.8 TRIPPING MECHANISMS:

- 5.8.1 A manual tripping mechanism shall be provided on each circuit breaker. It shall be clearly marked "MANUAL/HANDBEDIEN".
- 5.8.2 Two 2,5 A trip coils (for overload and short circuit protection) and one 1,0 A trip coil (for earth fault protection) shall be provided where current transformer operated direct acting series tripping is specified. The trip coils shall be suitably rated to withstand the secondary saturation current of the current transformers specified.
- 5.8.3 Where shunt tripping is specified DC shunt trip coils shall be provided. The rated control voltage shall be 32 V DC unless specified to the contrary in the Detail Technical Specification.
- 5.8.4 Shunt trip coils shall be suitable for operation at any voltage between 80% -120% of the nominal voltage at the device terminals.
- 5.8.5 Secondary contacts operated by the circuit breaker mechanism shall be provided and rated to interrupt the maximum trip coil current after the circuit breaker has opened. These contacts shall close the tripping circuitry before the circuit breaker closes.

5.9 RACKING MECHANISMS

The racking mechanisms for inserting or withdrawing the circuit breaker shall be designed and constructed to provide a positive action throughout the operations.

5.10 INDICATING DEVICES

- 5.10.1 Each circuit breaker shall be equipped with mechanical indicators to indicate the switching positions

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and the state of the spring mechanisms (if applicable).

5.10.2 A mechanical indicator shall also be provided to indicate whether the circuit breaker is racked in or out.

5.10.3 All mechanical indicators shall be clearly visible from the front of the panel.

5.10.4 In all cases positive indication must be provided.

5.11 AUXILIARY CONTACTS

5.11.1 Circuit breakers shall be provided with sufficient auxiliary contacts to suit the circuits served.

5.11.2 Auxiliary contacts shall be coupled in such a manner as to follow positively the operation of the switching device concerned.

5.11.3 At least two spare normally open and two spare normally closed contacts shall be provided and shall be completely wired to an accessible terminal block.

6. NON-AUTOMATIC OIL SWITCHES AND FUSED OIL SWITCHES

6.1 GENERAL

6.1.1 Oil switches shall be of the fault-making, load-breaking type with earthing and testing facilities.

6.1.2 Oil switches shall be manufactured and tested in accordance with BS 5463.

6.2 CONSTRUCTION

6.2.1 The switches shall be totally enclosed, metal-clad, of the bulk or low oil content type.

6.2.2 The switch units shall be designed for extension with circuit breaker panels described in this specification and/or similar switch units.

6.2.3 Each unit shall be installed in a free stand-ing metal dad cubicle and the front of the cubicle shall be totally enclosed.

6.2.4 The switch may be either of the horizontal draw-out with vertical or horizontal isolation, or non-withdrawable fixed tank types.

6.3 BUSBAR AND CIRCUIT SHUTTERS

Busbar and circuit shutters shall be provided on all withdrawable type switches as specified for circuit breakers.

6.4 INTERLOCKS

6.4.1 The mechanism shall be incapable of moving directly to the "EARTH" position from the "ON" position.

6.4.2 A time delay shall be built into the mechanism to prevent immediate opening of the switch after closure. This shall be achieved by means of non-reversible operating handles, mechanical sliding interlocking gates or a non-reversible movement.

6.4.3 Padlocking facilities shall be provided.

6.4.4. Access to the testing facilities shall only be possible with the switch in the "EARTH" position. With the testing devices fitted operation to either the "ON" or "OFF" positions shall be prevented.

6.4.5 Interlocks shall be provided on withdrawable type switches to prevent:

(a) The switch from being withdrawn from or inserted into the isolating contacts.

(b) The closing of the switch except when it is correctly located or fully withdrawn.

(c) The opening of the tank unless the switch is fully withdrawn and the racking-in of the switch unless the tank is securely fitted.

6.5 OPERATING MECHANISM

- 6.5.1 The switch shall have three positions, namely "ON", "OFF" and "EARTH".
- 6.5.2 Except for removing the earth, the switch actuating mechanism shall have a positive action and shall be spring assisted to ensure that once the operation is initiated it becomes completely independent of the operator.
- 6.5.3 The fused oil switch shall close fully when making onto a fault to ensure full clearance of the fault by the fuses before tripping and opening the switches.
- 6.5.4 A blown fuse on any of the three phases shall open all three phases of the switch and shall inhibit the closure of the switch pending fuse replacement,

6.6 EARTHING

- 6.6.1 Refer to par. 5.5.1.
- 6.6.2 Integral cable earthing facilities shall be provided for non-withdrawable switch units. For withdrawable switches earthing facilities similar to that of circuit breakers shall be provided. Refer to par. 5.5.2, 5.5.3 and 5.5.4.

6.7 CABLE TEST FACILITIES

- 6.7.1 Cable test facilities are required and must be easily accessible.
- 6.7.2 Refer to par. 6.4.4 regarding interlocking of test facilities.
- 6.7.3 In the event of a separate test unit being provided, it shall be easily fitted.

6.8 RATINGS

- 6.8.1 The fault making capacities, impulse levels and busbar ratings shall be identical to the ratings of the circuit breakers installed in the same switchboards.
- 6.8.2 The continuous current rating shall not be less than 400A.
- 6.8.3 Each unit shall be clearly marked to show the current and voltage ratings and fault making capacity.

6.9 INDICATING DEVICES

- 6.9.1 Each switch shall be equipped with positive mechanical indicators to indicate the switching position and the racked mode (where applicable).
- 6.9.2 All indicators shall be visible from the front of the panel.
- 6.9.3 Neon indicator lights shall be provided on the incoming panel of a switchboard to indicate the status of all three phases of the incoming cable.

6.10 FUSES

- 6.10.1 Fuses shall comply with BS 2692.
- 6.10.2 Fuse links shall be of the striker pin type, hermetically sealed and shall be suitable for use under oil.
- 6.10.3 The fuse link carriage shall be suitable to accept either 254mm or 359mm long fuses both with a diameter of 63,5mm. The carriage shall be adjustable for this purpose and shall not necessitate additional parts.
- 6.10.4 Automatic shutters shall be provided to safeguard against inadvertent contact with live parts when the fuse carriage is removed.
- 6.10.5 The ratings of the fuses shall be as specified.

7. BUSBARS

See Section C15 for details

8. CABLE END BOXES

- 8.1 Cable end boxes to accept the cables specified for each panel shall be provided.
- 8.2 The boxes shall be of the metal clad type suitable for indoor use. They shall be equipped with armour clamps and brass or gunmetal conical wiping glands for lead covered steel tape or galvanised steel wire armoured, paper-insulated cables.
- 8.3 The cable end boxes shall comply with the Department's standard specification for "CABLE END BOXES AND COMPOUND", Section C8.
- 8.3 The cable boxes shall be fitted with insulating pieces to allow for the possible future installation of frame leakage busbar zone protection when specified in the Detail Technical Specification.
- 8.5 The lowest point of any cable gland position shall be at least 300mm above finished floor level.
- 8.6 Cable boxes shall be so designed that cable terminal connections can be made below compound level.

9. SECONDARY CIRCUITRY**9.1 CABLING**

- 9.1.1 Gland plates, suitably drilled to accept the glands for all the external power, control, protection and DC supply cables, shall be provided.
- 9.1.2 The internal wiring to be connected to the cabling mentioned in par.
- 9.1.3 Where external DC supplies are connected to the switchboard, semiconductor diodes of a suitable power and voltage rating shall be installed in all DC circuits, in both the positive and negative conductors, to prevent reverse polarity connections.

9.2 WIRING

- 9.2.1 All wiring shall present a neat appearance and shall be suitably braced, placed in wiring channels or clipped and/or laced.
- 9.2.2 Connections to equipment mounted on doors shall be arranged to give a twisting motion and not a bending motion to the conductors.
- 9.2.3 All panel and equipment terminals, labels, etc. shall be completely accessible after the wiring and cabling has been completed.
- 9.2.4 Conductors shall be identified at both ends by means of durable closed ring interlocking cable marking ferrules. PVC or other tape is not acceptable. The numbers on the markers shall also be shown on the wiring diagrams.
- 9.2.5 Where conductors are terminated on equipment terminals that do not require the use of lugs, the identification ferrules shall be fixed so that they do not fall off when disconnecting a conductor.
- 9.2.6 Identification ferrules shall read from the terminal along the wire.
- 9.2.7 All wiring terminating on meters, fuse holders and other equipment with screwed terminals, shall be fitted with lugs. The lugs shall be soldered or crimped to the end of the conductor. Conductors connected to terminals complying with the Departments standard specification for "WIRING TERMINALS", Section C9 need not be soldered or ferruled.
- 9.2.8 Secondary wiring shall generally consist of insulated stranded copper conductors with a minimum cross-sectional area of $2,5\text{mm}^2$. Solid core conductors are not acceptable. Flexible cords not smaller than $1,0\text{mm}^2$ shall be installed between equipment mounted on doors and the rest switchboard. For voltage ratings in excess of 50 V the wiring insulation shall withstand a test voltage of 2 kV to earth

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for one minute. For voltages of 50 V or less the insulation shall withstand 500 V to earth for one minute.

- 9.2.9 All wiring between different panels within the same switchboard shall be installed in wiring channels. Grommets shall be installed in each hole in the metalwork through which conductors pass. Wiring shall also be kept away from exposed metal edges or shall be protected where they cross metal edges. All wiring shall be installed away from terminals, clamps or other current carrying parts.
- 9.2.10 Conductors may be jointed at equipment terminals or numbered terminal strips only.
- 9.2.11 To minimise the effect of electrolysis, DC circuits shall be so arranged that the isolator or N/O operation contacts are connected to the positive pole of the battery.

9.3 SECONDARY TERMINALS

- 9.3.1 All external wiring and connections to auxiliary contacts, all alarm, protection, intertripping, DC supply circuits, etc. shall terminate on numbered terminal strips. All numbers shall appear on the switchboard drawings.
- 9.3.2 Terminals of the type where clamping screws are in direct contact with the conductor are not acceptable.
- 9.3.3 Where stud type terminals are provided they shall have a minimum size of 0 B.A.
- 9.3.4 Approximately 10% with a minimum of 2 spare terminals shall be provided on each terminal strip.
- 9.3.5 Terminal and test blocks shall be provided in each panel for the secondary wiring of the current transformers.

10. CUBICLE CONSTRUCTION

10.1 GENERAL

- 10.1.1 All cubicles shall be of the totally enclosed, floor mounted type and shall be vermin proof and where possible dust proof.
- 10.1.2 Cubicles shall be designed so that it is possible to add additional panels to existing switchboards without undue difficulty.

10.2 SEGREGATION OF CIRCUITS

- 10.2.1 Each circuit in a switchboard shall be provided with an individual cubicle so arranged that accidental contact with live metal in adjacent circuit cubicles is impossible.
- 10.2.2 It shall be possible to terminate the cables of any circuit without exposure to any live conductors of the same circuit while the busbars are energised.

10.3 DOORS

- 10.3.1 Where doors are provided on circuit breaker or switch cubicles, the doors shall be fitted with handles consisting of a push-button and handle combination with spring loaded latch or a rotary handle-and-catch combination. The closing mechanism shall be designed to draw the door closed. Flush mounted ring type handles or square key operated latches are not acceptable. Locking latches shall be padlock able.
- 10.3.2 Doors shall be suitably braced and stiffened to carry the weight of equipment installed in doors and to prevent warping.
- 10.3.3 Control panel doors shall be fitted with handle closing mechanisms as described in par. 10.3.1 above. Alternatively, captive knurled bolts designed to be screwed in by hand may be used.
- 10.3.4 Doors shall have stops to prevent overswing of the door when opening and to prevent interference with adjacent panels.
- 10.3.5 Doors shall be fitted with suitable rubber or synthetic rubber seals.

10.3.6 All doors shall be bonded to the framework by a braided copper earth strap.

10.4 EARTHING

10.4.1 All metal parts other than those forming part of electrical circuits shall be connected to the cubicle earth bar.

10.4.2 All non-current carrying conductive parts, including relays, instruments, transformer and contactor cores, etc. shall be effectively connected to the earth bar either by means of their mounting arrangements on the panel or by means of a special earthing conductor fitted with lugs for attaching to the earth bar.

11. CURRENT TRANSFORMERS

11.1 GENERAL

11.1.1 Current transformers shall comply with the Department's standard specification for "CURRENT TRANSFORMERS", Section C26.

11.1.2 The short time current rating of current transformers shall not be less than that of the associated circuit breaker.

11.1.3 Current transformers shall be easily replaceable.

11.1.4 The secondary windings of the current transformers shall be brought out to terminal and test blocks. Windings shall be earthed at one point only. (Refer also to par. 9.3.5).

11.1.5 Current transformers shall be installed and labelled so that the ratio is clearly visible.

12. VOLTAGE TRANSFORMERS

12.1 GENERAL

12.1.1 Voltage transformers shall comply with BS 3941 and IEC 186A and IEC 358 where applicable.

12.1.2 The transformers shall be double wound. The neutral (star point) connection shall be brought out via a neutral link. The secondary voltage shall be 110V unless specified to the contrary.

12.1.3 Voltage transformers shall be metal-clad, of the oil-immersed or epoxy resin encapsulated type. Oil filled types may not be used with air or vacuum circuit-breakers.

12.1.4 The transformer shall be withdrawable and shall be so arranged that the primary fuses are not accessible unless the transformer is in the fully isolated or withdrawn position. The voltage transformer shall be padlock able in both the withdrawn and inserted positions.

12.1.5 Automatic shutters shall be provided to cover the isolating contact when the transformer is withdrawn. Refer also to par. 5.3. The shutters shall be padlock able.

12.2 VOLTAGE TRANSFORMER PROTECTION

12.2.1 The primary side of all voltage transformers shall be connected to the circuit through high voltage HRC fuses.

12.2.2 Secondary HRC fuses shall be provided on the voltage transformer, preferably under a removable cover secured by captive knurled nuts. The fuses shall be located as close as possible to the transformer output terminals.

12.3 VOLTAGE TRANSFORMER RATINGS AND TESTS

12.3.1 The voltage transformers shall have an output suitable for the connected load but at least 200VA per phase at class B accuracy.

12.3.2 The voltage ratios shall be suitable for the primary busbar and the required output voltages.

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- 12.3.3 Voltage transformers shall be tested in accordance with BS 3941 and shall withstand an impulse level of 95 kV.

13. PROTECTION RELAYS

- 13.1 Protection relays shall be contained in dustproof cases which shall not allow accumulated dust to fall into the relay when opened.
- 13.2 All cases shall be of the flush mounting withdrawable type.
- 13.3 Relay contacts shall be capable of repeatedly making and, where the circuit renders it necessary, repeatedly breaking the maximum current possible in the circuits they control.
- 13.4 Where more than one set of contacts are provided, all contacts shall operate simultaneously.
- 13.5 Tripping contacts shall not dose due to vibration engendered by the normal or the fault condition operation of the associated or adjacent circuit breakers.
- 13.6 Hand resetting shall be accomplished without opening the case and these relays shall be accessible to a person standing on the floor.
- 13.7 All relays shall be provided with test blocks to permit tests to be carried out without disconnecting any wiring. These test blocks may be either included in the relay cases or separately mounted.
- 13.8 The ratio of the associated current transformer shall be clearly marked on the relay face plate.
- 13.9 All relays shall be adjusted during manufacture to conform to the limits stipulated in BS 142.

14. INSTRUMENTS

- 14.1 Instruments, i.e. ammeters, voltmeters, combined maximum demand and indicating ammeters, kilowatt-hour meters, frequency meters and running-hour meters shall generally comply with the Department's standard specification for "DIRECT ACTING INDICATING INSTRUMENTS", Section C23.
- 14.2 Voltmeter and ammeter scales shall have a full scale reading at least 5% higher - than the system voltage or associated current transformer rating with the latter values clearly marked.
- 14.3 The instruments shall be suitably rated for the supply voltage, current and frequency.
- 14.4 Each voltmeter shall be protected with easily accessible HRC fuses.
- 14.5 Each circuit breaker shall be equipped with a trip counter with cyclometer dial.

15. AUXILIARY EQUIPMENT

15.1 CONTROL SWITCHES

- 15.1.1 Circuit breaker closing and tripping control switches shall close the associated circuit breaker when rotated clockwise.
- 15.1.2 Control switches may be fitted with one pair of lazy contacts, i.e. contacts which make when the control switch is turned to the closed position, remain closed when the handle returns to the neutral position and only open when the control switch is moved to the trip position.
- 15.1.3 The switches shall be provided with a suitable face plate indicating the angle of throw and the switching positions.
- 15.1.4 The switches shall be suitable for the supply voltage and the contacts shall be silver-plated or gold laminated and shall be suitably rated for the switching functions intended.
- 15.1.4 Control switches shall be lockable in the "NEUTRAL" or "OFF" position.

15.2 FUSES

- 15.2.1 All fuses for the protection of auxiliary circuits shall be of the high rupturing capacity cartridge type and shall be mounted on insulated draw-out carriers which shall hold the fuses positively after withdrawal.
- 15.2.2 The top terminal shall be the live terminal in all cases.
- 15.2.3 HRC fuses shall be provided in the positive leads of all DC circuits.
- 15.2.4 Fuses shall be so positioned that they are readily accessible to a person standing on the floor in front of the panel.
- 15.2.5 Labels shall be fitted adjacent to fuses stating their use, rating and duty.

15.3 INDICATOR LAMPS

- 15.3.1 Indicator lamps shall comply with the Department's standard specification for "INDICATOR LIGHTS", Section C27
- 15.3.2 The following indications shall be provided:

<u>FUNCTION</u>	<u>COLOUR</u>
Circuit breaker closed	Red
Circuit breaker open	Green
Incoming supply available (on incoming panel only)	White
Auto-trip	Amber
Trip circuit healthy	White

- 15.3.3 A lamp test push-button for all the indicating lights shall be provided on each switchboard.
- 15.3.4 The "trip circuit healthy" indication shall normally be off and a push-button shall be provided to indicate the status. The purpose of the indication is to ensure that the tripping voltage supply is available on the panel before the circuit breaker is closed. An indicator light with push-button is required on each panel and one indication per switchboard is not sufficient. The circuitry shall be arranged to provide an indication with the circuit breaker in both the "OPEN" and "CLOSED" positions.
- 15.3.5 The condition indicated shall be designated below each light.
- 15.4 Push-buttons and Push-button Assemblies Push-buttons and push-button assemblies shall comply with the Department's standard specification for these items, Section C32.

16. DC AUXILIARY SUPPLIES

If specified, a battery derived DC supply shall be provided with the switchboard. The nominal voltage shall be 32 V DC unless specified to the contrary.

16.1 BATTERIES

- 16.1.1 The batteries shall be of the nickel-cadmium type and the cells shall be in high impact polystyrene containers with a large reserve of electrolyte.
- 16.1.2 The number of cells and capacity shall be determined from the voltage requirements of the circuit breaker closing and tripping circuitry and the discharge duties required by the switchboard.
- 16.1.3 The battery capacity shall be sufficient to perform either of the following functions:.
- (a) Five successive tripping and reclosing operations of all the circuit breakers on the switchboard.
- or
- (b) A single tripping and reclosing operation of all the circuit breakers on the switchboard plus supplying

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all the standing loads on the battery for at least 10 hours.

Note: The alternative requiring the larger battery shall be used.

16.2 BATTERY CHARGING UNIT

16.2.1 A constant voltage type charger with current limiting facilities shall be provided. The output voltage shall be kept within 1% of the float charge voltage designed for maximum charge conservation and a maximum battery life for variations of + 10% of the input voltage.

16.2.2 The ripple content in the output of the charger shall be less than 2%.

16.2.3 The charger capacity shall be adequate to supply any standing load on the battery plus a charging current which will recharge a fully discharged battery within 8 hours.

16.2.4 A switch operated boost charge control shall be provided.

16.2.5 An auxiliary winding shall be added to the charger transformer providing a secondary

16.2.6 AC output suitable for all the indicating lights on the switchboard. The lights shall be supplied from this winding and not from the batteries.

16.2.7 The charger shall be suitable for operation on a nominal 230 V, 50 Hz mains supply or from a supply obtained from a voltage transformer.

16.2.8 The charger shall be complete with all the required controls including the following standard equipment:

- (a) Power supply isolator.
- (b) Ammeter indicating rectifier output.
- (c) Battery voltmeter.

16.2.9 The following HRC fuses shall be provided:

- (a) Input fuses.
- (b) Rectifier output fuses.
- (c) Voltmeter fuses.
- (d) Fuses in charger transformer auxiliary output.
- (e) A pair of fuses for each DC circuit plus fuses for 3 spare circuits.

If more than one battery output circuit is specified, each circuit shall be fitted with a pair of fuses.

16.3 CUBICLE

16.3.1 The batteries and charger shall be housed separately from the switchboard in a self-contained cubicle with the same finish and colour as the switchboard.

16.3.2 The cubicle shall be dust proof and vermin proof.

16.3.3 An undrilled removable cable gland plate shall be provided for bottom cable entry.

17. FINISH

17.1 All welds shall be ground smooth and joints wiped with plumber's metal in order to provide a smooth finish.

17.2 All the metalwork shall be painted in accordance with the Department's "STANDARD PAINTING SPECIFICATION", Section C39.

17.3 The final colour shall be "ADMIRALTY GREY", colour G12 to SANS 1091.

18. LABELS

18.1 Care shall be taken to ensure that all equipment is fully labelled and that accurate descriptions appear in both official languages.

18.2 Panel designation labels shall appear on the front and back of each panel and on the circuit breaker truck.

18.3 Engraved sandwiched interchangeable plastic or ivory strips shall be used throughout. The strips shall bear white lettering on a black background.

18.4 Labels shall be secured by means of brass bolts, nuts and washers. Where this is not practicable cadmium-plated self-tapping screws may be used. The glueing of labels will not be acceptable. Sufficient fixing screws shall be provided to prevent labels from warping.

19. TESTS

19.1 MANUFACTURER'S TESTS

19.1.1 All component parts of the equipment shall be subject to type tests and routine tests in accordance with the relevant SANS, BSI or IEC standard specifications.

19.1.2 Oil circuit-breakers shall be subjected to the following tests in accordance with BS5311- Part 4, adjusted for atmospheric correction:

Type Tests:	(a)	Mechanical Endurance.
	(b)	Temperature Rise.
	(c)	Dielectric Strength and
	(d)	Impulse Voltage.
	(e)	Making and Breaking Capacity
	(f)	and Short Time Current.

Routine Tests:	(a)	Power Frequency Voltage.
	(b)	Resistance of the Main Circuit.
	(c)	Mechanical Operation.

19.2 ON SITE TESTS

19.2.1 The equipment shall be tested on site after erection and prior to commissioning.

19.2.2 The following minimum tests shall be performed:

- (a) Pressure tests on the primary and secondary circuits in accordance with BS 5227 or IEC 298.
- (b) Insulating oil tests in accordance with SANS 555.
- (c) Insulation resistance tests.
- (d) Primary injection tests.
- (e) Earth continuity and earth resistance tests.
- (f) Operating tests.
- (g) Any other tests which may be required to ascertain the correct functioning of the equipment.

19.3 TEST CERTIFICATES

19.3.1 Copies of type test certificates shall be submitted together with the tender.

19.3.2 Copies of test certificates of all other tests i.e. routine tests and on site tests shall be forwarded to the Department on completion of the tests.

19.4 TEST PERFORMANCE AND INSPECTION

- 19.4.1 The Department shall be notified in writing at least two weeks in advance of any tests to be conducted to allow its representative to be present at such tests.
- 19.4.2 The Department shall also be notified timeously of the completion of the equipment in order that an inspection may be carried out prior to delivery.

20. OIL AND COMPOUND

- 20.1 The first filling of insulating oil for all the circuit breakers, oil switches, voltage transformers, etc. shall be provided by the switchgear supplier.
- 20.2 An adequate quantity of bituminous or cold filling compound shall be provided by the switchgear supplier for all the cable end boxes.
- 20.3 All other oils or compounds which may be required shall be provided by the switchgear supplier.

21. TOOLS AND AUXILIARY EQUIPMENT

The following equipment shall be provided with each switchboard and the cost shall be included in the tender price:

- (a) One raising and lowering handle for every three circuit breakers.
- (b) One complete set of special maintenance tools for all sizes of circuit breakers.
- (c) A full set of earthing devices or earthing trucks.
- (d) One wall mounted steel box for the storage of the above loose equipment. The door shall be padlockable.
- (e) At least six spare HRC fuses of each rating for secondary circuits and three voltage transformer, high voltage HRC fuses.
- (f) At least three spare high voltage HRC fuses of each rating suitable for the fused oil switches.
- (g) One cable test unit for each size circuit breaker or oil switch housed in a wall mountable metal box.

22. TECHNICAL INFORMATION

- 22.1 Tenderers shall submit descriptive literature of the equipment with their tenders.
- 22.2 Two copies of erection, operating and maintenance instruction manuals covering each type of equipment shall be provided with each switchboard.

23. DRAWINGS AND DIAGRAMS**23.1 DRAWINGS FOR APPROVAL**

- 23.1.1 A set of three prints of the following drawings shall be submitted to the Department for approval.

- (a) General Arrangement Drawings.
- (b) Detailed Dimensional Drawings.
- (c) Schematic Diagrams.
- (d) Wiring Diagrams.
- (e) Foundation Drawings.

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

23.2 FINAL DRAWINGS

23.2.1 On completion, a complete set of final transparent drawings shall be delivered to the Department. These drawings shall include the following:

- (a) An accurate "as built" wiring diagram of the complete installation showing circuit numbers, terminal strip numbers, conductor colours and numbers, etc.
- (b) A schematic diagram clearly showing the functions of all equipment.
- (c) An equipment schedule showing the make, model and characteristics of all components used including a recommended spares list.
- (d) Fully dimensioned "as built" physical layout of the panel.

24. COMPLETION

The contract shall be regarded as incomplete until all tests have been conducted successfully and all drawings and manuals have been handed to the Department.

SECTION C35**C.35 11 KV NON-AUTOMATIC OIL SWITCHES, FUSED OIL SWITCHES AND RING MAIN UNITS****1. GENERAL**

This section covers the manufacturing and testing of indoor and outdoor non-automatic oil switches, fused oil switches and ring main units.

1.1 STANDARDS

All materials and apparatus shall be new and of the best quality and shall comply with the relevant current specifications of the SANS, BSI or IEC and the Department's Quality and Installation Specifications.

The following standards may be used as a guide but must not be regarded as a complete list.

<u>DESCRIPTION</u>	<u>SANS</u>	<u>BSI</u>	<u>IEC</u>
Air & Oil Switches	-	5463	265-A-C
Busbar & Busbar Connections	1195	159	
Bushings	-	223	137
Cable Glands & Sealing boxes	-	542, 2562	
HV Fuses		2692	282-1
LV Fuses	172	88	269-1
Electrical Power Switchgear	-	5227	-
Galvanising	32&121	729	-
Insulating Oil	555	148	296
Isolators and Earthing Switches	-	5253	129
Oil Switches	-	5463	-
Protective Relays	-	142	255
Colours for specific purposes	1091		

2.1 Service Conditions

Frequency	50 Hz
Phases	3
Nominal voltage	11 kV
Rupturing Capacity	250 MVA
Impulse Level	95 kV
Highest System Voltage	12 kV
Atmospheric Temperature	-5°C to 40°C
Altitude	0mm minimum 1850m maximum
Lightning & Dust	severe
Average Power Factor	0,8
Maximum Humidity	95%

The system neutrals will be solidly earthed. All switchgear and auxiliary equipment shall be designed to withstand the stresses of an unearthed system.

2. CONSTRUCTION AND FINISH

- 2.1 The switches shall be totally enclosed, metal clad and of the bulk oil content type. Air break switches will not be acceptable. Switches shall be suitable for both indoor or outdoor use as specified.
- 2.2 The switches shall be self-supporting and free standing. At least four M20 high tensile steel holding-down bolts shall be provided with each switch. The holding-down bolts shall be suitable to be cast into the concrete base.
- 2.3 The switch shall be treated and painted in accordance with the requirements of clause 3.23 of SANS 780 as amended.
- 2.4 In the case of switches supplied for installation within 50km of the coast, in polluted industrial atmospheres or as specified, the total dry film thickness of the paint shall be increased to at least 0,125mm.

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- 2.5 The colour shall be "DARK ADMIRALTY GREY" to BS 381 C (Shade 632) or colour G12 of SANS 1091. A tin of matching touch up paint (not smaller than 500ml) shall be provided with each consignment.

3. MECHANISM

- 3.1 The switch shall have three positions, namely "ON", "OFF" and EARTH".
- 3.2 Except for removing the earth, the switch actuating mechanism shall have a positive action and shall be spring assisted to ensure that once the operation is initiated it becomes completely independent of the operator.
- 3.3 The fused oil switch shall close fully when making onto a fault to ensure full clearance of the fault by the fuses before tripping and opening the switch.
- 3.4 A blown fuse on any one of the three phases shall open all three phases of the switch and shall inhibit the closure of the switch pending fuse replacement.

4. INTERLOCKS

- 4.1 The mechanism shall be incapable of moving directly to the "EARTH" position from the "ON" position.
- 4.2 A time delay shall be built into the mechanism to prevent immediate opening of the switch after closure. This shall be achieved by means of non-reversible operating handles, mechanical sliding interlocking gates or a non-reversible movement.
- 4.3 Padlocking facilities shall be provided to prevent either operation.
- 4.4 Access to the testing facilities shall only be possible after the switch is in the "EARTH" position. With the testing devices fitted, operation to either the "ON" or "OFF" positions must be prevented.
- 4.3 Access to the fuse carriage shall only be possible with the switch in the "OFF" position.

5. CABLE TEST FACILITIES

- 5.1 Cable test facilities are required and must be easily accessible.
- 5.2 All units required for installation in miniature substations must be equipped with integral testing facilities. Testing by means of a separate test harness is not acceptable.
- 5.3 Refer to par. 4.4 regarding interlocking of test facilities.
- 5.4 Where a separate test unit is supplied for use in a substation (not mini substation) it shall be easily fitted and shall be supplied and stored in a suitable padlockable receptacle mounted in a convenient position on the switch.

6. RATINGS

- 6.1 Continuous rated currents (minimum):
- | | |
|---------------------------|------|
| Busbars | 400A |
| Oil switch contacts | 400A |
| Fused oil switch contacts | 90A |

7. FUSES

- 7.1 Fuse-links shall be of the striker pin type, shall be hermetically sealed and shall be suitable for use under oil.
- 7.2 The fuse-link carriage shall be suitable to accept either 254mm or 359mm long fuses both with a diameter of 63,5mm. The carriage shall be adjustable for this purpose and shall not necessitate additional parts.
- 7.3 Automatic shutters shall be provided to safeguard against inadvertent contact with live parts when the fuse carriage is removed.

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- 7.4 Three spare fuses in addition to the three fuses supplied with the fused oil switch shall be supplied with each unit. The rating of the fuses will be specified in the Detail Technical Specification.

8. CABLE END BOXES

- 8.1 The switches must be supplied with cable end boxes suitable to accept armoured, paper-insulated cables as specified.
- 8.2 The cable end boxes shall be of the metal clad type suitable for indoor or outdoor use.
- 8.3 The boxes shall be equipped with armour clamps and brass or gunmetal conical wiping glands for lead covered steel tape or galvanised steel wire armoured cables.
- 8.4 The cable boxes shall comply with the Department's standard specification for "CABLE END BOXES AND COMPOUND", Section C8.

9. OIL FOR SWITCHES

9.1 OIL FILLING

Sufficient oil shall be supplied with the switchgear to fill the fuse and switch chambers.

9.2 BUSBAR CHAMBER

If the busbar chamber is designed to be filled with compound, sufficient compound shall be supplied with the switchgear for this purpose if the chamber is not factory filled.

10. UNIT COMBINATIONS

10.1 A SINGLE OIL SWITCH OR FUSED OIL SWITCH

A single oil switch shall be supplied with a busbar end cap and insulating compound on one end. A cable end box shall be fitted to the opposite busbar end.

10.2 EXTENSIBLE OIL SWITCHES AND FUSED OIL SWITCHES

Extensible oil switches and fused oil switches shall be supplied complete with two busbar end caps, busbar coupling links, busbar band joints and filling compound for the end caps and joints.

10.3 EXTENSIBLE RING MAIN UNIT WITH FUSED OIL SWITCH TEE-OFF

An extensible ring main unit with a fused tee-off shall comprise two extensible oil switches and one extensible fused oil switch complete with equipment and material. (Refer to par. 10.2). The fused oil switch tee-off shall be located between the two oil switches.

10.4 NON-EXTENSIBLE RING MAIN UNIT WITH FUSED TEE-OFF

A non-extensible ring main unit shall comprise two oil switches and one fused oil switch tee-off combined in a compact single unit with no external busbar access.

The three switches shall preferably be housed in a common oil tank. The fused oil switch tee-off shall be located between the two oil switches.

11. LABELS

- 11.1 Labels shall consist of engraved plastic or ivory sandwiched strips. The labels shall bear white lettering on black background. Painted or printed labels are not acceptable.
- 11.2 Each switch shall have a label designating the circuit. All label designations shall be obtained from the Department and shall be confirmed in writing with the Department before manufacture.
- 11.2 Labels shall be secured by means of brass bolts, nuts and washers. Where this is not practicable cadmium-plated self-tapping screws may be used. The gluing of labels is not acceptable. Sufficient fixing screws shall be provided to prevent labels from warping.

12. INSPECTION AND TESTS

The Department shall be notified at least two weeks in advance of the completion of the switches and of the date of testing in order that an inspection may be carried out before delivery and that tests may be witnessed.

13. TECHNICAL INFORMATION

13.1 One copy of each of the following information shall be submitted to the Department together with the tender:

- (a) Type test certificates.
- (b) Complete technical details and brochures.

13.2 Immediately after the award of the contract, a detail drawing of the concrete bases showing concrete mixes, dimensions, cable entry openings, steel reinforcing details and holding-down bolt fixing shall be submitted to the Department. Three prints of each of the different drawings shall be provided.

13.3 The following information shall be supplied together with the equipment:

- (a) One operating and maintenance manual.
- (b) Installation and commissioning instructions.
- (c) Two copies of the unit test certificates.
- (d) A test certificates stating the average breakdown voltage of the oil at the time of filling.

13.3 One operating handle of each type of switch shall be supplied.

14. COMPLETION

The supply contract shall be regarded as incomplete until the technical information, operating handles, filling compound, fuses, test units (if required) and all other items as specified have been supplied to the Department.

SECTION C36**C.36 DISTRIBUTION TRANSFORMERS****1. GENERAL**

- 1.1 This specification covers the manufacture of distribution transformers for general reticulation and distribution systems in normal environmental conditions for 50 Hz, three-phase, 11 kV (nominal) primary and three-phase four-wire 400 V (nominal) secondary systems.
- 1.2 The transformers shall be of the low loss type and shall comply with SANS 780.
- 1.3 The number of transformers required shall be as specified.

2. POWER RATINGS

The rated power of the transformer shall be as specified and shall be one of the standard values given below in accordance with SANS 780:

- 2.1 Single-phase Transformers (kVA): 16, 25.
- 2.2 Three-phase Transformers (kVA): 16, 25, 50, 100, 200, 315, 500, 800, 1250, 2000.

3. BREATHING

- 3.1 Single-phase transformers shall be of the sealed type, with the tank covers welded to the tank.
- 3.2 Three-phase transformers shall be of the sealed type up to power ratings of 500kVA. Transformers rated at 800kVA and above may be of the free-breathing or sealed type. Sealed transformers shall have welded tank covers. Bolted tank covers will not be accepted on sealed transformers.
- 3.3 Sealed transformers above 500kVA rating shall be fitted with a pressure relief device, secured to the welded tank cover.

4. CONSTRUCTIONAL DETAILS AND FITTINGS

The transformer shall be fitted with the recommended standard fittings for transformers as specified in Table 1 of SANS 780 and as specified below:

- 4.1 An off-load tapping switch shall be provided on all transformers including miniature substation transformers.
- 4.2 A maximum indicating thermometer shall be provided on all transformers with a power rating of 1 000kVA and above to sense the oil temperature directly above a winding. One pair of alarm contacts shall be calibrated to close at 85°C one pair of trip contacts shall be calibrated to close at 95°C. These contacts shall not be easily adjustable without removal of a cover.
- 4.3 Gas-and-oil actuated relays shall be provided on all transformers of power ratings of 1000kVA and above. One pair of alarm and one pair of tripping contacts shall be provided.
- 4.4 Single-phase transformers shall be fitted with pole clamps.
- 4.5 Longitudinal skid under bases shall be provided on all transformers of power ratings of 800KVA and above. Axles and wheels are not required.

5. BUSHINGS AND CABLE BOXES

- 5.1 Open bushings and outdoor terminals shall be provided on both the primary and secondary sides of the transformers unless specified to the contrary. The bushings on the low voltage side shall all be of the same size.

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- 5.2 If specified, cable boxes shall be provided. Cable boxes on the primary side of the transformer shall comply with the following requirements:
- 5.2.1 Cable boxes shall be of the metal-clad type suitable for indoor and outdoor use and suitable to accept armoured, paper-insulated cables as specified.
 - 5.2.2 The boxes shall be equipped with armour clamps and brass or gunmetal conical wiping glands for lead covered, tape or wire armoured cables.
 - 5.2.3 The boxes shall comply with BS 2562.
 - 5.2.4 The boxes shall be suitable for filling with bituminous or cold filling compound.
 - 5.2.5 The boxes shall comply with the Department's standard specification for "CABLE END BOXES AND COMPOUND", Section C8.
- 5.3 Cable boxes on the secondary side shall comply with the following requirements:
- 5.3.1 The cable boxes shall be of the metal-clad type suitable for indoor and outdoor use and suitable to accept PVC-insulated and armoured cables as specified.
 - 5.3.2 The boxes shall be air insulated and shall be equipped with the required number, sizes and types of glands and waterproofing shrouds. Glands shall be equal or similar to "PRATLEY" adjustable glands.
 - 5.3.3 Where single core cables are used the base plate of the cable box shall be manufactured of non-ferrous material.

6. CABLE BOX FILLING COMPOUND

Where cable boxes are specified an adequate quantity of filling compound shall be provided. The filling compound shall comply with the Department's standard specification for "CABLE END BOXES AND COMPOUND", Section C8.

7. TERMINALS FOR THREE-PHASE TRANSFORMERS

- 7.1 Three terminals shall be provided on the primary side. Each terminal shall be fitted with the correct size and number of lugs, bolts, nuts, washers, etc. to accept the cables as specified. Bolted connections only are acceptable.
- 7.2 Four terminals shall be provided on the secondary side i.e. three phases and an insulated neutral. Each terminal shall be fitted with the correct size and number of lugs, bolts, nuts, washers, etc. to accept the cables as specified. Where parallel cables are specified bushing stud clamps or similar connectors of adequate size to accommodate the bolted cable lugs without overlapping of the lugs shall be provided.
- 7.3 Where busbars are specified on the secondary side, provision shall be made for the busbar enclosure to be made off on the transformer. Busbars rated at the transformer's full load current shall be accommodated. Adequate space shall also be allowed for busbar protection current transformers and allowance shall be made for the neutral to be brought out of the enclosure for external earthing.

8. CURRENT TRANSFORMERS

Current transformers are not required.

9. CORROSION PROTECTION

Corrosion protection shall comply strictly with SANS 780, clause 3.2.3. Where the transformers are required for installation within 50km of the coast the total dry film thickness of the paint shall be increased to at least 0,125mm.

10. METHOD OF COOLING

The transformers shall be of the ONAN type

11. OIL

The transformers shall be supplied completely filled with oil. The oil shall comply with SANS 555. Sealed transformers shall be filled with passivated transformer oil.

12. TECHNICAL INFORMATION

All the relevant technical information i.e. outline drawings, test cards, drawings of rating plate, etc. as specified in SANS 780 shall be submitted to the Department.

In addition a test certificate stating the average breakdown voltage of the oil at time of filling shall be submitted to the Department.

SECTION C37**C.37 MINIATURE SUBSTATIONS****1. GENERAL**

- 1.1 This specification covers the manufacture and supply of miniature substations suitable for use on 11 kV (three-phase) and 400 V (three-phase and neutral), 50 Hz systems.
- 1.2 The substation shall comply with the requirements of SANS 1029 and SANS 1030 unless otherwise specified.

2. CONSTRUCTIONAL REQUIREMENTS**2.1 FIBREGLASS HOUSINGS**

Where specified and for all substations to be installed within 50km of the coast and in all corrosive industrial atmospheres, the roof, walls, and doors shall be manufactured of fibreglass in accordance with the following minimum requirements:

- 2.1.1 The laminate shall be constructed to SANS 141.
- 2.1.2 The fibreglass shall comply with the minimum strength requirements of clause 3.4 of SANS 1029.
- 2.1.3 An outer isophthalic resin gelcoat with a minimum thickness of 0,4mm and ultraviolet absorption properties to prevent degradation of the surface from exposure to the sun shall be provided.
- 2.1.4 The gelcoat shall be backed by multiple layers of chopped strand mat glass rendering not less than 1,2kg/m². The strength shall be increased to 1,35kg/m² on all panels larger than 500 x 500mm.
- 2.1.5 The fibreglass shall be thoroughly impregnated with polyester resin. The resin should preferably be clear.
- 2.1.6 The resin to fibreglass ratio shall not be less than 2,5:1 and not more than 3,0:1.
- 2.1.7 Air entrapped between the glass mat layers shall be thoroughly worked out. The laminate must be free of air bubbles and voids.
- 2.1.8 All edges shall be reinforced with an additional 700g/m² of fibreglass.
- 2.1.9 All large surfaces, wider than 300mm. shall be reinforced or panelled to improve stiffness and rigidity.
- 2.1.10 A resin coat shall be applied to the inside of the panels to cover the fibre pattern.
- 2.1.11 Brass or steel backing plates shall be laminated into the fibreglass at hinge points locking mechanism catch support areas, door restraint fixing points and all other points which will be subjected to mechanical stress.
- 2.1.12 Doors shall be adequately, reinforced, ribbed or double laminated with an air gap between the two layers of laminate to ensure rigidity.

2.2 FINISH AND COLOUR OF FIBREGLASS MINIATURE SUBSTATIONS

- 2.2.1 The outside surface of the fibreglass shall have a glossy, smooth finish to ensure good weathering. To obtain this the manufacturer shall ensure that the moulds are smooth, free of voids, hairline cracks, pores or other defects.
- 2.2.2 Compound rubbing or sanding of the outside surface will not be permitted.
- 2.2.3 Pigments shall be added to the outer gelcoat to obtain a matching colour to "AVOCADO GREEN", colour C12 or "LIGHT STONE", colour C37 of SANS 1091.

2.2.4 Fibreglass panels shall not be painted.

2.3 SHEET STEEL HOUSINGS

2.3.1 Where specified, the roof, walls and doors shall be manufactured of steel.

2.3.2 The sheet steel construction shall comply with the minimum strength requirements of clause 3.4 of SANS 1029.

2.3.3 All welds shall be ground smooth and the joints wiped with plumber's metal in order to provide a smooth finish.

2.3.4 All panels, the roof and doors shall be suitably braced and stiffened to ensure rigidity and to prevent warping.

2.3.5 The colour of the outer coat of paint on the outer surfaces of the substation shall be an acceptable match to "AVOCADO GREEN" colour C12 or "LIGHT STONE". colour C37 of SANS 1091. A tin of matching touch-up paint (not smaller than 500ml) shall be provided with each mini-substation:

3. CONCRETE PLINTH

3.1 The mini-substation shall be mounted on a concrete plinth. Plinth shall be cast on site.

3.2 The Contractor shall issue to the Department a detailed plinth drawing suitable for each type of mini-substation supplied. Refer to par. 11.1.1 (e).

3.3 The top of the plinth shall protrude at least 200mm above the final surrounding, ground level. The concrete plinth shall protrude approximately 100mm beyond the edges of the mini-substation to form an apron.

3.4 The concrete apron and plinth shall be wood float finished and shall slope from the base to permit rain water run off. A 3mm thick gasket of approved malthoid shall be inserted between the mini-substation and the concrete surface. The gasket shall be as wide as the base.

3.5 Cable ducts shall be provided in the plinth to accommodate all the incoming and outgoing cables. The cable ducts shall be sealed to prevent entry of rodents. The sealing shall be easily removable in the event of future cable work and may consist of a layer of 10:1 sand and cement mix, approximately 10mm thick, and finished flush with the top of the concrete plinth.

4. BASE

Steel bases shall be supplied for the mini-substations. Bases shall be hot-dip galvanised and then epoxy tar coated before being painted.

5. DOORS

5.1 Long pedestal type hinges with at least two fixing bolts per hinge or similar hinges shall be used to hang the doors. The pedestal hinges shall be arranged in opposed fashion so that doors cannot be lifted off. Piano hinges are not acceptable. The hinges shall be of brass or other corrosion resistant materials. Nylon or aluminium hinges are not acceptable.

5.2 At least three hinges shall be provided on doors higher than 1,2m.

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

5.4 Doors shall be fitted with brass or stainless steel lever locks equal or similar to the "BARKER & NELSON" type with a 180° movement. The locking mechanism shall have a catch on the rear which catches behind the frame or door entry surround. The locking mechanism as well as the catch support area shall be backed by brass or galvanised steel plates. The locking mechanism shall be padlockable. Padlocks will be provided by the Department.

5.4 Bypass bolts and nuts shall be used to fix the hinges.

6. HIGH VOLTAGE COMPARTMENT

- 6.1 The high voltage compartment shall be equipped with a non-extensible bulk oil filled ring main unit with a fused tee-off unless otherwise specified. This unit shall be manufactured and supplied in accordance with the Department's standard specification for "11kV NON-AUTOMATIC OIL SWITCHES, FUSED OIL SWITCHES AND RING MAIN UNITS", Section C35.
- 6.2 All ring main units or other HV switchgear installed in miniature substations must be fitted with integral testing facilities. Testing by means of a separate test harness is not acceptable.
- 6.3 The minimum clearances between connecting cables and jumpers and any sharp metal edges or protrusions shall be at least 75mm.
- 6.4 "DELARON" or "THIOLITE" resin bound synthetic wood or other suitable dielectric material shall be used to maintain the phase-to-phase and phase-to-earth spacing of the cables and jumpers. The surfaces of these spacers shall be treated to prevent surface tracking.
- 6.5 Stranded annealed copper conductors only shall be used for jumper cables.
- 6.6 All terminals shall be shrouded with "RAYCHEM", or similar heat-shrinkable shrouds. Taping is not acceptable.
- 6.7 The high tension connections between the fused switch unit and the transformer shall be suitably blanked off so that they cannot be touched.

7. TRANSFORMER COMPARTMENT

- 7.1 The transformer compartment shall be equipped with a transformer as specified and in accordance with the Department's standard specification for "DISTRIBUTION TRANSFORMERS". Section C36 and the requirements of SANS 1029.
- 7.2 An off-circuit tap switch shall be provided.
- 7.3 The transformer shall be sealed and shall not contain a silica-gel breather.

8. LOW VOLTAGE COMPARTMENT

8.1 EQUIPMENT

- 8.1.1 The specified equipment shall be installed in the low voltage compartment.
- 8.1.2 The equipment shall comply with the Department's standard quality specifications.
- 8.1.3 The low voltage compartment shall be of ample size to accommodate the specified equipment and provide space for future requirements as specified.

8.2 EQUIPMENT SUPPORT FRAME

- 8.2.1 A rigid angle iron or folded metal support framework shall be provided.
- 8.2.2 The frame shall be bolted down on the base by at least four M16 high tensile steel bolts.
- 8.2.3 A cable gland plate shall be provided at the bottom of the frame across the full width of the compartment. The gland plate shall be at least 100mm above the plinth height. A minimum distance as required by the bending radius of the cores of the outgoing cables shall be provided between the lowest terminals of major equipment and the gland plate.
- 8.2.4. The gland plate shall be suitably punched to accept the number and size of cables specified.
- 8.2.5 All steelwork shall be hot-dip galvanised in accordance with SANS 32&121.
- 8.2.6 A resin bound synthetic wood or other suitable dielectric material panel shall be provided for the mounting of all equipment and busbars. Impregnated hardboard or other treated or untreated wood

products are not acceptable.

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

8.3 BUSBARS

8.3.1 Application

- (a) Busbars shall be manufactured of solid drawn high conductivity copper with a rectangular cross section in accordance with SANS 1195 and BS 159 and BS 1433, where applicable.
- (b) Although SANS 1473 refers to overhead and rising busbars, busbars in miniature substations shall comply with applicable sections of this specification, especially as far as insulation and clearance values, creepage distance, joints, insulation resistance, dielectric strength, deflection test, absorption resistance and rated short time withstand current are concerned.
- (c) Busbars shall be supplied for the following applications:
 - (i) Distribution of supply voltage.
 - (ii) Connecting of equipment with ratings exceeding the current rating of 70mm² conductors.
 - (iii) Connection of outgoing circuits with current ratings in excess of that allowed for 70mm² conductors (par. 8.4.1).
 - (iv) Collector bars for parallel cables.
 - (v) Connection bars for neutral conductors (par. 8.3.8).
 - (vi) Earth busbars (par. 8.3.9).
 - (vii) Connections to miniature circuit breakers.

8.3.2 See Section C15 for details.

8.4 WIRING

See Section C17 for details 8.4.1

8.5 MOUNTING OF EQUIPMENT

8.5.1 The mounting of equipment shall comply with SANS 1765 where applicable. Equipment shall be fixed to the support panel with bolts, nuts, washers and spring washers. Self-tapping screws will not be accepted.

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

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

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

8.6 ACCESS

All equipment, busbars and wiring shall be completely accessible with the front cover panel removed.

8.7 LABELLING

8.7.1 All equipment shall be fully labelled and accurate descriptions and safety warning notices shall be given in both official languages.

8.7.2 Engraved plastic or ivory sandwiched strips shall be used for labels. The labels shall bear white lettering on a black background, painted or printed labels are not acceptable.

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

8.7.3.1 Designation of mini-substation

CHURCH ST.	MINI-SUB
E.g. KERKSTR.	MINI-SUB

(Lettering: At least 40mm high. Label on the outside in a prominent position on both the front and back of the substation).

8.7.3.2 Designation of circuit i.e. circuit breaker, isolator, meter, etc.

e.g. HOUSE 473
HUIS 473

PUMP SUPPLY
POMPTOEVOER

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

8.7.3.3 The main switch shall be labelled in accordance with the regulations.

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

8.7.3.5 The labels shall be secured by means of brass nuts and bolts, self-tapping screws, pop-rivets or slotted label holders. Engraved labels shall be secured to facilitate a neat alteration of the designation of the labels. Labels shall not be glued to their mounting positions. Sufficient fixing points shall be provided to prevent labels from warping.

8.7.3.6 All label designations shall be confirmed with the Department before manufacture.

9. NOTICES

The notices in terms of clause C52 of the Occupational Health and Safety Act 1941 and labels as required on the outside of the mini-substation, shall be rivetted to the steel door or panelling so that they cannot easily be removed. Brass rivets shall be used. In the case of fibreglass housings, the notices shall be laminated into the fibreglass except for the designation label.

10. INSPECTION

The Department shall be notified at least two weeks in advance of the completion of the mini-substation in order that an inspection may be carried out before delivery.

11. DRAWINGS

11.1 DRAWINGS FOR APPROVAL

11.1.1 A set of three prints of the shop drawings of the mini-substations shall be submitted to the Department for approval before manufacture commences. The following information shall be presented:

- (a) Schematic and wiring diagrams.
- (b) A complete layout of the internal arrangement of the mini substations showing all equipment dimensions and constructional details. The positions and method of fixing of busbars shall be shown.
- (c) All labelling information in both the official languages on a separate sheet.
- (d) The makes, catalogue numbers and capacities of all equipment scheduled on a separate sheet.
- (e) A detail drawing of the concrete plinth showing concrete mixes, dimensions, opening sizes, steel reinforcing details and holding down bolts fixing details.

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11.1.2 The approval of drawings shall not relieve the Contractor of his responsibility to the Department to supply the mini-substations according to the requirements of this Specification.

11.2 FINAL DRAWINGS

A complete set of "as built" transparent drawings of the mini substations shall be submitted to the Department within two weeks after delivery. The information called for in par. 11.11 (a) to (e) above shall be provided.

11.3 COMPLETION

The supply contract shall be regarded as incomplete until all drawings have been handed to the Department.

SECTION C38**C.38 INSULATORS AND FITTINGS FOR OVERHEAD LINES****1. GENERAL**

- 1.1 This section covers the manufacture, supply and delivery of insulators and associated fittings for use on overhead lines with system voltages up to 22 kV and with a frequency of 50 Hz.
- 1.2 Insulators together with their metal fittings shall comply with the following standards:
 - (a) For system voltage up to 1 kV (Low Voltage): SANS 461
 - (b) For system voltages from 1 kV to 22 kV (High Voltage): SANS 60383.
- 1.3 All other non-current carrying accessories shall comply with SANS 61284.
- 1.4 Insulators shall be suitable for use with the size and type of conductor specified.
- 1.5 All low voltage and high voltage pin insulators shall be of glazed ceramic manufacture. Glass string insulators shall only be used in areas with abnormal air pollution and where specified. In all other cases glazed ceramic string insulators shall be used.
- 1.6 Insulators, complete with all fittings, shall not exhibit excessive or localised corona formation at voltages less than 1,3 times nominal phase-to-neutral voltage.

2. HV INSULATORS

- 2.1.1 Pin insulators shall comprise a ceramic insulator mounted on a steel pin.
- 2.1.2 Pin insulator shall be of Class B to SANS 60383.
- 2.1.3 The insulators for nominal system voltages of 11 kV and 22 kV shall be designed to limit radio interference and the marking "RIF" shall appear on the insulator. A semi-conductive glaze coating applied to the tie-top portion of the insulator and cemented-in metal thimbles in the pin hole may be employed for this purpose.
- 2.1.4 The pins of pin insulators shall be straight and shall be complete with washers and nuts. The shank and threaded lengths shall be as specified on the drawings or as required for the mounting application. Pins, nuts and washers shall be hot-dip galvanised in accordance with SANS 32&121.

2.2 STRING INSULATORS

- 2.2.1 String insulators shall comprise a single string insulator unit together with its metal fittings or multiple-string insulator units arranged in a single string together with their metal fittings.
- 2.2.2 String insulators shall normally be applied in tension positions. However they may be specified for suspension positions.
- 2.2.3 String insulator units shall be in accordance with SANS 60383 and shall be complete with gudgeon pins, washers and split pins.
- 2.2.4 Wherever string insulators are required, a single insulator shall be used on 11 kV systems and two insulators on 22 kV systems.
- 2.2.5 All metal parts shall be hot-dip galvanised in accordance with SANS 32&121 excluding the split pins for the securing of the gudgeon pin which shall be of phosphor bronze or stainless steel.
- 2.2.6 The insulators for nominal system voltages of 11kV and 22kV shall be designed to limit radio interference and the marking "RIF" shall appear on the insulator.

2.3 VOLTAGE RATINGS

2.3.1 The voltage ratings of pin insulators shall be as follows:

	SYSTEM VOLTAGE	
	11kV	22kV
(a) Flashover voltage		
dry	95kV	110kV
wet	53kV	80kV
(b) Puncture withstand voltage	95kV	130kV
(c) 50% lightning impulse voltage		
positive	140kV	170kV
negative	165kV	215kV

2.3.2 The voltage ratings of string insulators shall be as follows:

(a) Flashover voltage	
dry	84kV
wet	53kV
(b) Puncture withstand voltage	115kV
(c) 50% lightning impulse withstand voltage	
positive	152kV
negative	148kV

3. LV INSULATORS

3.1 LV PIN INSULATORS

3.1.1 Low voltage insulators shall be of white glazed porcelain with top and side grooves. The groove sizes shall be suitable for the size of conductor used.

3.1.2 The insulators shall be internally threaded to accept "CORDEAUX" threaded spindles.

3.1.3 Insulators shall be supplied complete with mild steel straight spindles, fibrous or neoprene washers, washers and nuts. All steel parts shall be hot-dip galvanised in accordance with SANS 32&121.

3.2 LV SHACKLE AND REEL INSULATORS

3.2.1 All low voltage shackle and reel insulators shall be of white glazed porcelain with a side groove. The groove size shall be adequate to accept the conductor size used.

3.2.2 Where these insulators are specified for tension or angle points, hot-dip galvanised mild steel straps or "D" brackets and bolts, nuts and washers shall be provided. Two fibrous or neoprene washers shall also be provided for each insulator. Galvanising shall be in accordance with SANS 32&121.

4. STAY INSULATORS

4.1 Stay insulators shall be of brown glazed porcelain.

4.2 The minimum dry and wet flashover voltages shall be 35 kV and 30 kV respectively.

4.3 The ultimate breaking strength of the insulators shall be at least 110kN.

5. FITTINGS

5.1 GENERAL

5.1.1 All fittings made of steel or malleable iron, including the threaded portions of bolts, shall be hot-dip galvanised in accordance with SANS 32&121 to prevent corrosion.

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- 5.1.2 Bolts and nuts shall be of steel with hexagonal heads. Where metal parts are secured by bolts and nuts, single flat mild steel washers shall be used at both the bolt head and nut sides.
- 5.1.3 Bolts shall be locked by means of locknuts or other approved methods.
- 5.1.4 All line, earth conductor and staywire fittings shall not employ screw threads loaded in tension with the exception of cross-arm eye bolts and tumbuckle type stay rods.
- 5.1.5 Adequate bearing areas between fittings shall be provided. Point or line contacts shall be avoided where possible without adversely affecting the flexibility of the fittings.
- 5.1.6 All split pins shall be of phosphor bronze or stainless steel and shall be backed by flat steel washers.
- 5.1.7 The mechanical strength of insulators and fittings shall provide a factor of safety of at least 2.5 based on the guaranteed minimum failing load when they are subjected to the maximum design tension in the conductor or earth wire to which they are attached. The ultimate breaking strength of insulators and fittings specified for tension applications shall in any event not be less than 70kN.

5.2 TENSION CLAMPS

- 5.2.1 Tension clamps shall be of the bolted type "snail" clamps.
- 5.2.2 The clamps shall be made of malleable cast iron to BS 310 and manufactured in compliance with SANS 61284.
- 5.2.3 Tension clamps shall not permit slipping of or cause damage to or failure of the complete line conductor or any part thereof at a load less than 95% of the ultimate strength of the line conductor for which it is intended.
- 5.2.4 The tension clamps shall be designed so that relative movement between individual conductor layers shall not occur during assembly.
- 5.2.5 All bolts or U-bolts shall be provided with locknuts or an alternative locking manner approved by the Department. All nuts shall be backed with flat steel washers.
- 5.2.6 The clamps shall match the clevis and tongue string insulator units without additional adaptors and shall also be suitable for the specified conductor type and size.

5.3 THIMBLE CLEVISES

- 5.3.1 Thimble clevises shall be used with preformed dead-ends.
- 5.3.2 Thimble clevises shall be made of malleable cast iron to BS 310.
- 5.3.3 The radii of the thimble clevis shall be suitably designed to accept the preformed dead-ends.
- 5.3.4 The thimble clevises shall match the clevis and tongue string isolating units without any additional fittings.

5.4 CROSS-ARM AND TOWER ATTACHMENTS, SHACKLES, LINKS, ADAPTORS AND YOKE-PLATES

- 5.4.1 These fittings shall be made of malleable cast iron to BS 310 and manufactured in compliance with SANS 61284.
- 5.4.2 The fittings shall match the specified immediate adjacent fitting or string insulator unit without the use of additional adaptors.

6. SURGE DIVERTERS

Surge diverters are surge protective devices for repeated operation to limit voltage surges on AC power circuits and to interrupt power follow current.

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6.1 LOW VOLTAGE SURGE DIVERTERS

- 6.1.1 Surge diverters for installations with a rated voltage of up to 660V shall comply with SABC 171.
- 6.1.2 The voltage rating for these surge diverters shall be 250V, 500V or 660V with an insulation resistance of not less than 50 megohms.
- 6.1.3 Surge arresters for indoor use shall be clearly marked "INDOOR".

6.2 HIGH VOLTAGE SURGE DIVERTERS

- 6.2.1 Surge diverters for installations with a rated voltage above 660V shall conform to IEC 99-1 for "NON-LINEAR RESISTOR TYPE ARRESTERS FOR AC SYSTEMS" and shall be 10 kA Series A arresters of the heavy duty type.
- 6.2.2 The line and earth connections shall consist of terminal lugs, complete with bolts, nuts, stainless steel washers and cable washers.
- 6.2.3 The mounting bracket which will be supplied with the surge diverter shall be hot-dip galvanised steel brackets complete with damping band, bolts, nuts and washers. The mounting bracket shall have the dimensions of and comply with the NEMA bracket 1. All the bracket accessories shall be hot-dip galvanised.

SECTION C39**C.39 STANDARD PAINT SPECIFICATION****1. FINISH REQUIRED**

Metalwork of electrical equipment such as switchboards, equipment enclosures, sheet steel luminaire components, purpose-made boxes, etc. shall be finished with a high quality paint applied according to the best available method. Baked enamel, electrostatically applied powder coating or similar proven methods shall be used.

2. CORROSION RESISTANCE

Painted metal shall be corrosion resistant for a period of at least 168 hours when tested in accordance with SANS 166.

3. EDGES

Care shall be taken to ensure that all edges and comers are properly covered.

4. SURFACE PREPARATION

Surface preparation shall comply with SANS 10064. Prior to painting, all metal parts shall be thoroughly cleaned of rust, mill scale, grease and foreign matter to a continuous metallic finish. Sand or shot blasting or acid pickling and washing shall be employed for this purpose.

5. BAKED ENAMEL FINISH

- 5.1 Immediately after cleaning all surfaces shall be covered by a rust inhibiting, tough unbroken metal-phosphate film and then thoroughly dried.
- 5.2 Within forty eight (48) hours after phosphatising, a passivating layer consisting of a high quality zinc chromate primer shall be applied, followed by two coats of high quality alkyd-based baked enamel.
- 5.3 The enamel finish on metal luminaire components shall comply with SANS 783, Type III.
- 5.4 Other metal parts e.g. switchboard panels, etc., shall comply with SANS 783, Type IV with a minimum paint thickness after painting of 0,06mm. In coastal areas, the dry film thickness shall be increased to at least 0,1mm.
- 5.5 The paint shall have an impact resistance of 5,65 J on cold-rolled steel plate and a scratch resistance of 2kg

6. POWDER COATED FINISH (NOT TO BE USED LESS THAN 50KM FROM SEASIDE)

- 6.1 Immediately after cleaning the metal parts shall be pre-heated and then covered by a microstructure paint powder applied electrostatically.
- 6.2 The paint shall be baked on and shall harden within 10 minutes at a temperature of 190°C.
- 6.3 The minimum paint thickness after baking shall be 0,05mm. The dry film thickness shall be increased in coastal areas. The paint cover shall have an impact resistance of 5,65 J on cold-rolled steel plate and a scratch resistance of 2kg.

7. TOUCH-UP PAINT

In the case of switchboards and larger equipment enclosures, a tin of matching touch-up paint not smaller than 1 litre shall be provided.

8. COLOURS

- 8.1 The colour of HV switchboards and HV switchgear enclosures shall be "DARK ADMIRALTY GREY", colour G12 of SANS 1091.
- 8.2 The colour of LV switchboards and equipment enclosures in buildings shall be "LIGHT ORANGE", colour B26 of SANS 1091 as recommended in SANS 10140, Part II unless specified to the contrary.
- 8.3 The colour of LV distribution kiosks and miniature substations shall be "AVOCADO GREEN", colour C17 or "LIGHT STONE", colour C37 of SANS 1091.
- 8.4 The standby power section of LV switchboards in buildings shall be coloured "SIGNAL RED", colour A11 of SANS 1091.
- 8.4 Switchboards for No-Break Power Supplies or sections of switchboards containing No-break power supplies, shall be coloured "DARK VIOLET", colour F06 or "OLIVE GREEN" colour H05 of SANS 1091.

SECTION C40**C.40 FIBREGLASS REINFORCED POLYESTER LIGHTING POLES**

The poles offered shall be of a filament fibreglass reinforced polyester type. The pole shall be cylindrical in shape and have a continuous taper of 18mm per metre. The poles shall be manufactured according to Quality System Assurance SANS 9000.

The material used must comply with the requirements of SANS 141.

The material shall be of glass filament wound manufacture, employing a filament winding process achieving optimum results for strength and rigidity. The surface shall be smooth tapered seamless.

The pole shall be coloured throughout in the standard colour grey.

The surface shall be of a special pure resin coat to achieve a weatherproof U.V. resistant fire retardant and impact resistant surface.

The mechanical strength of the pole shall be designed for a fluctuating wind load of 700 PA onto a surface area of 0,25m². Under these circumstances a maximum deflection of 5% of the mounting height (height above ground) shall be permissible. The pole shall be designed with a safety factor of 3.

A cable entry of 80mm diameter shall be provided ± 600mm below ground level.

The pole shall have an access door of 250mm x 80mm. The door cover shall be an overlapping polycarbonate cover smaller in diameter than the pole to ensure a tight fit. The cover shall be secured to the pole by means of two captive stainless steel ALLEN cap screws that are completely tamper proof and only accessible with an ALLEN key. The door cover shall be completely replaceable and interchangeable.

The poles shall have a minimum filament wall thickness of 8mm ± 20%.

The pole is to have a 300mm x 300mm hot dipped galvanised baseplate secured to the pole by means of 2 x M8 hook bolts.

The pole shall be supplied with a gland plate to accommodate 2 x 20mm glands, MCCB, 4x16 amp terminal block and earth stud. This gland plate shall be removable so that the work can be executed outside the pole.

A SANS certificate certifying the bending strength of the pole shall be enclosed.

Copy of Quality Assurance Certificate of SANS 9000 shall be enclosed.

A pamphlet furnishing full details of the pole offered, shall be submitted with the tender.

SECTION C41**C.41 GALVANISED STEEL LIGHTING POLES****1. GENERAL**

All poles supplied must be absolutely straight, have the same shape and shall be as described in this specification. The poles must have a well-finished appearance and must not be twisted in any way due to manufacturing or as result of handling. The pole must be of sufficient strength that it will not undergo any permanent shape change as a result of normal of normal transportation, handling or erection.

The pole as a whole, including all fittings shall be galvanised on the inside as well as on the outside in accordance with SANS 32&121. The welding work on the pole shall be smooth and neat. No splatter, slag or air bubbles shall be visible. The galvanising process shall be done after all welding and machine work have been done.

The pole diameter shall decrease gradually or in steps from the pole's base to the pole top and the pole shall be as slender as possible with an outer diameter of $145 \pm 5\text{mm}$ at the bottom. The minimum material thickness of the pole shall be 4,5mm. The pole shall be absolutely round.

The manufactures shall provide acceptable ventilation holes in the pole to prevent condensation of moisture in the pole. The pole shall also be rain and bee-proof

A rectangular access hole shall be provided at the bottom end of the pole $\pm 0,9$ above finished ground level.

The opening shall be provided with a rain proof cover plate with the same profile as the pole. The cover plate may only be removed by using special tools. The cover plate shall undergo the same galvanising process after forming, cutting and drilling. The thickness of the cover plate shall not be less than 4mm.

A back plate suitable for the mounting of equipment shall be bolted in the pole. A clip-tray suitable for mounting two circuit breaker's shall be provided on the mounting plate as well as a Din track for terminal blocks of the clip on type and a 6mm earth stud with nut, washer and spring washer.

The poles shall be provided with foot plates of size of 350mm and thickness of 6mm attached to the pole with a least two hook bolts of sufficient strength.

The foot plate shall not be welded onto the pole and the same rust protection that is used on the pole shall be applicable on the foot plate and hook bolts. The thread of the hook bolts shall be cleaned after been galvanised.

Each pole shall be provided with a cable entry at the bottom end of the pole. When planted $\pm 600\text{m}$ below finished ground level.

The cable entry shall be manufactured in such a way the cables will not be damaged by the sides of the hole. The minimum dimensions of the hole are 100mm x 60mm. The cable entry shall be at the back of the pole.

Pole extension and pole stubs shall comply with this specification.

A pamphlet furnishing full details of the pole's extensions and stubs offered shall be submitted with the tender.

2. STANDARDS

2.1 The poles to be provided in accordance with this specification shall comply fully with all the requirements of this specification. Any deviations from this specification shall be clearly indicated.

2.2 The poles to be provided in accordance with this specification shall comply with the relevant subdivisions of the following standard specification:

2.2.1 SANS 62 Steel pipes and pipefittings with a nominal bore of 150mm, suitable to be

			screwed to ISO R7 - pipe thread.
2.2.2	SANS 657	-	Steel tubes for general engineering purposes.
2.2.3	SANS 32&121	-	Hot-dip (galvanised) zinc coatings. (Other than on continuously zinc-coated sheet and wire.)
2.2.4	SANS 10160	-	General procedures and loading to be adopted for the design of buildings.
2.2.5	BS 4360	-	Weldable structural steel.

3. ENVIRONMENTAL CONDITIONS

3.1 The poles to be provided in accordance with this specification shall be suitable for outdoor use in the varied weather conditions prevailing in the Pretoria area during the various seasons. The following conditions are of special import:

3.1.1	Attitude above sea-level	1 530m
3.1.2	Maximum environmental temperature	40 EC
3.1.3	Minimum environmental temperature	-5 EC
3.1.4	Wind velocity	40m/s

4. DESIGN REQUIREMENTS

4.1 GENERAL

4.1.1 The poles shall be manufactured in accordance with the attached drawing:

SLP-1 Streetlight pole for Townships.

SLP-2 Streetlight pole (Double bracket).

SLP-3 Streetlight pole (Single bracket).

4.1.2 The poles can take on any of the following shapes:

- a) Round, tubular (pole diameter decreases step by step from pole base to pole end).
- b) Round, tapered.
- c) Octagonal, tapered.

4.1.3 The poles shall be properly finished and shall not be skew in any respect because of the manufacturing process or the handling thereof.

4.1.4 The poles shall be strong enough in order that no permanent deformation shall take place as a result of normal transportation, handling or erection or after the luminaire has been mounted and during the life span of the pole.

4.1.5 The poles shall be provided complete with mounting plate for the terminal blocks, clip plate for a miniature circuit breaker, pole base plate, cable access hole, inspection hole and lantern-mounting piece.

4.1.6 The Tenderer shall provide a complete design, including all calculations and drawings. This design shall be approved and certified by a registered professional mechanical engineer as being suitable to the proposed operating conditions.

4.2 MEASUREMENTS

4.2.1 Every pole shall be manufactured in accordance with the measurements indicated on the applicable drawing.

4.2.2 The following measurements are of special import and may not be altered:

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- a) Mounting height and overhang.
 - b) Minimum inside diameter at access opening.
 - c) Outside diameter at end of pole.
 - d) Position and size of holes in flange.
 - e) Mounting pieces (see paragraph 4.7.4).
- 4.3 CABLE INLET
- 4.3.1 Each pole shall be provided with a cable inlet of 100mm x 60mm at the bottom end of the pole, as indicated on the applicable drawing.
 - 4.3.2 The cable inlet shall be manufactured in such a manner that the sides of the opening will not damage the cable.
- 4.4 POLE BASE PLATE
- 4.4.1 Each pole shall be provided with a square steel base plate with a diameter of 350mm and shall be at least 4mm thick.
 - 4.4.2 The pole base plate shall be welded to the base of the pole.
- 4.5 PROVISION FOR CONTROL EQUIPMENT
- 4.5.1 A rectangular access opening shall be provided at the bottom end of the pole, as indicated on the drawing. The opening shall be covered by a rainproof cover plate with the same profile as the pole and shall be kept in position by means of one heptagonal 10mm brass nut. The cover plate shall be manufactured from the same material as the pole and shall endure the same galvanising process after it has been shaped, cut and drilled. The thickness of the cover plate shall be at least the thickness of the pole.
 - 4.5.2 A mounting plate suitable for the mounting of equipment shall be welded into the pole. Two dip-on mounting rails for Heinemann circuit breakers, as well as a rail for a Klippon terminal block shall be provided on the mounting plate. The clip plate shall be mounted after the pole has been galvanised.
 - 4.5.3 Two rectangular holes shall be made next to the opening and each one shall be provided with a galvanised or plated 8mm x 25mm coach bolt.
 - 4.5.4 Full particulars shall be provided if the Tenderers should offer an alternative with regard to the access opening and the cover plate of the control equipment.
- 4.6 FLANGE
- 4.6.1 Poles with flanges shall be delivered complete with bolts and nuts as indicated on the drawings. The strength of the flanges and the quality of the welding shall be such that the pole will show no signs of deterioration in its structure.
- 4.7 STREET-LIGHT BRACKETS AND MOUNTING PIECES
- 4.7.1 The streetlight brackets shall be manufactured according to the attached drawings:
 - 4.7.2 The streetlight bracket shall not be welded to the pole. Special care shall be taken to ensure that the bracket(s) will not rotate.
 - 4.7.3 Provision shall be made at the end of the bracket(s) for the mounting of a streetlight luminaire.
 - 4.7.4 The ends of the mounting pieces to which the luminaire will be secured shall be round, with a outside diameter of 42,5 (+0,-1 mm) and a length of 125mm.
- 4.8 VENTILATION
- 4.8.1 The manufacturer shall provide ventilation holes in the pole in an acceptable manner so that no

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condensation of moisture will take place inside the pole. The pole shall also be rain- and insect-proof.

4.9 STREET-LIGHT LUMINAIRE

4.9.1 The following requirements are applicable to poles manufactured in accordance with drawings

4.9.1.1 Each pole shall be used to carry a street luminaire with a mass of 20kg.

4.9.1.2 The projected lateral area of the luminaire shall be 0,1m².

4.9.2 The following requirements are applicable to poles manufactured according to drawing

4.9.2.1 Each pole shall be used to carry a streetlight luminaire with a mass of 10kg.

4.9.2.2 The projected lateral area of the luminaire shall be 0,025m².

4.10 INTERCHANGEABILITY

Spares for poles manufactured according to the drawings shall be interchangeable, whether for a single- or a double-bracket pole.

5. FINISHING

5.1 WELDING

5.1.1 Welding work on the poles shall be smooth and neat. There may be no spatters, slag or air bubbles.

5.2 GALVANISING

5.2.1 The galvanising process shall take place after all welding and machining have been completed.

5.2.2 The poles, including all fittings, but excluding the circuit-breaker dip-on rail, shall be hot-dip galvanised inside as well as outside, in accordance with the latest edition of SANS 32&121.

6. TESTS

6.1 The manufacturer shall personally and in the presence of a representative Engineer execute the following tests on five poles and shall make the results of such tests available for submission to the Engineer.

6.2 TESTING OF STREET-LAMP POLES

In order to ensure that the actual situation is simulated, the vertical gravitational forces and horizontal wind forces (simulated) shall simultaneously act upon the lamp pole. The following testing methods shall be followed in order to simulate the combined loads, viz.:

- (i) Place the lamp pole in the vertical position, as it would be mounted under normal circumstances.
- (ii) Determine the position of the end of the bracket (unloaded condition) to the nearest one millimetre from the pole base as reference A (see figure 1). This may be done by attaching a plumb to the end of the bracket. The method shall be sufficiently accurate for the purposes of the test provided that the tests take place in fine weather conditions.
- (iii) The resultant loading and angle of application obtained from the combined horizontal and vertical loading shall be applied by means of a nylon rope (minimum breaking force 500kg) put up from the top end of the lamp pole. The loading may be applied in various ways, for example by attaching weights to the rope, or by placing a turnbuckle or ratchet tensioner and spring scale in line with the rope.
- (iv) The loading shall be applied in increments of 4 kg. After each loading the momentary deformation of the lamp pole shall be measured (x₁, x₂ ... x_n) and be plotted against the loading. A linear course of momentary deformation is considered to be normal, whilst a non-linear course will be an indication of a deterioration in the structure.

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- (v) After the lamp pole has been loaded to the maximum, the loading shall be removed and the position of the plumb shall be measured (X_d permanent deformation).
- (vi) Steps (iii), (iv) and (v) shall be repeated three (3) times in order to determine an average value for the permanent deformation (X_d).
- (vii) The following table indicates the loading and application angle to be applied for each individual lamp pole. Details of calculations appear in paragraph 6.4.

Note that amp-pole numbers refer to drawings in accordance with Council Specifications.

Lamp-pole number	Loading (N)	Equivalent load	Angle of application	Length of rope (m)
	224,7	24	40 E	10,9
	409,4	43	45 E	15,1
	383,3	40	49 E	12,2

- (viii) By comparing the unloaded condition (X_o) to the average of the conditions obtained after loading (X_d), the percentage permanent deformation can be determined by means of the following formula:

$$\text{Def \%} = (X_d - X_o) / X_d \times 100.$$

If this permanent deformation exceeds the proposed 15%, the pole does not comply with the specification and does not pass the test.

The above mentioned test is based on the principles of SANS 10160 viz, the general procedures and loading to be adopted for the design of buildings.

6.4 DETAILED CALCULATIONS OF LOADING

All formulae refer to SANS 10160.

The wind pressure on the element. $F_n = C_f q_z A_e$ [refer SANS 10160 - p39 5 (c)]

C_f = pressure coefficient

$$= 1,1 \quad [\text{refer SANS 101601 - p68, Table 15}]$$

q_z = free current wind pressure at height z (N/m²)

$$= k_p V_z^2 \quad [\text{refer SANS 10160 - p49, 5(d)}]$$

k_p = constants with a view to allowance for altitude above sea-level

$$[\text{refer SANS 10160-p49}]$$

V_z = characteristic wind velocity at altitude Z

Take a site category 3 with a design wind velocity of 20m/s [refer SANS 10160 - p123. Table D-1].

$$q_z = k_p V_z^2 = 0,5 (20)^2 = 200 \text{ N/m}^2$$

$$C_f q_z = 1,1 (200) = 220$$

A_e = Total effective frontal area

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Lamp pole number	Total frontal area Ae (m ²)
	(0,14 x 1,3) (0,09 x 6,7) = 0,785 (0,1651 x 2) (0,114 3 x 8,7) =1,325 (0,1651 x 2) (0,114 3 x 7,2) =1,153

The following represents the resultant force with the angle at which it shall be applied:

Lamp-pole number	Vertical loading (N) Fv	Horizontal loading (N) Fn	Resultant Loading (N) Fr	Application angle 0	Rope length (m)
	143,7	172,7	224,7	40 E	10,9
	287,4	291,5	409,4	45 E	15,1
	287,4	253,7	383,3	49 E	12,2

(Gravitational force = 9,58 for the PWV.)

NB: The vertical loading provides for the mass of the light luminaire with a safety factor of 1,5.

6.5 The Tenderer shall include in his tender all measurements and results of tests in the form of a table for submission to the Department of Public Works.

7. DELIVERY

7.1 The successful Tenderer shall timeously notify the Engineer in writing before the delivery of the poles in order that they may be inspected upon receipt. No payment shall be made for poles, which have not been inspected or certified by the Engineer as being in order.



public works

Department:
Public Works
REPUBLIC OF SOUTH AFRICA

DETAIL SPECIFICATION
FOR THE
ELECTRICAL INSTALLATION
PART D

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SPECIFICATION FOR ELECTRICAL WORK

PART 1 - GENERAL

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PART 1 - GENERAL

1 TESTS

After completion of the works and before practical completion is achieved, a full test will be carried out on the installation for a period of sufficient duration to determine the satisfactory working thereof. During this period the installations will be inspected and the Contractor shall make good, to the satisfaction of the Principle Agent/Electrical Engineer or the employer, any defects which may arise.

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

2 MAINTENANCE OF INSTALLATIONS

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

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

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

3 REGULATIONS

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

4 NOTICES AND FEES

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

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

5 SCHEDULE OF FITTINGS

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

6 QUALITY OF MATERIALS

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

Wherever applicable the material is to comply with the relevant South African Bureau of Standards, specifications, or to IEC Specifications, where no SANS Specifications exist.

Materials wherever possible, must be of South African manufacture.

7 CONDUIT AND ACCESSORIES

The type of conduit and accessories required for the service, i.e. whether the conduit and accessories shall be of the screwed type, plain-end type or of the non-metallic type and whether metallic conduit shall

be black enamelled or galvanised, is specified in Part 2 of this specification.

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

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

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

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

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

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

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

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

Running joints in screwed conduit are to be avoided as far as possible and all conduit systems shall be set or bent to the required angles. The use of normal bends must be kept to a minimum with exception of larger diameter conduits where the use of such bends is essential.

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

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

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

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

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

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

8 CONDUIT IN ROOF SPACES

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

Nail or crampets will not be allowed.

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

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

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

9 SURFACE MOUNTED CONDUIT

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

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

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

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

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

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

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

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

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

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

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

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

10 CONDUIT IN CONCRETE SLABS

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

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

Draw-boxes, expansion joint boxes and round conduit boxes are to be provided where necessary. Sharp bends of any nature will not be allowed in concrete slabs.

Draw and/or inspection boxes shall be grouped under one common cover plate, and must preferably be installed in passages or male toilets.

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

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

11 FLEXIBLE CONNECTIONS FOR CONNECTING UP OF STOVES, MACHINES, ETC.

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

Connectors for coupling onto the flexible tubing shall be of the gland or screw-in types, manufactured of either brass or cadmium or zinc plated mild steel, and the connectors after having been fixed onto the tubing, shall be durable and mechanically sound.

Aluminium and zinc alloy connectors will not be acceptable.

12 WIRING:

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

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

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

Wiring for lighting circuits is to be carried out with 1,5mm² conductors and a 1,5mm²-earth conductor. For socket outlet circuits the wiring shall comprise 4mm² conductors and a 2,5mm²-earth conductor. In certain instances, as will be directed in Part 2 of this specification, the sizes of the aforementioned conductors may be increased for specified circuits. Sizes of conductors to be drawn into conduit in all other instances, such as feeders to distribution boards, power points etc., shall be as specified elsewhere in this specification or indicated on the drawings. Sizes of conductors not specified must be determined in accordance with the "Wiring Code".

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

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

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

13 SWITCHES AND SOCKET OUTLETS

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

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

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

14 SWITCHGEAR

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

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

15 SWITCHBOARDS

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

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

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

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

Clearly engraved labels are to be mounted on or below every switch. The working of the labels in English, is to be according to the lay-out drawings or as directed by the Electrical Engineer and must be confirmed on site. Flush mounted boards to be installed with the top of the board 2,0m above the finished floor level.

16 WORKMANSHIP AND STAFF

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

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

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

17 VERIFICATION AND CERTIFICATION OF ELECTRICAL INSTALLATION (CERTIFICATE OF COMPLIANCE AND TEST REPORT

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

18 EARTHING OF INSTALLATION

Main earthing

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

meet test standards.

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

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

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

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

All other hot and cold water pipes shall be connected with 12mm x 0,8mm perforated for solid copper strapping (not conductors) to the nearest switchboard. The strapping shall be fixed to the pipework with brass nuts and bolts and against walls with brass screws at 150-mm centres. In all cases where metal water pipes, down pipes, flues, etc., are positioned within 1,6m of switchboards an earth connection consisting of copper strapping shall be installed between the pipework and the board. In vertical building ducts accommodating both metal water pipes and electrical cables, all the pipes shall be earthed at each distribution board.

Roofs, gutters and down pipes

Where service connections consist of overhead conductors, all metal parts of roofs, gutters and down pipes shall be earthed. One bare 10mm² copper conductor shall be installed over the full length of the ceiling void, fixed to the top purlin and connected to the main earth conductor and each switchboard. The roof and gutters shall be connected at 15m intervals to this conductor by means of 12mm X 0,8mm copper strapping (not conductors) and galvanised bolts and nuts. Self-tapping screws are not acceptable. Where service connections consist of underground supplies, the above requirements are not applicable.

Sub-distribution boards

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

Sub-circuits

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

Ring Mains

Common earth conductors may be used where various circuits are installed in the same wire way in accordance with SANS 10142. In such instances the sizes of earth conductors shall be equivalent to that of the largest current carrying conductor installed in the wire way, alternatively the size of the conductor shall be as directed by the Engineer. Earth conductors for individual circuits branching from the ring main shall be connected to the common earth conductor with T-ferrules or soldered. The common earth shall not be broken.

Non-metallic Conduit

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

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

Flexible Conduit

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

Connection

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

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

19 MOUNTING AND POSITIONING OF LUMINAIRES

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

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

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

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

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

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

PART 2: INSTALLATION DETAILS

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PART 2: INSTALLATION DETAILS

1 CABLE SLEEVE PIPES

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

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

2 NOTICES

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

3 ELECTRICAL EQUIPMENT

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

4 DRAWINGS

The drawings generally show the scope and extent of the proposed work and shall not be held as showing every minute detail of the work to be executed.

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

5 BALANCING OF LOAD

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

6 SERVICE CONDITIONS

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

7 SWITCHES AND SOCKET OUTLETS

The installation of switches and socket outlets must conform to clause 13 of Part 1 of this specification.

8 LIGHT FITTINGS AND LAMPS

The installation and mounting of luminaires must conform to clause 19 of Part 1 of this specification.

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

The light fittings must be of the type specified on the Engineers drawings.

9 EARTHING AND BONDING

The Contractor will be responsible for all earthing and bonding of the building and installation. The earthing and bonding is to be carried out strictly as described in clause 18 of Part 1 of this specification and to the satisfaction of the Employer/s Electrical Engineer.

10 MAINTENANCE OF ELECTRICAL SUPPLY

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

11 EXTENT OF WORK

The work covered by this contract comprises the complete electrical installation, in working order, as shown on the drawings and as per this specification, including the supply and installation of all fittings and also the installation of such equipment supplied by the Employer.

12 SUPPLY AND CONNECTION

The supply will be at 400/230 Volt 50Hz.

The Contractor must arrange in good time with the local Municipality for the installation of the 2 x 100kVA transformers and low-tension meter point .

The Contractor will be responsible for the supply and installation of the supply cable from the meter box to the main low-tension distribution board (MDB). The size and length of the cable is listed in the Schedule of Cables and measured in the Bills of Quantities.

Standby Plant

The 160kVA standby plant complete with automatic changeover control panel forms part of this specification.

13 CONDUIT AND WIRING

Conduit and conduit accessories shall be black enameled/galvanized screwed conduit or black enameled/galvanized plain end conduit in accordance with SANS 61386.

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

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

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

13.1 Telephone Installation

The Contractor shall allow for the complete installation of all conduits, outlet boxes, the communication service provider Distribution boards, sleeve pipes, etc., required for the telephone system as shown on the drawings.

The sizes of all telephone conduits are indicated on the drawings and must be installed in the floor slab. Galvanized steel draw-wires shall be installed in all conduits.

End boxes must consist of a 50mm x 100 mm x 100mm outlet box fitted with suitable blank cover plates, flush mounted 0,4m above floor level.

The communication service provider Distribution Board must consist of a 150mm x 600mm x 600mm metal box and hinged door with a 20mm thick wooden backboard. The board must be flush mounted, 1,37m above the floor.

13.2 Intercom Installation

The supply and installation of the intercom system is not included in this Contract.

The Contractor shall allow for the complete supply and installation of all conduits and outlet boxes required for the intercom installation as shown on the drawings.

The size of all conduits, boxes and mounting heights of the end boxes are indicated on the drawings. Galvanized steel draw-wires shall be installed in all conduits and the boxes fitted with suitable blank cover plates.

13.3 Power Trunking

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

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

14 POWER POINTS

Allow for the installation of power points and equipment as listed in the schedule, indicated on the drawings and described below:

14.1 WATER HEATERS, ETC.

Water Heaters

The Contractor must electrically connect all water heaters as specified and listed in the Schedule of Power Points.

15 CABLES

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

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

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

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

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

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

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

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

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

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

15.1 LAYING, JOINTING AND MAKING OFF OF ELECTRICAL CABLES

1. The use of the term "Inspector", includes the engineer or inspector of the Department or an empowered person of the concerned supervising consulting engineer's firm.
2. No cable is to be laid before the cable trench is approved and the soil qualification of the excavation is agreed upon by the Contractor and inspector.
3. After the cable has been laid and before the cable trench is back-filled the inspector must ensure that the cable is properly bedded and that there is no undesirable material included in the bedding layer.
4. All cable jointing and the making off of the cables must only be carried out by qualified experienced cable jointers. Helpers of the jointers may not saw, strip, cut, solder, etc. The cable and other work undertaken by them must be carried out under the strict and constant supervision of the jointer.
5. Before the Contractor allows the jointer to commence with the jointing work or making off of the cable (making off is recognized as half a joint) he must take care and ensure:
 - 5.1 That he has adequate and suitable material available to complete the joint properly and efficiently. Special attention must be given to ensure the cable ferrules and cable lugs are of tinned copper and of sufficient size. The length of the jointing lugs must be at least six times the diameter of the conductor,
 - 5.2 That the joint pit is dry and that all loose stones and material are removed,
 - 5.3 That the walls and banks of the joint pit are reasonable firm and free from loose material which can fall into the pit,

- 5.4 That the necessary coffer-dams or retaining walls are made to stop the flow of water into the joint pit,
- 5.5 That the joint pit is provided with suitable groundsheet so that the jointing work is carried out in clean conditions,
- 5.6 That the necessary tents or sails are installed over the joint pit to effectively avert unexpected rainfall and that sufficient light or lighting is provided,
- 5.7 That the necessary means are available to efficiently seal the jointing or cable end when an unexpected storm or cloudburst occurs, regardless of how far the work has progressed,
- 5.8 That the cables and other materials are dry, undamaged and in all respects are suitable for the joint work or making off;
- 5.9 That the heating of cable oil, cable compound, plumbers metal and solder is arranged that they are at the correct temperature when required so that the cable is not unnecessarily exposed to the atmosphere and consequently the ingress of moisture (care must be taken of overheating)

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

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

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

Froth on the surface of the oil is an indication that moisture is present in the impregnated insulation and the amount of the froth gives an indication of the moisture present.
7. If the cable contains moisture or is found to be otherwise unsuitable for jointing or making of the inspector is to be notified immediately and he will issue the necessary instruction to cope with the situation.
8. The joint or making off of paper insulated cables must not be commenced during rainy weather.
9. Once a joint is in progress the jointer must proceed with the joint until it is complete and before he leaves the site.
10. The jointer must ensure that the material and his tools are dry at all times, reasonably clean and absolutely free from soil.
11. Relating to the jointing of the cable the following requirements apply:
 - 11.1 All jointing must be carried out in accordance with recognized and tried techniques and comply strictly with the instructions given by the supplier of the jointing kit.
 - 11.2 The cables must be twisted by hand so that the cores can be joined according to the core numbers. If necessary the cable is to be exposed for a short distance to accomplish this. Under no circumstances may the cores in a joint be crossed so as to enable cores to be joined according to the core numbers. If it is not possible to twist the cables so that the preceding requirements can be met, then cores are to be joined in the normal way without any consideration of the core numbers.
 - 11.3 Normally the cables will have profile conductors. The conductors shall be pinched with gas pliers to form a circular section, bound with binding wire so that they do not spread, and then tinned

before jointing.

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

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

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

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

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

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

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

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

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

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

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

16. DISTRIBUTION BOARDS

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

The Contractor shall supply and install the distribution boards as indicated on the drawings and listed in the distribution Board Schedule. All distribution boards shall comply with the quality specification in Part 3 of this specification, and be approved by the Employer's Electrical Engineer.

18. SCHEDULE OF LIGHT FITTINGS

The light fittings and accessories are to be according to the quality specifications in Part 3 and shall be approved by the Employer.

LED lamp specification requirements. (Additional to the quality specification for DPW luminaires)

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

SANS475	Luminaires for interior lighting, street lighting and floodlighting - Performance requirements
SANS 10114:1	Interior lighting Part1: Artificial lighting of interiors.
SANS 10114:2	Interior lighting Part 2: Emergency lighting
SANS 60598-1	Luminaires Part 1: General requirements and tests.
SANS 60598-2-1	Luminaires Part 2: Particular requirements Section 1: Fixed general purpose luminaires.
SANS 60598-2-2	Luminaires Part 2-2: Particular requirements - Recessed luminaires
SANS 60598-2-3	Luminaires Part 2-3: Particular requirements - Luminaires for road and street lighting
SANS 60598-2-5	Luminaires Part 2-5: Particular requirements - Floodlights
SANS 61347-1	Lamp control gear Part 1: General and safety requirements.
SANS 61347-2-13	Lamp control gear Part 2-13: Particular requirements for dc or ac supplied electronic control gear for LED modules.
SANS62031	LED modules for general lighting - Safety specifications.
SANS 62384	DC or AC supplied electronic control gear for LED modules - Performance requirements
SANS62560	Self-ballasted LED-lamps for general lighting services by voltage > 50 V - Safety specification
SANS62612	Self-ballasted LED lamps for general lighting services with supply voltages > 50 V - Performance requirements
EN 55015	Limits and methods of measurement of radio disturbance of electrical lighting or equipment.
EN 61000-3-2	Electromagnetic compatibility (EMC) Limits for harmonic current emissions
EN 61000-3-3:	Electromagnetic compatibility (EMC) - Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems
EN 61547	Equipment for general lighting purposes: EMC immunity requirements
IEC-EN 62471	Photo biological Safety of Lamps and Lamp Systems for LED's
IES LM-79-08 -	Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
IES LM80:	Approved Method: Measuring lumen maintenance of LED light sources

Any other standards referred to in the above specifications.

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

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

NOISE: Due to the sensitive environment in which the luminaire is used, the noise level emitted from the luminaire shall be kept as low as possible. Drivers/electronic components shall, therefore, comply fully with the requirements of the latest edition of SANS 55015.

The luminaire shall be suitable for operation with Mid Power LED's. **Note that no LED tubes are allowed to be used.**

The luminaire shall be suitable for operation on a 230V +/- 10%, single-phase 50Hz mains supply.

Power factor capacitors shall be supplied to correct the power factor to at least 0,95 or higher.

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

The driver should be 198-277V tolerance.

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

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

LEGEND			
NORMAL	STANDBY	UPS	DESCRIPTION
			10W LED 3500K 60° BEAM ANGLE DOWNLIGHT
			LED 1200x300 3500K 40W, PANEL LIGHTS
			LED 1200x600 3500K 45W, PANEL LIGHTS
			LED 600x600 3500K 40W, PANEL LIGHTS
			EMERGENCY ESCAPE SIGN
			SURFACE MOUNTED WALL LIGHT FITTING. DI-CAST ALUMINIUM BASE WITH OPAL NON DISCOLOURING DIFFUSER 15W LED. BULKHEAD. MOUNTING HIGHT TO BE CONFIRMED ON SITE
			PHOTOCELL FOR DAY LIGHT SWITCHING. MOUNTING HEIGHT TO BE CONFIRMED ON SITE.
			OCCUPANCY SENSOR
			OPEN CANNEL FITTING WITH 2x 1200mm LED TUBES

19. SCHEDULE OF DISTRIBUTION BOARDS

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

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

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

BOARD	TYPE	PANEL	FAULT LEVEL	LOAD A
DB-M	Flush with door	Standby power	10	150
		UPS power	2,5	20
DB-1	Flush with door	Standby power	5	60
		UPS power	2,5	20
DB-2	Flush with door	Standby power	2,5	30
		UPS power	2,5	20
DB-P	Weather-proof	Standby power	2,5	10

20. MAIN ELECTRICAL CONNECTION

The 100kVA main / bulk electrical connection will be planned and coordinated between contractor , Eskom , engineer and Local Authority

PART 3: ELECTRICAL WORK MATERIAL SCHEDULE

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

Item	Material	Make or trade name	Country of origin
1.	Distribution boards		
2.	Circuit breakers 1P, 2P, 3P		
3.	On load isolators without trips		
4.	Contactors 1P, 2P, 3P		
5.	Earth leakage relays 1 & 3 phase		
6.	H.R.C. fuse switches		
7.	Kilowatt hour meter		
8.	Current transformers		
9.	Voltmeter		
10.	Maximum demand ammeter		
11.	Daylight sensitive switch		
12.	Time switch		
13.	Conduit		
14.	Conduit boxes		
15.	Power skirting		
16.	Surface switches		
17.	Watertight switches		
18.	16A flush socket outlets		
19.	16A surface socket outlets		
20.	16A watertight socket outlets		
21.	Fluorescent luminaires		
22.	10W LED Down light		
	1200x300 40W LED Panel		
	1200x600 40W LED Panel		
	600x600 40W LED Panel		
23.	Bulkhead fittings: 15W		
24.	PVCA cable		
25.	Cable trays		

PARTICULARS OF ELECTRICAL CONTRACTOR

NAME OF CONTRACTOR: ELECTRICAL

.....
.....

ADDRESS:

.....
.....

TELEPHONE NO:

.....

EMAIL:

.....

CELL PHONE:

.....

CONTRACTOR REGISTRATION NUMBER:

.....

.....
SIGNATURE OF ELECTRICAL CONTRACTOR

PART 5: DRAWINGS

PROJEK: PROJECT:	GRIEKWASTAD SASSA Offices				
TEKENING NR. DRAWING NO.	TITEL EN TITLE AND DESCRIPTION	BESKRYWING TYPE	GROOTTE SIZE	AANTAL NUMBER	
33150.00-330-01	TEL & DATA LAYOUT	PAPER	A0	1	
33150.00-370-01	POWER POINT LAYOUT	PAPER	A0	1	
33150.00-380-01	LIGHTING LAYOUT	PAPER	A0	1	
33150.00-740-01	HVAC LAYOUT	PAPER	A0	1	
OPMERKINGS REMARKS					

**DRAWINGS - ELECTRICAL AND MECHANICAL
INSTALLATIONS**

- LIST OF SYMBOLS**
- PAN - TELL ROOM CAMERA
 - ELECTRONIC DOOR MANGNET FOR ACCESS CONTROL • POWER SUPPLY
 - KEYPAD CONTROL POINT •
 - ROUND OUTLET PROGRAMMABLE
 - INTERCOM SYSTEM CONNECTED TO ACCESS CONTROL
 - BP11
 - SPEAKER
 - BREFVAGLASS
 - DOOR
 - RELEASE



DATE	31 Mar 2023	SCALE	A3	PROJECT	01
DESCRIPTION	PRELIMINARY INFO ONLY FOR TENDER FOR CONSTRUCTION AS-BUILT				

CITY ENGINEER / CLIENT	REG. NO.	DATE
APPROVED BY COUNCIL / CLIENT		
AMENDMENTS CODE		
A B.C. / BEFORE READER	A BY CLIENT	
B D. / TENDER DRAWING	B BY ARCHITECT	
C E. / AFTER READER	C BY ARCHITECT	
D F. / AS-BUILT	D BY ARCHITECT	

DATE	INITIAL	DESCRIPTION	PERSON DESCRIPTION
31 Mar 2023	AK	AK	AK

COMPLIANCE
 This drawing is the property of the Architect. It is to be used only for the purpose for which it is issued. It is not to be used for any other purpose without the written consent of the Architect. It is not to be used for any other purpose without the written consent of the Architect.

PROVIDOR	OFFICE	EMAIL
Architect	Architect	architect@architect.com
Structural Engineer	Structural Engineer	struct@struct.com
Electrical Engineer	Electrical Engineer	elec@elec.com
Mechanical Engineer	Mechanical Engineer	mech@mech.com
Plumbing Engineer	Plumbing Engineer	plumb@plumb.com
Fire Engineer	Fire Engineer	fire@fire.com
Quantity Surveyor	Quantity Surveyor	qs@qs.com
Cost Consultant	Cost Consultant	cc@cc.com
Contract Administrator	Contract Administrator	ca@ca.com
Project Manager	Project Manager	pm@pm.com
Client Representative	Client Representative	cr@cr.com



CLIENT
 SASSA OFFICES
 GRIEKWASTAD

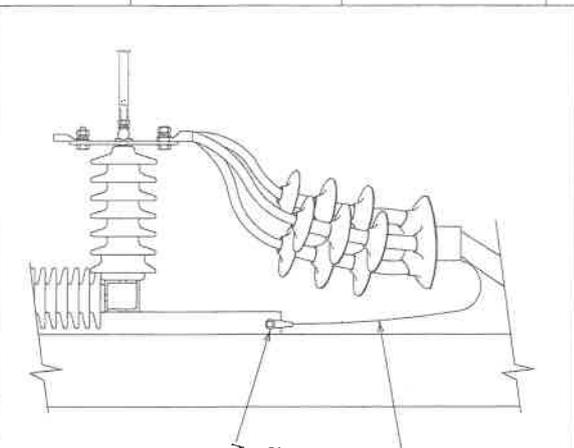
PROJECT
 ACCESS CONTROL

REGISTERED ENGINEER	2024000026	DATE	11 Mar 2023
REGISTERED ARCHITECT	2024000026	DATE	11 Mar 2023
REGISTERED ELECTRICAL ENGINEER	2024000026	DATE	11 Mar 2023
REGISTERED MECHANICAL ENGINEER	2024000026	DATE	11 Mar 2023
REGISTERED PLUMBING ENGINEER	2024000026	DATE	11 Mar 2023
REGISTERED FIRE ENGINEER	2024000026	DATE	11 Mar 2023
REGISTERED QUANTITY SURVEYOR	2024000026	DATE	11 Mar 2023
REGISTERED COST CONSULTANT	2024000026	DATE	11 Mar 2023
REGISTERED CONTRACT ADMINISTRATOR	2024000026	DATE	11 Mar 2023
REGISTERED PROJECT MANAGER	2024000026	DATE	11 Mar 2023



8 7 6 5 4 3 2 1

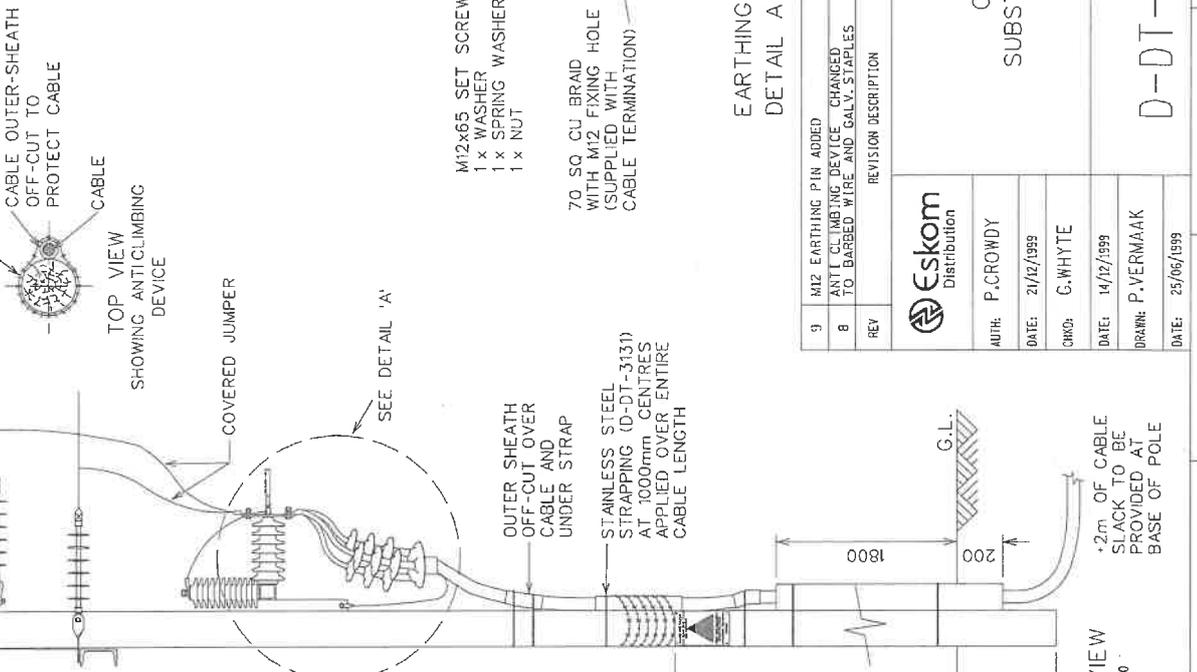
REFERENCE DRAWINGS	
ITEM	DESCRIPTION
1	ANY OVERHEAD LINE CONFIGURATION
EQUIPMENT ATTACHMENTS	
2	CABLE TERMINATION ASSEMBLY (Sheet 1)



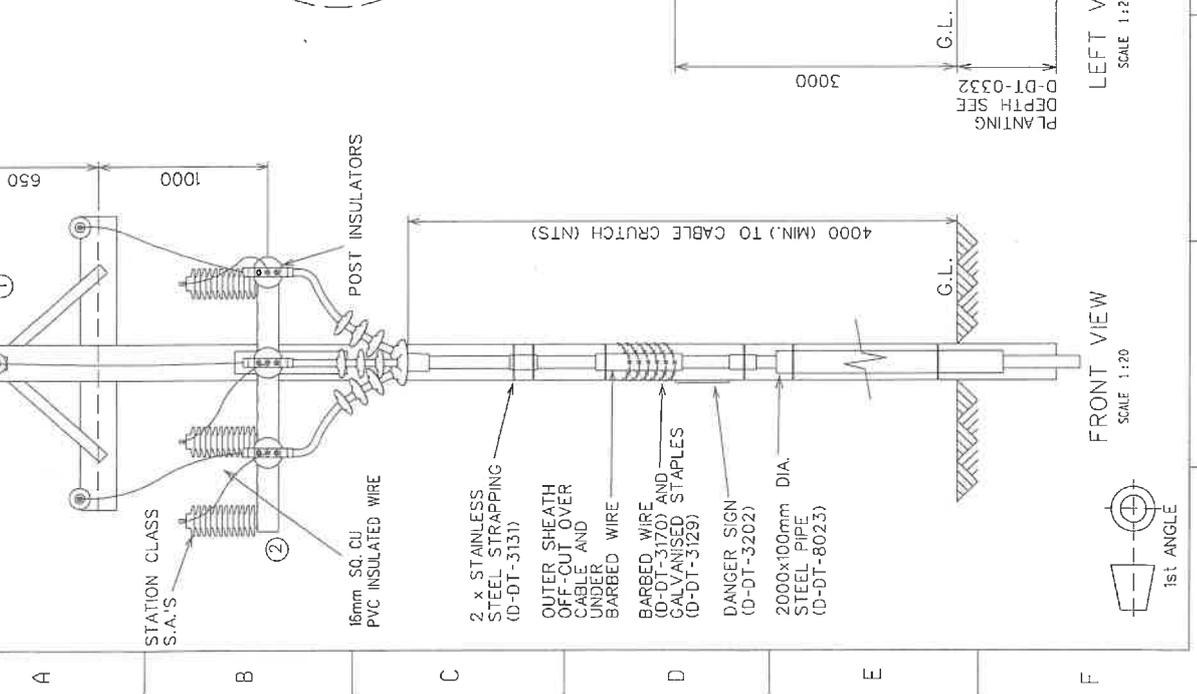
REV	REVISION DESCRIPTION	BY	CHKD	AUTH	DATE	PROJECT NO.
9	M12 EARTHING PIN ADDED	R. KELLY			05.08.08	
8	ANTI CLIMBING DEVICE CHANGED TO BARBED WIRE AND GALV. STAPLES	R. KELLY			06.06.05	

CABLE RETICULATION	
CABLE TERMINATION FROM	
SUBSTATION ONTO OVERHEAD LINE	
GENERAL ARRANGEMENT	
D-DT-0850	3 1 9

6 5 4 3 2 1



6 5 4 3 2 1



Eskom Distribution	
AUTH: P.CROWDY	DATE: 21/12/1999
CHKD: G.WHYTE	DATE: 14/12/1999
DRAWN: P.VERMAAK	DATE: 25/06/1999

8 7 6 5 4 3 2 1

A3L

SUBSTATION EARTH MAT AND EARTH TAILS NOTES ::

1. THE MAIN EARTH GRID SHALL BE CONSTRUCTED FROM A 10mm DIAMETER BLACK ANNEALED COPPER (UNLESS OTHERWISE INDICATED), BURIED AT LEAST 1000mm BELOW FINISHED GROUND LEVEL, WHERE PASSING UNDER DEEPER FOUNDATIONS AND DRAINS, THE EARTH MAT IS TO BE LAID 150mm BELOW CONCRETE.
2. WHERE A CONCRETE BLINDING IS CAST UNDER BUILDING FOUNDATIONS THE EARTH MAT MESHES ARE TO BE INSTALLED ON TOP OF THE BLINDING AND UNDER THE CONCRETE FOOTING OF COLUMNS ETC.
3. WHERE THE EARTH MAT PASSES UNDER DRAINS WITH LESS THAN 1000mm OF COVER, IT IS TO BE BURIED AS DEEPLY AS POSSIBLE.
4. THE MAIN EARTH GRID SHALL BE 1000mm AWAY FROM THE FENCE INSIDE THE SUBSTATIONS AND EXTEND 1000mm AWAY FROM THE FENCE, OUTSIDE THE SUBSTATION.
5. ON FOUNDATION AND EARTHING DRAWINGS, ROD TRANSVERSE CROSSINGS SHALL BE INDICATED BY  AND THESE CROSSINGS SHALL BE JOINED AS PER NOTE 9.
6. EARTH TAILS SHALL BE CONSTRUCTED FROM A 50 x 3mm FLAT BLACK ANNEALED COPPER BOLTED TO HOLDING DOWN BOLTS (UNLESS OTHERWISE INDICATED).
7. WHERE EARTH TAILS CROSS THEY SHALL BE WELDED TOGETHER.
8. WHERE THE EARTH MAT IS NOT DIMENSIONED, IT IS TO BE PLACED AS CLOSE TO THE MAIN FOUNDATIONS AS POSSIBLE.
9. ALL JOINTS SHALL BE EXOTHERMICALLY WELDED OR OXY-ACETYLENE BRAZEN USING A 3mm DIAMETER SILBRALLOY BRAZING RODS OR EQUIVALENT. NO FLUX IS REQUIRED.
10. ALL HOLDING DOWN BOLTS TO BE M24 OR LARGER.
11. THE NUMBER OF SUPPORT STEEL EARTHING CONNECTIONS, FOR THE INDICATED FAULT LEVELS, SHALL BE (UNLESS OTHERWISE INDICATED):

UNDER 25kA	TWO CONNECTIONS PER SUPPORT
25kA AND ABOVE	FOUR CONNECTIONS PER SUPPORT

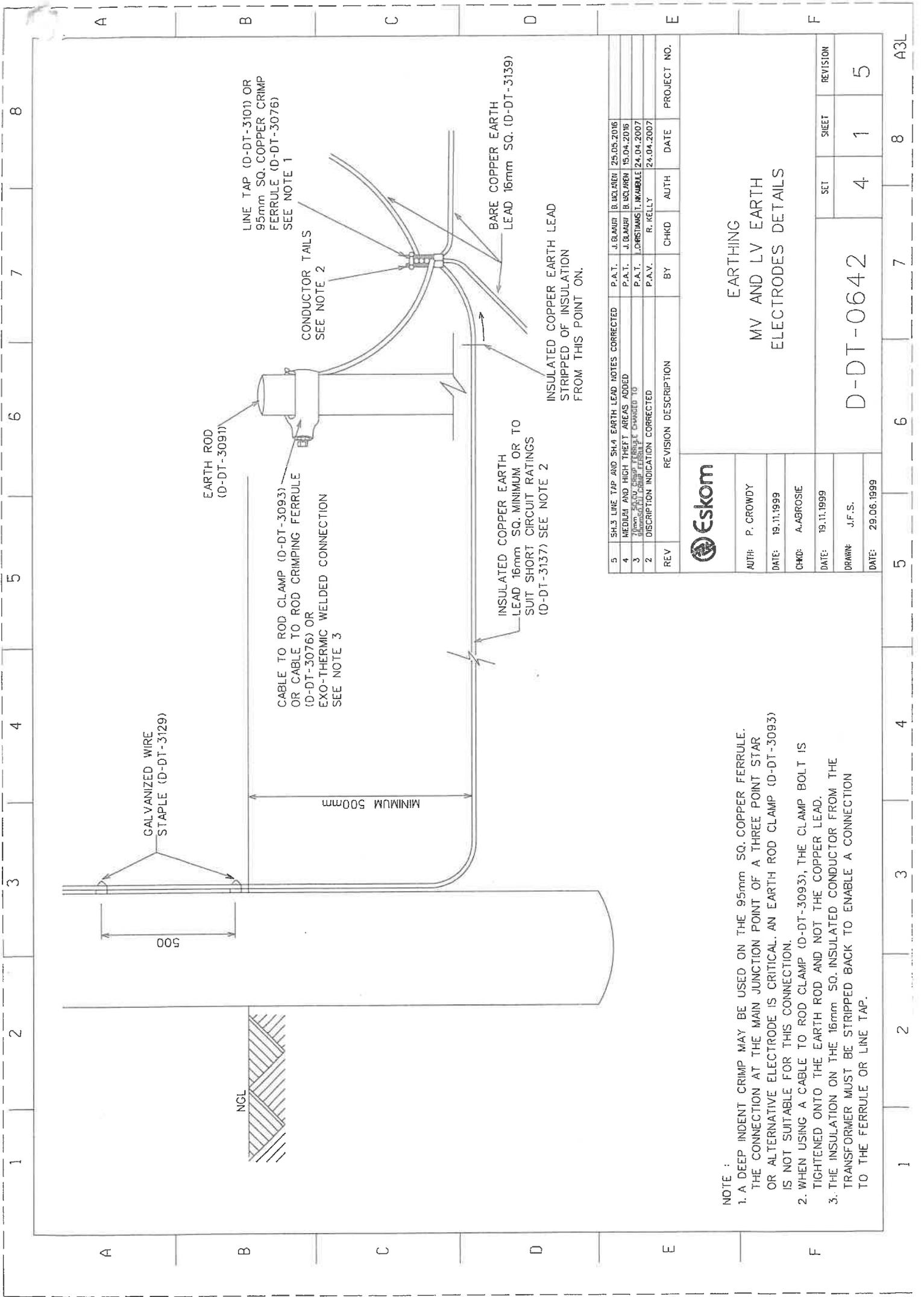
NOTE: ALL SUPPORTS SHALL BE EARTHED AT LEAST TWICE.

12. SACRIFICIAL EARTH MAT ANODES SHALL BE INSTALLED FOR MILD TO SEVERE CORROSIVE SOIL CONDITIONS (< 100 OHM.M). THE APPLICATION OF THESE ANODES WILL BE DETERMINED BY THE RESULTS OF SOIL TESTS CARRIED OUT BY ESKOM OR AN APPOINTED REPRESENTATIVE. WHERE THE REQUIRED SACRIFICIAL ANODES ARE TO BE MANUFACTURED AND CONNECTED TO THE MAIN EARTH MAT, THIS SHALL BE DONE ACCORDING TO SHEET 11.
13. A ROOF EARTHING STRAP OF AT LEAST 50 x 3mm ANNEALED FLAT COPPER IS TO BE RUN ON THE OUTSIDE SURFACE OF THE BRICK BUILDING WALL OF THE ROOF AND JOINED TO METAL ROOF SHEETING WITH AT LEAST MB BOLTS.
14. WHERE A CONNECTION IS MADE TO PAINTED STEELWORK, THE PAINT SHALL BE REMOVED OVER A MINIMAL AREA TO ALLOW FOR A GOOD CONTACT BETWEEN THE SURFACES. SURFACES SHALL BE COATED WITH A NON-OXIDE GREASE BEFORE BOLTING. AFTER BOLTING, ANY SCRAPPED AREA NOT COVERED BY THE COPPER CONNECTION SHALL BE PAINTED USING THE ORIGINAL TYPE AND COLOUR OF PAINT.
15. WHERE A CONNECTION IS TO BE MADE TO GALVANISED STEELWORK, PRIOR TO BOLTING, THE SURFACE SHALL BE COATED WITH A NON-OXIDE GREASE OR AN ALTERNATIVE.
16. WHERE A FLAT COPPER STRAP RUNS ACROSS VERTICAL OR HORIZONTAL FLAT SURFACES OF CONCRETE PLINTH OR BRICK WALL, IT SHALL BE SECURED AS PER DETAIL A IN SHEET 12; AT ALL CORNERS, INTERSECTIONS AND AT NOT MORE THAN 1000mm SPACING.
17. FOR EARTH STRAP ARRANGEMENT IN CABLE TRENCHES SEE DETAIL B IN SHEET 12.
18. FOR PART OF THE EARTH MAT THAT RUNS ALONG CABLE RACKING, SEPARATE INSTRUCTIONS SHALL BE ISSUED.
19. WHERE FLAT COPPER EARTH STRAPS HAVE RUN ON TOP OF FINISHED FLOOR SURFACES, ACROSS WALKWAYS, THE STRAP SHALL BE SCREWED TO THE FLOOR AS PER DETAIL A IN SHEET 12.

ESTKORN IS THE KEY REFERENCE NUMBER AND IT SUPERSEDES ALL SHEET FILED SHEETS	
4	DATE OF ISSUE: 01/03/2013
5	DATE OF REVISION: 01/03/2013
6	DATE OF REVISION: 01/03/2013
7	DATE OF REVISION: 01/03/2013
8	DATE OF REVISION: 01/03/2013
9	DATE OF REVISION: 01/03/2013
10	DATE OF REVISION: 01/03/2013
11	DATE OF REVISION: 01/03/2013
12	DATE OF REVISION: 01/03/2013
13	DATE OF REVISION: 01/03/2013
14	DATE OF REVISION: 01/03/2013
15	DATE OF REVISION: 01/03/2013
16	DATE OF REVISION: 01/03/2013

EARTHING STANDARD
GENERAL NOTES

SCALE: 1:1	PROJECT NO: 0-01-5240	SHEET NO: 22	TOTAL SHEETS: 4
DATE OF ISSUE: 01/03/2013	DATE OF REVISION: 01/03/2013	DATE OF REVISION: 01/03/2013	DATE OF REVISION: 01/03/2013



NOTE :

1. A DEEP INDENT CRIMP MAY BE USED ON THE 95mm SQ. COPPER FERRULE. THE CONNECTION AT THE MAIN JUNCTION POINT OF A THREE POINT STAR OR ALTERNATIVE ELECTRODE IS CRITICAL. AN EARTH ROD CLAMP (D-DT-3093) IS NOT SUITABLE FOR THIS CONNECTION.
2. WHEN USING A CABLE TO ROD CLAMP (D-DT-3093), THE CLAMP BOLT IS TIGHTENED ONTO THE EARTH ROD AND NOT THE COPPER LEAD.
3. THE INSULATION ON THE 16mm SQ. INSULATED CONDUCTOR FROM THE TRANSFORMER MUST BE STRIPPED BACK TO ENABLE A CONNECTION TO THE FERRULE OR LINE TAP.

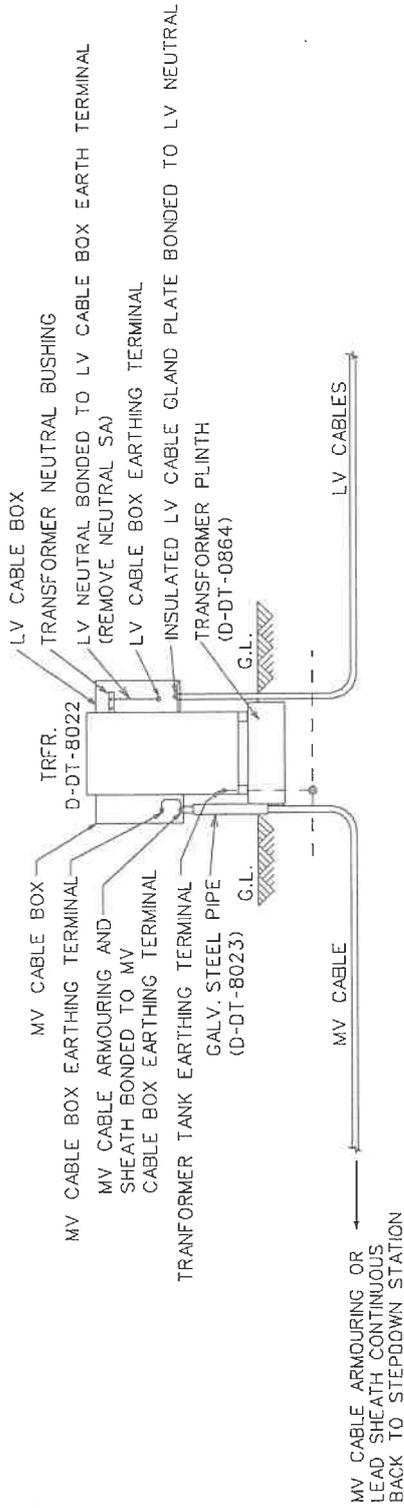
REV	REVISION DESCRIPTION	BY	CHKD	AUTH	DATE	PROJECT NO.
5	SH.3 LINE TAP AND SH.4 EARTH LEAD NOTES CORRECTED	P.A.T.	J. BLAUW	B. MOURIN	25.05.2016	
4	MEDIUM AND HIGH THEFT AREAS ADDED	P.A.T.	J. BLAUW	B. MOURIN	15.04.2016	
3	REVISION TO SH.3 AND SH.4 EARTH LEAD NOTES	P.A.T.	J. BLAUW	B. MOURIN	24.04.2007	
2	DISCUSSION INDICATION CORRECTED	P.A.V.	R. KELLY	R. KELLY	24.04.2007	



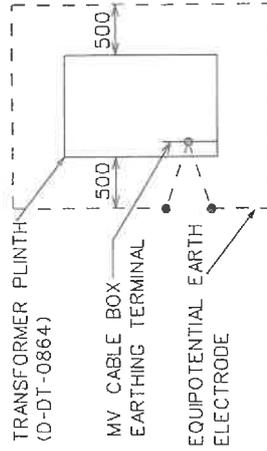
EARTHING
MV AND LV EARTH
ELECTRODES DETAILS

SET	SHEET	REVISION
4	1	5

D-DT-0642



FRONT VIEW



TOP VIEW

LEGEND :
 BARE 16mm SQ. CU (D-DT-3139)
 SHOWN THUS : - - - - -

- NOTE :
- 16mm SQ. COPPER EARTH LEAD BURIED AT 0.5m BELOW NATURAL GROUND LEVEL TO SERVE AS EQUIPOTENTIAL EARTH ELECTRODE
 - EQUIPOTENTIAL EARTH ELECTRODE TO BE INSTALLED 0.5m FROM TRANSFORMER FOUNDATION AND TO ENIRCLE ENTIRE TRANSFORMER
 - EACH END OF THE EQUIPOTENTIAL EARTH ELECTRODE IS TO BE BONDED TO THE TRANSFORMER TANK EARTH TERMINAL.

2	G. WHYTE	MAY/03	EQUIPOTENTIAL EARTH ADDED FOR MV SYSTEMS WITH/ WITHOUT CONTINUOUS EARTHING. ADDED	P.A.V.	T. GILLARD
1	A. BEKKER	15.03.02	FIRST ISSUE / EERSTE UITREIKING	P.A.V.	G. WHYTE
0			REVISION/REVISIES	BY	CHKD
REV	AUTH	DATE	INDEX REF/INDEXVERW	DEUR	INDICES
					D-DT- VERWYSINGSTERMINNE

		TRANSFORMER EARTHING FOR MV SYSTEMS WITH CONTINUOUS EARTHING CONDUCTOR TO SOURCE SUBSTATION	
DRAWN R. ABRAHAMS P.A.V.	APPROVED P. CROWDY 17.11.2000	CADJREF: SERIES 0800 FILE No. 0862	REV D-DT-0862 (Sheet 2 of 3)
SCALE SKAAL	17.11.2000	0862	2

Part C4: Site Information

C4 Site Information

PG-03.2 (EC) SITE INFORMATION – JBCC 2000 PRINCIPAL BUILDING AGREEMENT (edition 4.1 of March 2005)

Project title:	<i>GRIEKWASTAD REHABILITATION OF OLD SAPS CANTEEN INTO OFFICES FOR SASSA</i>		
Tender no:	<i>KIM 08/2024</i>	Reference no:	<i>19/2/4/2/2/2316/23</i>

C4 Site Information

- (a) The location of the site is next to the Post Office in the main road in Griekwastad in the Northern Cape Province.
- (b) There is enough space on site for materials delivery, site office, stores, etc.
- (c) No information regarding the surface conditions, water table, etc. are available. Tenderers must take into consideration that a natural fountain runs through / underneath the site.
- (d) Access to the site is easy using a tar road.