

JOHANNESBURG WATER (SOC) Ltd.

BULK WASTEWATER

PARTICULAR SPECIFICATION

E18 : ELECTRICAL MINIATURE

SUBSTATIONS



Johannesburg Water (SOC) Ltd.
PO Box 61542
Marshalltown
2107

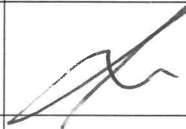
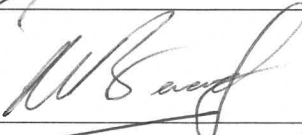

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PARTICULAR SPECIFICATION: VOLUME E18: ELECTRICAL MINIATURE SUBSTATIONS

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E18.1 SCOPE

This section covers the design, manufacture supply and delivery of distribution miniature substations.

E18.2 STATUTORY DOCUMENTS AND STANDARDS

E18.2.1 Standards

The miniature substations offered in terms of this specification shall comply with the requirements as set out in the detailed specification as well as the relevant sections of SANS SANS 1029.

The units offered shall have the SANS mark of approval.

Any deviation from these conditions shall be clearly indicated, and any equipment so offered shall only be used with the express permission, in writing, of the engineer

The equipment offered and work performed, shall comply with the requirements of the governing occupational Health and Safety act, at time of tender.

The miniature substation shall be produced in a factory with SANS ISO9001 rating and the applicable quality assurance standards.

- | | | |
|--------------------|---|--|
| (a) SANS 780 | : | Distribution transformers |
| (b) SANS 1029 | : | Miniature substations for rated a.c. voltages up to and including 24 kV |
| (c) SANS 555 | : | Fluids for electro technical applications |
| (d) SANS 60529 | : | Degrees of Protection Provided by Enclosures (IP Code) |
| (e) SANS 61958 | : | Indicating devices |
| (f) SANS 62271-1 | : | High-voltage switchgear and control gear Part 1: Common specifications for alternating current switchgear and control gear |
| (g) SANS 62271-200 | : | High-voltage switchgear and control gear Part 200: AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV |
| (h) SANS 62271-102 | : | High-voltage switchgear and control gear Part 102: Alternating current disconnectors and earthing switches |
| (i) SANS 62271-103 | : | High-voltage switchgear and control gear Part 103: Switches for rated voltages above 1 kV up to and including 52 kV |
| (j) SANS 62271-102 | : | High-voltage switchgear and control gear Part 100: Alternating-current circuit-breakers |
| (k) SANS 62271-105 | : | High-voltage switchgear and control gear Part 105: Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV |
| (l) SANS 61869-2 | : | Instrument transformers Part 2: Additional requirements for current transformers |
| (m) SANS 61869-3 | : | Instrument transformers Part 3: Additional requirements for |

inductive voltage transformers

- (n) IEC 60255 : Measuring relays and protection equipment
- (o) SANS 1091 : National colour standard

E18.2.2 Particular Specifications to be read in conjunction with this specifications

The following particular specifications shall be read in conjunction with this specification:

- (a) E15 : ELECTRICAL TRANSFORMERS
- (b) E19 : ELECTRICAL 11kV RING MAIN UNIT
- (c) E25 : ELECTRICAL COLOUR CODING OF EQUIPMENT

E18.3 ENVIRONMENTAL CONDITIONS

The miniature substations shall be suitable for use at full continuous rating, in terms of Paragraph 1.3 of the latest issue of SANS 780.

E18.4 CONSTRUCTION REQUIREMENTS

In addition to the requirements of SANS 780, the following shall also be considered:

- (a) The miniature substations are intended for as self-contained distribution centres in wastewater treatment works and are to be mounted on side of road where possible. Therefore the compactness in design and a pleasing appearance is important
- (b) The miniature substation enclosure (roof, walls and doors) shall be manufactured from stainless steel grade (3CR12). Glass reinforced resin or other non-metallic substances is not acceptable.
- (c) The colour of the miniature substation shall be colour no. C12 Avocado Green (6022-G91Y) to SANS 1091.

E18.5 MANUFACTURING AND QUALITY CONTROL

Detailed drawings indicating the dimensions and weight of the miniature substation must be submitted with the tender.

The supplier must provide a specification and quality management procedure to be used during the manufacturing of the miniature substations, complete with a checklist and schedule of inspections to be done by the client and engineer. Manufacturing may not proceed without approval of these documents. A Factory Acceptance Test of the equipment must be witnessed and signed off by the Engineer prior to shipment.

E18.6 MV COMPARTMENT

E18.6.1 Miniature Substation MV Compartment

An approved 11kV Ring Main Unit (RMU) shall be installed in the MV compartment. The RMU shall comprise of a combined fuse-switch feeding the transformer and two cable/ring main network isolators connecting the ring main circuit. Three individual switchgear units, each with a separate vacuum or gas (SF6) tank will be combined into one compact unit. The RMU will have the following characteristics:

- a) The busbars and switching elements of each module shall be in a separate vacuum/gas tank.

Each tank will be equipped with a meter showing vacuum/gas pressure values;

- b) Suitable for indoor use;
- c) It must be possible to operate all the switch mechanisms from the front;
- d) Three manually selected positions (ON-OFF or EARTH) on all modules. The operating handle is to be such that it must be relocated from the ON – OFF position to the EARTH position before the earthing switch can be closed;
- e) Clearly visible ON – OFF and OFF – EARTH indicators shall be provided and provision shall be made for locking the mechanisms by means of selector levers, preventing the insertion of the operating handle in any position;
- f) A mechanical interlock will prevent the opening of the cable termination cubicle if the module is not in the EARTH position;
- g) Transparent inspection windows that display the position of the earthing contacts, allowing; a visually check that the earthing switch is in the closed position;
- h) A voltage presence-indicating device on all modules to check whether a voltage is present across the cables. (IEC 62271-206: Part 206: Voltage presence indicating systems for rated voltages above 1 kV and up to and including 52 kV);
- i) Cable test facility where the cable can be tested without disconnecting the cable from the switchgear bushings or opening the cable termination cubicle;
- j) The switchgear must be designed to withstand the impact of an internal arc caused by a fault current in order to provide the maximum protection to switching operators;
- k) All bushings shall be Type C rated at 630Amp according to BS EN 50181;
- l) A protection relay (self-powered from the CT units) on the circuit breakers connected to the ring circuit with:
 - Overcurrent and earth fault protection
 - Thermal overload protection
 - Current measurement functions
 - No PC or specific tool required for setting or commissioning
- m) No oil-filled circuit breakers are accepted in the miniature substations.

E18.6.2 11kV cable termination

The Contractor must ensure that suitable methods of 11kV cable termination are applied. Indoor terminations with screened separable connectors (SSC's) must be used to terminate 11kV cables on the RMU. This allows for the use of PILC cable for 11kV reticulation. Because of the short clearances in the switchgear cable termination box the flashover risk is minimised by ensuring that the terminations and SSC's are type tested in accordance with IEC 60055-1 and IEC 60502-4.

E18.6.3 Ratings

The continuous current rating of the Ring Main Unit shall not be less than 630A. The continuous current rating of the combined fuse-switch shall not be less than 90A with overload making capacity minimum 32.5kA. The short circuit rating shall be at least 350MVA at 11kV.

E18.6.4 Combined fuse-switch

The combined fuse-switch shall be in accordance with SANS 60282.

The operating mechanism of the combined fuse-switch shall be of the fixed trip type, which ensures the full closure of the switch and full clearance of fault by the fuses before tripping the switch.

- a) The fuse carriage must be so arranged that when the striker pin fuses are fitted, the operation of a fuse in any phase trip all the phases simultaneously. Conversely, if any one fuse is blown,

then it shall not be possible to close the switch.

- b) Manual tripping is to be provided by means of a pushbutton and not by using the operating handle.
- c) Automatic shutters shall be provided, to safeguard against inadvertent contact with “live” parts when the fuse carriage is removed.
- d) The operating mechanism must be interlocked with the fuse carriage cover, to allow access to the fuse carriage only when the operating mechanism is in the OFF position.
- e) The fuses and carriage shall be housed vertically in a separate compartment on the front of the unit. The fuse carriage design is preferred, which would accept both 336mm and 254mm long by 64mm diameter HRC fuses.
- f) One designation blank label shall be provided.
- g) Fuses shall be fitted before delivery.

E18.6.5 Ring Main Network Isolators

- a) The triple pole contacts of the isolators shall be gang-operated by a spring assisted manual mechanism.
- b) Integral cable test terminals shall be provided and shall only be accessible from the front of the unit when the switch is in the EARTH – TEST position. Interlocks shall be provided to ensure that the switch cannot be moved from the EARTH – TEST position when the test terminal cover is open. If alternative ring main units are offered, then one set of test prongs shall be supplied for each unit.
- c) No cable end boxes are required. However, provision shall be made for the clamping of cross-linked polyethylene and PILC type cables by means of a split wooden block.
- d) The size of cables used shall be 70mm², 3 core and 185mm² PILC. The clamps which must accept different sizes of cable shall be mounted approximately 600mm below the terminals.
- e) Each isolator shall be provided with a designation white sandwich board label which shall be left blank.

E18.6.6 Circuit breaker with overcurrent and earth fault relay

- a) It is required that these miniature substations be supplied with at least 630A 11kV circuit breaker ring main units with overcurrent and earth fault protection relay switches or protection relay that has the same tripping curves as normal HRC MV fuses.
- b) Manually operated mechanisms for cable and transformer switches are to be supplied as standard with an option that they can also be fitted with motor operation.
- c) The circuit breaker system of protection shall not require an external power supply.
- d) SF6 or vacuum circuit breakers shall be acceptable for this purpose although a virtually maintenance-free system with a high level of reliability is preferred.

E18.6.7 General

- a) This RMU is required to be supplied with the following standard equipment:
 - i. Earthing switches
 - ii. Operating mechanisms with integral mechanical interlocking
 - iii. Operating handle
 - iv. Facilities for padlocks on all switches functions
 - v. Bushings for cable connection in front with cable covers.
 - vi. Manometer for SF6 pressure/density monitoring (where applicable).
 - vii. Lifting lug for easy handling.

viii. All units are designed for the subsequent fitting of an integral remote control and monitoring unit.

ix. Three-way configuration.

b) All RMU's shall comply with SANS 1874.

c) All RMU operating, cable testing facilities cable terminating and indication devices must be fully accessible only from the front of the MV compartment.

d) The RMU configuration shall be Switch Disconnecter, Circuit Breaker and Switch Disconnecter.

e) The cable boxes shall comply with SANS 876 and shall require type 2 terminating clearances.

E18.6.8

Drawings

One set of drawings shall be supplied detailing:

a) Front, side and a plan elevation, the position of the cable entry in relation to the switchgear and the details for the supporting of the cross-linked polyethylene type or PILC.

b) All schematic drawings.

c) Concrete plinth with minimum required specifications.

E18.6.9

Finish

a) Corrosion protection

The transformer and all cooling radiators will be painted as specified in SANS 12944.

b) Final Coat Colour

The colour of the final paint coat is specified in the detailed specification according to SANS SANS 1091: National colour standard.

c) Damaged Paintwork

E18.6.10

Fuses

The ring main unit shall be supplied with suitably rated HRC striker pin fuses to suit the transformer rating size and voltage with dimensions of 254mm long by 63.5mm diameter. Fuses shall be fitted to the unit and not be supplied loose.

Before changing fuses the unit must be isolated and earthed. The electrical isolation integrity must be checked and proper PPE must be used during the procedure.

E18.6.11

Loose items

All maintenance tools and operating handles shall preferably be housed inside the front MV compartment cover of each ring main unit. An operating and maintenance manual with instructions shall be supplied.

The ring main unit shall be bolted to the steel base to form an integral unit with the miniature substation.

E18.7

LOW VOLTAGE SECTION

The low voltage section shall house the LV circuit breakers or fuses. The LV compartment shall have a separate door with separate locking facilities.

The following are the minimum requirements:

E18.7.1

Low voltage circuit breaker compartment

The LV compartment shall consist of a mounting panel with the following (the panel layout shall be submitted when tendering):

a) Phase busbars (red, yellow and blue) rated to carry the full load of the transformer and will not be rated for currents less than 2000A;

- b) A single Neutral busbar rated to carry the full load of the transformer and will not be rated for currents less than 2000A;
- c) A single Earth busbar rated to carry the full load of the transformer and will not be rated for currents less than 2000A;
- d) All busbars will be standard rectangular aluminium busbars
- e) A suitable unistrut utilising K-clamps to support the cable from each outgoing circuit breaker at the bottom. The unistrut shall be suitable to accept 4 core copper SWA cables from 70sq. mm to 240sq. mm;
- f) The Main circuit breaker feeding the busbars will be an ACB. Moulded case circuit breakers will not be accepted. The rated service breaking capacity (Icu) will be 65kA minimum;
- g) Provision shall be made for feeder circuits with triple pole moulded case circuit breakers or fuses with stub busbar connectors as shown in the schedule below. The space between the unistrut and the bottom terminals of the circuit breakers shall be at least 550mm. A clear space of 70mm shall be allowed above the MCCB's for circuit labels.
- h) Three (3) x instantaneous and maximum demand indicating ammeters for total transformer load with a fifteen minute response time scaled for the CT ratio as shown in the schedule below. A 20% over scale shall be provided. The indicating needles of the ammeter shall have a common pivot. Class 3, 10VA current transformers to measure the transformer load
- i) One 0 to 250V Voltmeter (industrial type) together with a selector switch shall be fitted. The selector switch must switch the voltmeter so that the various phase voltage can be measured.
- j) The low voltage compartment shall contain the following:
 - Two support brackets with a fibre panel attached to it on the one side, including the mounting of the following equipment:
 - A minimum of 4 to 400A three-phase fuse units directly on the support brackets (including the neutral link).
 - Three maximum demand indicating ammeters on the fibre panel with current transformers, busbars and tails from the low tension bushing to the busbars.

Transformer Rating kVA	Number and Size of circuit Breakers	Number of circuit for fuses	CT Ratio
1000kVA	6 x 300A	6	1500/5
800kVA	5 x 300A	6	1200/5
630kVA	4 x 300A	6	1000/5
500kVA	5 x 250A	6	800/5
400kVA	4 x 300A	6	600/5
315kVA	4 x 250A	4	500/5
200kVA	3 x 175A	4	300/5

E18.7.2 Meter Compartment (if required when ordered subject to confirmation by the Engineer)

- a) The meter compartment shall have a separate set of busbars to carry a load of at least 400A. The busbars must be protected by means of a separate three phase air circuit breaker (ACB) within the low voltage compartment with the following kA ratings:

Transformer	Fault Current	Circuit Breaker Size
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Rating kVA		Size
1000kVA	32.5kA	250A
800kVA	26.3kA	250A
630kVA	17.3kA	250A
500kVA	13.9kA	250A
400kVA	12.4kA	200A
315kVA	9.8kA	200A
200kVA	6.3kA	150A

- b) Provision shall be made for mounting 24 single phase kWh meters and 24 miniature (curve 1) circuit breakers. The miniature circuit breakers shall be held in position by clip-trays. Provision shall be made to replace 12 single phase meters with 9 three phase kWh meters.
- c) The kWh meters shall be supplied and installed after the delivery of the miniature substations.
- d) The metal or Masonite mounting plate shall be drilled, tapped, and provided with 20mm long 3mm diameter screws for securing the meters to the mounting plate, or alternatively, screws with nuts in suitable clearance holes could be supplied.
- e) The tenderer is to provide the wiring for the meter compartment. The wiring required shall consist of 24 x 16mm² copper conductors, coloured black, crimped into suitable lugs and bolted to the neutral busbar and 8 red, 8 yellow and 8 blue, 16mm² copper conductors shall be supplied from the 24 miniature circuit breakers to the meter positions.
- f) The neutral wires shall be wired to each meter position. The coloured wires shall be wired to the 24 MCB's. Suitable labels marked 1 to 24 shall be fixed to the MCB and meter positions so that each MCB can indicate which meter is controlled. The ends of all wiring shall be taped up.
- g) No wiring shall be provided from the load side of the ammeters. Wiring from the earth/neutral busbar shall be taken to the neutral terminal of each meter. All meter wiring shall be made with 16mm² PVC insulated copper conductor, bearing the SANS mark.
- h) One combined neutral and earthing bar with mounting holes to accommodate 9 x 16mm² copper conductor and 1 x 35mm² minimum copper conductor each, shall be bolted to the mounting plate.

E18.8 DOORS

All the doors shall be mounted on a suitable number of non-removable or hidden hinges.

All doors shall be fitted with locking mechanisms with provision for pad-locking. A suitable cover shall be fitted over the handles to prevent vandalism. The top of the cover shall be cut open and covered with expanded metal. Provision must be made for a night latch to be installed.

E18.9 COMPOSITION OF ENCLOSURE

The enclosure of the miniature substation shall be fabricated of mild steel and of suitable thickness for an application of this nature. Suitable reinforcing ribs shall be incorporated.

After manufacturing, the steel and welding shall be cleaned and passivated in accordance with the Code of Practice issued by the suppliers of the steel. Full details of proposals shall accompany the tender.

E18.10 DANGER NOTICES

The standard 100 x 150 mm embossed danger (WW7) and MV, LV notice shall be attached to each door. Cast aluminium notices are also acceptable. Painted labels shall not be acceptable.

Notices shall be fixed to the doors by means of brass rivets or other approved means.

E18.11 TESTS

(a) Ring Main Unit

The contractor shall supply copies of all type tests and routine tests performed by the equipment manufacturer with the RMU.

The RMU shall be tested on site after erection and prior to commissioning. The following minimum tests shall be performed:

- i. Pressure tests on the primary circuit in accordance with IEC 62271-1.
- ii. Insulation resistance tests.
- iii. Primary injection tests.
- iv. Earth continuity and earth resistance tests.
- v. Operating tests.
- vi. Any other tests that may be required to ascertain the correct functioning of the equipment.

After putting the panel to service for a minimum 1 week, a thermal image must be scanned and analysed for any hot spots. The image should be presented as part of the Operations and Maintenance manual.

(b) Transformer

Routine tests in accordance with SANS 780 shall be performed. Type tests and special tests to SANS 780 shall be performed on one transformer of the size to be delivered in terms of this contract unless the manufacturer can provide certificates of previous tests done on identical transformers. The Engineer reserves the right to witness such tests.

The results of these tests will be made available to the Engineer for his evaluation prior to acceptance and delivery of the transformers. Two copies of test results will be provided to the Engineer.

Before installing the transformer on site, the following inspections/test should be performed as a minimum:

- i. Check the transformer bushings thoroughly for any signs of cracks / damages;
- ii. Check the oil level in the transformer and check for any signs of oil leakage through bushings, gaskets or welded joints;
- iii. Insulation Resistance test;

The contractor must arrange for site acceptance tests (SAT) on all miniature substation transformers. The SAT must be witnessed by the Engineer and results recorded.

- i. Insulation resistance test;
- ii. Check oil level in conservator tank, colour of silica gel in the breather and oil level at the bottom of the breather;
- iii. Charge the transformer on no load. Wait until noise of the transformer stabilizes then measure the secondary voltages phase to phase and phase to neutral;
- iv. Check the phase rotation on the transformer secondary terminals;
- v. Check the transformer tap settings when loaded (take note that the tap changer settings can only be changed under no-load conditions).

The contractor shall arrange for a thermal imaging of the transformer a minimum of 1 week after commissioning and while the miniature substation is in continuous use. The results of the imaging and SAT are to form part of the deliverable Operations and Maintenance Manuals.

(c) LV Compartment

The following checks should be performed at the premises of the manufacturer:

- i. Check the layout of fitted components
- ii. Check the overall dimension of switchboard, size of busbars, cables and earthing conductors and location of feeder entry point.
- iii. Check and verify the brand, model, and circuit identification of components installed such as circuit breakers, current transformers, fuses, ammeters, voltmeters, power meters and protection relays etc.
- iv. Check overall paintwork, door locking device, door gasket, door hinges and door cut-out holes
- v. Check the busbar and cable tightening, the marking, busbar clearance and base angle bar
- vi. Check the labels, name plate and phase identification

Before energising the miniature substation, the insulation resistance must be tested.

The contractor shall arrange for thermal imaging of the LV Compartment a minimum of 1 week after commissioning and while the miniature substation is in continuous use. The results of the imaging and SAT are to form part of the deliverable Operations and Maintenance Manuals.

E18.12 TECHNICAL DATA AND DRAWINGS

Tenderers shall furnish the following drawings together with their tenders:

- (a) Outline drawings of the miniature substations, with all fittings, showing the most important external dimensions.
- (b) Details of MV and LV bushings

The successful tenderer shall provide three copies of each of the following drawings, to the engineer, before manufacturing may commence:

- (a) GA drawings indicating the headroom necessary to remove the cores *in situ*
- (b) Show the mass of the various components on the GA drawings
- (c) The internal construction of the miniature substation and the arrangement of the windings, giving full particulars of insulation, as well as the bracing of the cores and windings.
- (d) A diagram of the connections showing the exact manner in which the leads are taken from the tank, as well as the number of windings.
- (e) Full technical details of all components.

E18.13 SOUND LEVEL

During design and manufacture of miniature substations, care should be exercised to limit miniature substation noise and vibration to within the parameters as recommended in SANS 780.

E18.14 IDENTIFICATION TAGS

All data on the identification tags shall be in SI units.

E18.15 MEASUREMENT AND PAYMENT

<u>Item</u>	<u>Unit</u>
Supply, delivery and off-loading of miniature substations	No

The tendered rate shall include full compensation for the supply, delivery and off-loading of the miniature substations together with all other materials and ancillary equipment required to effect a complete installation.

<u>Item</u>	<u>Unit</u>
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Installation, testing and commissioning of miniature substations No

The tendered rate shall include full compensation for installing the miniature substations in the designed positions and for the testing and commissioning of the miniature substations.

The rate shall include for the installation of the control cables between the miniature substation and the switchgear and all auxiliaries and the connection thereof.

The rate shall include for the filling of the miniature substation with oil to the specified level, as well as the undertaking of any drying out process which may be required to ensure the miniature substations are ready for operation.

Item

Unit

Type tests and special tests of miniature substations..... Sum

The tendered sum shall include full compensation to undertake special and type tests as required in the detailed specification. Each test shall be separately priced.