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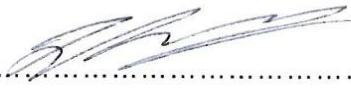
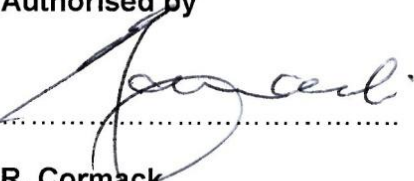
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1. INTRODUCTION

This document consist of Additional Technical Requirements for Minisubstations in Accordance with Eskom Specification DSP 34-1621 technical bulletin

2. SUPPORTING CLAUSES

2.1 SCOPE

None

2.1.1 Purpose

None

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

None

2.2.2 Informative

None

2.3 DEFINITIONS

Definition	Description
	None

2.3.1 Classification

- a. **Controlled Disclosure:** Controlled Disclosure to External Parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
	none

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2.5 ROLES AND RESPONSIBILITIES

None

2.6 PROCESS FOR MONITORING

None

2.7 RELATED/SUPPORTING DOCUMENTS

None

3. REQUIREMENTS

3.1.1 Mini-substation RMU MV transformer protection relay

The following Eskom approved self-powered protection relay shall be provided for all Type B mini-substations for the RMU tee-off supplying the transformer: **WIC1-4** relay.

NOTES

- a. Type B mini-substations are fitted with ring main units (RMU) that have a circuit-breaker tee-off (i.e. 2R-1B RMU) supplying the transformer. The transformer is protected by a relay which trips the RMU MV circuit-breaker tee-off in the event of a fault.
- b. The relay is selected because it is able to offer over-current protection co-ordination with most of the available low voltage circuit breakers which are installed downstream in the low voltage network. Eskom reserves the right to amend this requirement in the event that other relay manufacturers provide a suitable alternative relay which offers the required protection grading and coordination with the downstream LV circuit breakers.

3.1.2 Unscreened separable connectors (USC)

The Eskom accepted unscreened separable connectors in accordance with Eskom technical bulletin 09TB-021 (i.e. the "RICS 3133" series connector manufactured by Raychem/Tyco) shall be used for those mini-substation 11 kV indoor cable terminations employing unscreened separable connectors. The "RICS" unscreened separable connectors supersede the previously accepted "RCAB" boots.

3.1.3 Mini-sub transformer

3.1.4 Transformer top oil temperature measurement Addition to DSP 34-1621 Rev 0 Clauses 4.2.1.2.2 and 4.3.1.4.

The transformer unit shall be fitted with a top oil temperature gauge which indicates the top oil temperature in degrees Celsius. The transformer top-oil thermoelectric protection element switch (contacts for shunt tripping facility) shall be incorporated with the temperature gauge. A dial type analogue gauge is preferred. Digital gauges with backup power supply may be accepted and will be subject to approval by Eskom.

3.1.5 LV earthing connections

DSP 34-1621 clause 4.1.2.3.5 is replaced by the following clauses:

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- a. For mini-substations of rating up to and including 500 kVA, two insulated electrolytic copper conductors of cross-sectional area of at least 70 mm² each shall be fitted to provide an electrical bridge between the cable gland plate support structure and the LV neutral-earth bar.
- b. For mini-substations of rating 1000 kVA, four insulated electrolytic copper conductors of cross-sectional area of at least 70 mm² each shall be fitted to provide an electrical bridge between the cable gland plate support structure and the LV neutral bar. Alternative copper conductors having an equivalent total cross sectional area may be accepted.
- c. For mini-substations of rating 1000 kVA, four insulated electrolytic copper conductors of cross-sectional area of at least 70 mm² each shall be fitted to provide an electrical bridge between the LV neutral bar and LV earth bar. Alternative copper conductors having an equivalent total cross sectional area may be accepted.

3.1.6 LV auxiliary equipment

Smart metering requirements for Type B mini-sub of rating up to and including 500 kVA

3.1.6.1 The LV ASSEMBLY shall be fitted with a smart metering or advanced metering infrastructure (AMI) panel in accordance with the drawing D-DT-1013.

- a. A hinged meter plate shall be provided at the top of the panel (see D-DT-1013 sheet 1). The meter plate shall be fitted with the following:
 1. CT and VT test blocks;
 2. surge arresters;
 3. HRC fuses; and
 4. terminals.

NOTES

1. The main meter and modem will be supplied by Eskom.
2. A data concentrator will be supplied by Eskom and be fitted in the place of the backup meter.
- b. All wiring indicated on D-DT-1013 sheet 3 shall be provided and shall have sufficient slack to allow the meter plate to be hinged outward to at least 90° relative to the mini-sub LV compartment. The wiring that is to be terminated onto the meters shall be taken through the 32 mm diameter holes in the meter plate and shall have at least 300 mm of excess wire when measured from the 32 mm hole to the wire end with the meter plate hinged outward.
- c. Class 0,5 current transformers (CTs) shall be fitted to the phase busbars and shall only be accessible once the meter plate has been hinged outward. Details of the CTs are stated in table 1 below.

Table 1: Smart metering CTs specification

1	2	3
Mini-Sub rating	CT Ratio	VA rating
315 kVA	500/5	5 VA (minimum)
500 kVA	800/5	5 VA (minimum)

- d. Adequate space shall be provided for the metering technicians to insert a primary current test probe over the LV busbars in order to confirm the CT ratios on site.

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- e. All the current instrument transformers shall be tested for accuracy according to SANS 60044-1 by a SANAS approved laboratory before installation in the kiosk. The test results shall be shipped with the mini-sub in a suitable cover for protection against damage. A test label (sticker) shall be on each instrument transformer, certifying that the instrument transformer has been tested.

3.1.6.2 Metering voltage secondary circuit

- a. The voltage circuit shall take its supply from the busbars.
- b. The VT wires shall be connected onto fuse-holders situated on DIN-rail A at the back of the panel.
- c. From the fuse-holders the wiring shall go to the bottom connections of a PK2 4-way test block. The removal of the male adapter of the test block shall ensure the open-circuiting of the voltage circuit. The terminals that protrude into the panel shall be suitably insulated from the steel edges.
- d. Single-pole surge arresters shall be installed between the PK2 4-way test block and the terminals on the voltage circuit from all three phases – to ground and from neutral – to ground, to protect the meter from lightning.
- e. From the PK2 4-way test block the wiring shall go to the terminals and from there to the meter.

3.1.6.3 Metering current secondary circuit

- a. The current supply wiring shall come from the CTs onto the bottom terminals of the PK2 4-way test block and then to the meter.
- b. On removal of the male adapter, short-circuit parts shall ensure the short-circuiting of the current transformer terminals and earth. The terminals that protrude into the panel shall be suitably insulated from the steel edges.

3.1.6.4 Metering circuit surge arrester specification

- a. The surge arrester shall be the metal oxide, DIN rail mount type with LED indication suitable for Zone 1 protection. The arrester shall comply with SANS 61643-1 and bear the SABS mark.
- b. The technical specification for the surge arresters shall be:

I _{max} (8/20 □s)	40 kA or 65 kA (4/20 □s)
Response time	< 25□s
Max. operating voltage	275 V a.c. (phase-to-neutral) 360 V d.c.
Frequency	50 Hz
Internal fuse	Yes
Open-circuit Indication	Open-circuit on expiry of the device Clear change-of-state (functional or non-functional) indication

3.1.6.5 Metering circuit HRC fuse specification

The LV HRC fuses shall comply with the requirements of SANS 60269-2 and the fuse holders shall be suitable for DIN rail mounting.

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3.1.6.6 Meter, modem and data concentrator

The meter, modem and data concentrator shall be supplied by Eskom.

3.1.6.7 Metering circuit wiring

- a. The mini-sub metering circuit shall be wired in accordance with the drawing D-DT-1013.
- b. No individual wire numbering is required.
- c. Not more than two conductors shall be connected to a terminal.
- d. No bare wiring or bare part of lugs shall be exposed at termination points on the meter, the circuit-breakers, the relay base, fuse holders and the terminals.
- e. Only JST type YNT or Cembre type HP4 crimping tools shall be used for the crimping of lugs.

3.1.6.8 External antenna provision

- a. A 22 mm diameter hole shall be made on the LV compartment for pulling through an external antenna cable and the hole shall be fitted with a plastic grommet.
- b. The hole shall be positioned on the rear side of the mini-sub (LV compartment side) and as near as possible to the mini-sub roof.
- c. A provision to prevent easy sticking of a wire through the hole shall be made by means of an appropriate blocking plate installed inside the LV compartment.

3.1.6.9 Street lighting PECU mounting plate

DSP 34-1621 clause 4.1.2.7.4 is replaced by the following clause:

A removable 3CR12/stainless steel blank mounting plate shall be provided in the LV compartment for the installation of street lighting Photo Electric Control Unit (PECU) as and when required. The minimum plate dimensions shall be approximately 300 mm x 300 mm and it shall be located as near as possible to or adjacent to the photocell compartment.

3.1.7 Protection settings for the Type A mini-Sub LV mains MCCB

The MCCBs protection settings shall be configured in accordance with the guidelines stated in table 2 below.

Table 2: protection settings for the LV mains MCCB

Protection Function	200 kVA setting	315 kVA setting	500 kVA setting
Overload current setting	300 A	450 A	800 A
Overload time delay setting or curve	Maximum or slowest curve settable on MCCB	Maximum or slowest curve settable on MCCB	Maximum or slowest curve settable on MCCB
Short circuit current setting (minimum)	3000 A	4500 A	8000 A
Short circuit time delay setting (maximum)	0,5 s	0,5 s	0,5 s

NOTES

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- a. The transformer unit is fitted with a top-oil thermoelectric temperature-sensing element which trips the LV circuit breaker through a shunt-trip facility when the transformer top-oil temperature exceeds 105 °C. This provides the main transformer overload protection facility. The long-time delay has been selected to maximum because it only acts as a backup to the main transformer overload protection. The settings also reduce spurious tripping due to acceptable overloading periods as the transformer is allowed to operate at 1.5 times its rated current for a limited period during cyclic loading in accordance with SANS 60076-5.
- b. The instantaneous time delay current and time are selected so as to allow protection grading with the downstream MCCBs especially for LPU applications where an equivalent sized MCCB may be installed downstream.

3.1.8 MCCB mounting plate details

For mini-substations designed for the fitting of LV MCCBs, the LV feeder MCCB mounting plate and barricade plates shall be designed in accordance with the requirements given in figure 1.

The corrosion requirements for the MCCB mounting plate shall be manufactured in accordance with clauses 4.1.2.3.9 and 4.1.2.3.10 for inland and coastal respectively.

The MCCB mounting plate shall be made of perforated plate "Round 60 degrees staggered" with the following minimum specifications:

- a. Aperture = 7 mm
- b. Pitch of Aperture = 17 mm
- c. Thickness of material = 3 mm
- d. Minimum perforated area for Type B, L X W = 940 mm X 295 mm
- e. Minimum perforated area for Type A, L X W = 510 mm X 295 mm

NOTE Eskom no longer accepts MCCB mounting rails for the LV MCCB mounting equipment which can only accommodate MCCBs having the same frame size.

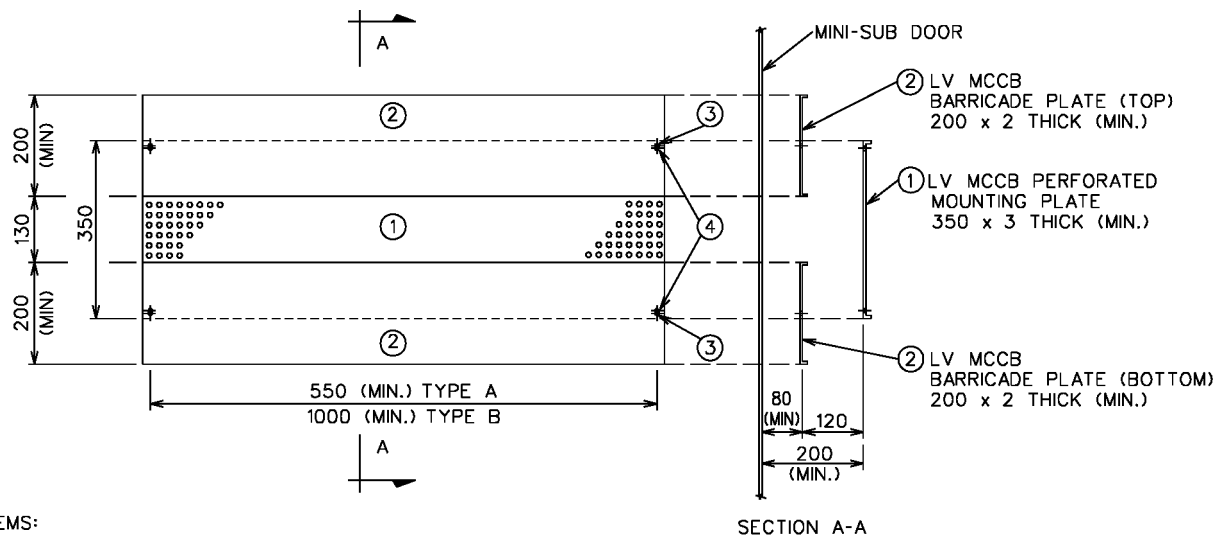


Figure 1: LV MCCB mounting details

3.1.9 Transformer protection RMU relay settings

The appendix A shall be replaced by the following appendix:

4. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
	Document Approved by TDAC ROD 13 March 2013

5. REVISIONS

Date	Rev.	Compiler	Remarks
November 2012	0	B Mwarehwa	Draft Document for review created from 12TB-03 and P 34-1621
May 2013	1	B Mwarehwa	Final document

6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- None

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7. ACKNOWLEDGEMENTS

None

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APPENDIX A

A.1 WIC1-4 relay

A1.1 The settings for the WIC1-4 relay shall be configured in accordance with the following tables

Table 3: Rated primary current of transformer (I_s)

	11 kV			22 kV		
Transformer size [kVA]	315 kVA	500 kVA	1000 kVA	315 kVA	500 kVA	1000 kVA
Rated Primary Current [A]	16.5 A	26.2 A	52.5 A	8.3 A	13.1 A	26.2 A
Primary Current Setting (I_s) [A]	24.6	39.2	56	16	19.6	39.2

A1.2 The WIC1-W2 CTs shall fitted for the WIC1-4 relay

Table 4: Protection characteristic curve

IMT Characteristic Curve	Fuse characteristic of a HV fuse
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Table 5: Phase overcurrent protection parameters

Phase current threshold (' $I>$ ')	1
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Table 6: Phase overcurrent protection parameters

	11 kV			22 kV		
Transformer size [kVA]	315 kVA	500 kVA	1000 kVA	315 kVA	500 kVA	1000 kVA
Time factor 'a' (' $t_1>$ ')	Factor 'a' = 5	Factor 'a' = 6	Factor 'a' = 8	Factor 'a' = 0.8	Factor 'a' = 5	Factor 'a' = 5

Table 7: Phase short-circuit protection parameters

Phase current threshold (' $I>>$ ')	6
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Table 8: Phase short-circuit protection parameters

Tripping time for DMT (' $t_1>>$ ')	' $t_1>>$ '=0.25
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Table 9: Earth fault protection parameters

Earth fault current (' I_E ')	0.4 (x I_s)
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Table 10: Earth fault protection parameters

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Tripping time for EF (t_{IE}')	$t_{IE}'=0.6$
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NOTES

- The WIC1-W2 CTs are to be fitted for the WIC1-4 relay.
- The primary current rating I_s has been selected to allow for cyclic loading of the transformer in accordance with the SANS 60076-7 loading guideline applicable to SANS 780 transformers (i.e. allowing $1.5 \times I$ rated for cyclic loading).
- The main overload protection of the transformer will be provided by the top-oil temperature protection set in accordance with SANS 60076-7 loading guideline applicable to SANS 780 (i.e. allowing up to 105 °C top-oil temperature).
- The earth fault current protection parameters have been selected to prevent spurious earth fault tripping due to a false earth fault detection resulting from the DC component of transformer inrush currents while energizing the transformer.

A1.3 The relay shall be tested in accordance with the following minimum requirements and a routine test certificate for the relay shall be produced and included with each mini-sub and stored in the documentation holder provided:

- A primary current injection test shall be carried out to confirm the correct operation of the relay (i.e. the CTs, the wiring and the relay settings). Primary current injection shall be carried out at $4 \times I_s$ and the tripping time shall be recorded. According to the HV-fuse characteristic this should result in a protection operating time in accordance with the table provided below. A tolerance of $\pm 10\%$ is considered to be acceptable.

Table 11: Tripping times for the current injection test at $4 \times I_s$

	11 kV			22 kV		
Transformer size [kVA]	315 kVA	500 kVA	1000 kVA	315 kVA	500 kVA	1000 kVA
Primary Current Setting (I_s) [A]	24.6	39.2	56	16	19.6	39.2
Injected primary current	98.4	156.8	224	49.6	78.4	156.8
Relay tripping time (s)	79 s	95 s	127 s	13 s	79 s	79 s

- A routine check shall be included on the test certificate that confirms that the configuration settings have been made in accordance with this technical bulletin.

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