Policy

POLICY FOR NEUTRAL EARTHING OF ELECTRICAL NETWORKS

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Foreword

This document provides a policy with regard to the neutral earthing of high-, medium- and low voltage electrical networks operated by Eskom Distribution. Customer networks which are galvanically connected to Eskom’s HV and MV networks shall adhere to this policy as a condition of their connection.

Revision history

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Authorisation

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This document shall apply throughout the Distribution Division of Eskom Holdings Limited.

Development team

The document was compiled through the efforts and contributions of the following individuals:

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The authors gratefully acknowledge valuable comments received on a draft version of this manuscript from Dr Hendri Geldenhuys and Dr Clinton Carter-Brown.

The section on neutral earthing of HV networks draws heavily from the work of Alan Ware (as published in SCSAGAAK6).
Introduction

This policy was compiled as a result of two main needs:

a) In partial fulfilment of the Eskom Distribution’s obligation towards the South African Distribution Code requirements:
   - Network Code Clause 6.4(1): “The Distributor shall advise Customers about the neutral earthing methods used in the Distribution System”; and
   - Network Code Clause 6.4(2): “The method of neutral earthing used on those portions of Customer’s installations that are physically connected to the Distribution System shall comply with the Distributor’s applicable earthing standards for loads and for embedded generators.”

b) Following a number of safety incidents on Eskom’s MV networks as a result of incompatible neutral earthing practices.

This document serves to specify Eskom’s policy regarding neutral earthing practices in HV, MV and LV networks. The document serves to formalise practices that have been followed, at least informally, since the 1970’s. In some cases (e.g. the neutral earthing policy on 132kV networks, and for MV networks), the policy addresses gaps identified in the previously-documented practices.

Keywords

earthing, neutral

Bibliography

BS 171: 1979, Specification for power transformers

* DISSCAAD3, Specification for large power transformers up to 132 kV, in the rating range of 1,25 MVA to 160 MVA


SANS 60076-3, Power transformers Part 3: Insulation levels, dielectric tests and external clearances in air

* SCSAGAAK6, System neutral earthing on 44 kV to 88 kV networks

* SCSASABA5, Protection Philosophy: Shunt Capacitor banks


*Available from Hyperwave: [http://eskom.hyperwave.co.za](http://eskom.hyperwave.co.za).
1  Scope

This document provides a policy for the neutral earthing of systems to be employed in Eskom Distribution’s HV, MV and LV networks. It further describes the policy with regard to the earthing of the neutral points of specific equipment: power transformers and capacitor banks.

The earthing of Single Wire Earth Return (SWER) networks is not addressed in this document. This information is included in DSP 34-453.

This document does not address the related topic of protective earthing (i.e. the bonding of metallic equipment, not intended to be energised, to the body of the earth so as to avoid the risk of electrical shock if a person touches a device in which an insulation fault has occurred) except in cases where the topics of neutral earthing and protective earthing overlap. As such, a neutral earth is generally classified as a functional earth: serving a purpose other than for the prevention of electric shock. The earthing of surge arresters is another example of functional earthing, but this is not covered in the present document.

2  Normative references

Parties using this policy shall apply the most recent edition of the documents listed below:

National standards

NRS000, Rationalized user definitions for use in the electricity supply industry

SANS 10142-1, The wiring of premises Part 1: Low-voltage installations

SANS 10200, Neutral earthing in medium voltage industrial power systems

SANS 10292, Earthing of low-voltage (LV) distribution systems

South African Distribution Code (All parts)

Eskom Standards

DSP 34-453, Particular requirements for 19kV Single Wire Earth Return (SWER) overhead reticulation

DSP 34-1690, Specification for combined three-phase Neutral Electromagnetic Couplers (NEC's) with Neutral Earthing Resisters (NER's) and auxiliary power transformers.

DST 34-1985, MV and LV distribution system earthing

SCSASAAK7 (obsolete), Singlepoint underground supply

SCSASAAK8 (obsolete), Intermediate Voltage Reticulation

SCSPVADJ2 (future DPC 34-1032), Procedure for the testing of power transformers

TGL 41-379, Shunt Capacitor Neutral Earthing

Buyer’s Guide Drawing D-DT-6212 (HV neutral terminal surge arresters)
3 Definitions and abbreviations

3.1 Definitions

Earthed neutral system or Neutral earthing system: [from NRS 000] A system in which the neutral is connected to earth, either solidly, or through a resistance or reactance of low enough value to reduce materially transient oscillations and to give a current sufficient for selective earth fault protection. Two types of neutral earthing systems are relevant to this policy:

- **Effectively earthed system**: An earthed system in which the phase-to-earth voltages on the unfaulted phases under earth fault conditions are limited to 80% of the normal phase-to-phase voltage. A point on the network is defined as being effectively earthed if the ratios of the Thévenin sequence impedances comply with the following relations under all operating conditions:

  \[
  \frac{X_0}{X_1} \leq 3 \quad \text{and} \quad \frac{R_0}{X_1} \leq 1
  \]

  where:  
  - \( R_0 \) = the Thévenin zero sequence resistance  
  - \( X_0 \) = the Thévenin zero sequence reactance  
  - \( X_1 \) = the Thévenin positive sequence reactance

- **Resistively earthed system**: A system in which the neutral is connected to earth through a resistance. A point on the network is defined as being resistively earthed if the ratios of the Thévenin sequence impedances comply with the following relations under all operating conditions:

  \[
  \frac{R_0}{X_0} \geq 2 \quad \text{and} \quad \frac{R_0}{X_1} > 1
  \]

  where \( R_0, X_0 \) and \( X_1 \) are defined as above.

**Extremely High Voltage**: Nominal voltage levels greater than 132kV.

**High Voltage**: Nominal voltage levels equal to or greater than 44kV up to and including 132kV [Distribution Code].

**Intermediate Voltage (IV)**: When applied in the context of low cost rural distribution and electrification schemes, is a sub set of the MV range where relatively low cost technologies allow for cost effective distribution of relatively light loads over relatively long distances. The loads and distances exceed typical LV system capabilities, however, are generally too small for conventional MV distribution. The voltage range of IV is typically between 1kV and 3.3kV (See SCSASAAK7 and SCSASAAK8 for full details).

**Low Voltage**: Nominal voltage levels up to and including 1kV [Distribution Code].

**Medium Voltage**: Nominal voltage levels greater than 1kV and less than 44kV [Distribution Code].

**Neutral Electromagnetic Coupler (NEC)**: A zig-zag neutral (ZN) connected winding used to provide an artificial neutral point in a delta-connected system, capable of passing a specified earth-fault current for a specified time. Also known as a Neutral Earthing Compensator.
Non-uniform insulation of a transformer winding: [from SANS 60076-3] The insulation of a transformer winding when it has a neutral terminal end for direct or indirect connection to earth, and is designed with a lower insulation level than assigned for the line terminal. Also known as “graded insulation” [BS 171]. Two levels of non-uniform/graded insulation are applied in South Africa:

- **Fully graded insulation**: transformers whose neutral terminals are insulated to such low levels as to require these to be solidly earthed whilst in service; and

- **Partially graded insulation**: transformers whose neutral terminals may be solidly earthed or left unearthed in service, but which require the protection of a suitably-rated surge arrester in the event of being operated unearthed.

Note: Refer to DISSCAAD3 for details on the minimum neutral terminal insulation levels for fully graded and partially graded insulation.

Uniform insulation of a transformer winding: [from SANS 60076-3] The insulation of a transformer winding when all its ends connected to terminals have the same rated insulation level. Also known as a “fully insulated” winding [BS 171].

Solidly earthed: A terminal connected to the body of the earth via a connection with no intentional impedance. Due to practical considerations (e.g. soil resistivity), solidly earthed equipment may have an impedance to the body of the earth of several ohms or tens of ohms.

TN-C-S system: [from SANS 10292] A system of LV earthing where the neutral and protective functions are combined in a single conductor between the source and the point of supply and separated in the consumer’s electrical installation.

### 3.2 Abbreviations

- **BIL**: Basic Insulation Level
- **ECC**: Earth Continuity Conductor
- **EHV**: Extremely High Voltage
- **HV**: High Voltage
- **IV**: Intermediate Voltage
- **LV**: Low Voltage
- **MCOV**: Maximum Continuous Over Voltage
- **MV**: Medium Voltage
- **NEC**: Neutral Electromagnetic Coupler
- **NECR**: Neutral Electromagnetic Coupler with a Neutral Earthing resistor or intentional resistance per phase
- **NER**: Neutral Earthing Resistor
- **NECRT**: NECR with an auxiliary power transformer
- **PEN**: Protective Earth and Neutral (conductor)
- **SWER**: Single Wire Earth Return
4 Policy

Eskom Distribution’s neutral earthing policy is described per voltage level category: HV, MV, IV and LV.

4.1 High Voltage networks

4.1.1 Earthing of transformer HV neutrals

High voltage networks shall be effectively earthed at the source substation. That is, the HV neutral of the EHV/HV transformers or the secondary (load-side) neutral of HV/HV source transformers shall be solidly earthed.

Note: In many cases, source substation transformers are autotransformers. The neutral is then common to both the primary and secondary windings, and shall be solidly earthed.

The Thévenin sequence impedances at the source substation busbars shall comply with the criteria for effective earthing as per Section 3.1.

The HV neutrals of load transformers (e.g. HV/MV transformers, or the primary-side winding of HV/HV transformers) shall be operated unearthed, except where:

a) The transformer winding has fully graded insulation. The affected transformer’s HV neutral shall be solidly earthed.

Note: Historically, 132kV transformer windings have been specified with fully graded insulation (i.e. the BIL of the neutral terminal was 110kV). This was amended to partially graded in Revision 8 of DISSCAAD3 (2007) (i.e. the BIL of the neutral terminal was increased to 250kV). All other transformer HV windings have historically been specified with partially graded insulation.

b) The transformer is an autotransformer. The transformer neutral shall be solidly earthed.

c) Single pole tripping is applied on the network. All transformer HV neutrals on the affected network shall be solidly earthed.

d) Network studies determine that by not earthing some or all load transformer HV neutrals that the healthy phase voltages exceed 80% of the nominal phase-to-phase voltage under the condition of a bolted single phase-to-earth or phase-to-phase-to-earth fault on the network. The results of the studies shall be used to determine which transformer’s HV neutrals shall be earthed to avoid the over voltage conditions.

e) Network studies determine that certain load transformer HV neutrals must be earthed in order for the network earth fault protection to function adequately (i.e. with adequate sensitivity and selectivity). The results of the studies shall be used to determine which transformer’s HV neutrals shall be earthed in this case.

f) The transformer is supplied via a radial feed and there is a high risk of single phasing of the HV line (e.g. in an area prone to conductor theft). The affected transformer’s HV neutral shall be solidly earthed.

Note: Earthing of the transformer HV neutral in this case serves to avoid the risk of high transient over voltages caused by ferro-resonance under the condition of one or two broken conductors on the supply feeder.

Where transformer HV neutrals are left unearthed, the neutral terminal shall be protected by a suitable surge arrester:
a) For a 66 kV, 88 kV or 132 kV partially graded winding, the neutral surge arrester Maximum Continuous Over Voltage (MCOV) shall be 48kV, with a protective level/maximum residual voltage of 165kV (see Buyer’s guide drawing D-DT-6212).

b) For a 44 kV partially graded winding, the neutral surge arrester MCOV shall be 36kV, with a protective level/maximum residual voltage of 125kV.

Note: The neutral surge arrester is provided so as to protect the neutral terminal (which has a lower BIL than the line terminals) from damage in the case of simultaneous voltage surges entering the star windings from two or more HV line terminals.

4.1.2 Earthing of HV shunt capacitor bank neutrals

The earthing methodology for a shunt capacitor bank depends on the three main aspects:

a) The avoidance of resonant conditions;

b) the fusing technology of the capacitor cans, which may be fuseless, or internally- or externally-fused; and

c) the capacitor bank configuration, which is determined mainly by the size of the bank and may be single- or double-star or an H-type configuration (amongst others).

The specific neutral earthing arrangement for HV shunt capacitor banks shall be determined on a case by case basis. TGL 41-379, Shunt Capacitor Neutral Earthing, may be used as a guide in this regard.

4.2 Medium Voltage networks

4.2.1 Earthing of transformer MV neutrals

Except as allowed in Section 4.2.2, the neutral point of a MV network shall be resistively earthed under all operating conditions. This requires that the neutral point be earthed via a suitable Neutral Earthing Resistor (NER). In the case of a HV/MV power transformer featuring a delta-connected MV winding, the neutral point of the MV network shall be provided and earthed by means of Neutral Electromagnetic Coupler (NEC) with internal NER, known as a Neutral Electromagnetic Coupler with Resistor (NECR), in accordance with DSP 34-1690. Historical designs whereby the NEC and NER were provided as separate items of plant are also permitted.

Note: It is common practice to include an auxiliary MV/LV transformer in the same tank as the NECR giving rise to the designation NECRT. The presence or absence of an auxiliary transformer in the NECR is not relevant to this document, and all references to NECRs should be taken to include NECRTs.

Specific requirements for the earthing of star-star transformers without delta secondaries are provided in Section 4.2.2.

4.2.1.1 Fault current contribution per neutral earthing point

In new installations, the NER or NECR for each point of MV neutral earthing shall be specified such as to limit the earth fault current contribution per neutral earthing point as follows:

a) In overhead (typically rural) distribution networks: 360A; and

b) In underground (typically urban) distribution networks: 960A.
4.2.1.2 Maximum number of neutral earthing points provided from a common earth mat

In an effort to limit the total earth fault current and the associated touch potentials imposed at the structures of faulted equipment, a maximum of three NEC/NECRs as per Section 4.2.1.1 shall be applied per overhead or underground distribution network. Networks including sections of both overhead and underground feeders shall be treated as overhead networks for this purpose. In cases where each HV/MV or MV/MV power transformer provides its own point of MV neutral earthing, this requirement effectively limits the maximum number of paralleled supply transformers to three.

Note: This requirement is derived from the calculated touch potentials appearing on the MV earth electrode at MV/LV distribution transformers in the event of a phase-to-tank fault. See DST 34-1985 Annex C.

Medium Voltage Industrial supply networks may be provided with more than three points of MV neutral earthing, subject to agreement between Eskom and the affected Customer(s). Except where agreed otherwise by Eskom and the Customer, the standard shall be to use 360A NER/NECRs in these applications. Neutral earthing of MV Industrial supplies shall be in accordance with SANS 10200.

Except in the cases outlined in Section 4.2.1.3 below, the neutral of each MV network shall be earthed from a common earth mat, usually from the source substation. This requires that the MV neutrals of load transformers (e.g. MV/LV transformers, or the primary-side winding of MV/MV transformers) shall be operated unearthed.

4.2.1.3 Neutral earthing points provided from separate earth mats

Customers (including Embedded Generators) requiring to provide an additional point of neutral earthing to an Eskom MV network (for example, to facilitate islanded operation of his plant), and which will not be provided from the same earth mat as the network’s neutral earth connection shall do so only with the written permission of Eskom’s regional Electricity Delivery Manager. Two alternative earthing arrangements may be permitted in this case:

a) The Customer operates a switched neutral earth such that the Customer’s neutral earthing point is earthed no more than 200ms prior to disconnecting the supply (and the earthing point) from the Eskom network, and disconnected from earth within 200ms upon re-connection of the Customer network to the Eskom MV network.

b) The Customer provides a permanent point of neutral earthing, but the NER is sized such that the total earth fault current contribution from the Customer earth(s) is less than or equal to 10% of the total earth fault current contribution from the Eskom source, but no more than 72A.

In case (a), provision shall be made for the detection of a failed neutral earthing switch, either in the open or closed positions. The control system shall isolate the Customer supply point from the Eskom network within 500ms in the event that the neutral earthing switch fails in the closed position.

In case (b), provision shall be made for suitably sensitive earth fault protection for both islanded and grid-connected operating modes of the Customer’s facility.

Note: Additional network earths may not be installed downstream of an open-delta connected voltage regulator as the regulator causes a neutral voltage shift which establishes circulating current between the distant earths, dependent on the regulator tap number. The application of three single-phase regulators avoids this problem.

4.2.2 Neutral earthing of MV-MV star-star transformers without tertiary windings

Most, if not all, MV/MV star-star transformers are designed without delta tertiaries, and with both windings uniformly insulated. These transformers shall be operated with the primary (source-side) winding unearthed and the secondary (load-side) winding either resistively or solidly earthed.
The policy allows one of the three neutral earthing methodologies for the secondary (load-side) winding:

a) Solid earthing. This requires that the transformer’s zero sequence impedance is measured for the configuration of the primary (source-side) winding unearthed, secondary (load-side) winding solidly earthed. Solid earthing may only be applied if network simulations using the measured transformer impedances confirm that the maximum earth fault level on the load-side network is less than three times the fault current value of Section 4.2.1.1 for the specific network type in question.

Note: The test procedure for a transformer zero sequence impedance test is given in SCSPVADJ2.

b) Resistive earthing via an NER (Preferred). In addition to performing the transformer zero sequence impedance measurements in (a) above, a resistor of the correct ohmic rating and wattage shall be installed between the load-side neutral and earth such as to limit the earth fault current contribution from each transformer to approximately those values stated in Section 4.2.1.1.

Note: This requirement has historically been met via the application of 20 ohm resistors for 11kV windings and 40 ohm resistors for 22kV windings. The resistors are rated to carry rated fault current for 10 seconds.

c) Resistive earthing via a standard (external) NECR. Both transformer neutrals shall be left unearthed in this case. Where an NECR is applied, the protection design shall ensure that the NECR forms part of the main transformer differential and/or Restricted Earth Fault protection zone.

4.2.3 Earthing of MV shunt capacitor bank neutrals

Shunt capacitor banks shall be installed in a delta configuration or an un-earthed star such as not to provide an additional point of neutral earthing to a MV network.

4.3 Intermediate Voltage networks

These are typically 3.3kV networks that are derived via a step-down MV/IV transformer or from a step-up LV/IV transformer, and use a specific cable technology for low cost distribution. Intermediate Voltage technology is presently not supported by Eskom with the result that no new IV networks will be designed or installed. The neutral earthing of existing IV networks shall be in accordance with the prevailing standards at the time that they were designed. In this regard, the user is referred to the following archived standards:

SCSASAAK7 (obsolete), Singlepoint underground supply; and

SCSASAAK8 (obsolete), Intermediate Voltage Reticulation

4.4 Low Voltage networks

4.4.1 Earthing of transformer LV neutrals

The neutral earthing policy for overhead and underground LV networks is governed by the same safety considerations. Unless the earth electrode resistance at the distribution transformer is 1 ohm or less, the MV (protective and surge arrester) and LV (neutral) earthing systems are required to be separated. This requires that, in addition to a transformer MV earth electrode, the LV neutral shall be solidly earthed using a separate LV earth electrode. This practice ensures that the two systems (MV and LV) are separated from
each other to avoid the transfer of dangerous potentials from the MV network to the LV network in the event of a MV earth fault occurring onto the transformer tank.

An exception to the above is made for some remote transformer installations supplying unmanned sites (e.g. the auxiliary supply to pole mounted auto-reclosers), whereby the MV and LV earths are combined despite the earth electrode resistance exceeding 1 ohm. See DST 34-1985 Section 4.1.1 for further details

Practical considerations dictate that the MV and LV earths are generally separated on transformers installed in overhead networks as it is extremely difficult to obtain an earth electrode resistance of less than 1 ohm. The MV and LV earths are normally combined at transformer installations on underground networks as the Earth Continuity Conductor (ECC) and/or cable armouring, coupled with remote substation earth mats are used to establish extremely low resistances to true earth.

Where separate MV and LV earthing systems are installed, a neutral surge arrester is installed between the two earthing systems to protect the transformer LV windings from excessive voltage stress in the presence of lightning surges. Significant transient voltages can occur between the transformer tank and earth when the transformer MV arresters operate in the event of lightning surges and the associated currents are discharged to earth.

The detailed MV and LV earthing requirements and applications are set out in DST 34-1985.

4.4.2 Type of LV system earthing

New LV distribution systems shall use the TN-C-S earthing system in accordance with SANS 10292 whereby the neutral and protective functions are combined in a single conductor between the source and the point of supply and are separated in the customer's electrical installation.

If the protective earth/neutral (PEN) conductor is broken, dangerous voltages to earth may exist at the Customer's earth terminal. It is therefore essential to pay particular attention to the conductor's integrity throughout the design, construction, maintenance and operation of the LV distribution system;

The preference is for LV networks to use single-point earthing at or near the distribution transformer. Multiple-point earthing (typically applied to mitigate the risk of floating neutral/earth voltages due to broken neutral conductors or poor joint integrity) shall be applied with caution. Refer to SANS 102092 for further details.

4.4.3 Earthing of customer premises

Customer installations shall comply with the earthing requirements of SANS 10142-1.

4.5 Implementation

This policy shall be implemented during network strengthening or normalisation projects. Specific focus shall be given to the normalisation of the neutral earthing of MV networks as this area has been without a standardised policy up until now. This must include an audit of all bulk supply points from MV feeders to ensure that existing customers have not applied “unauthorised” neutral earthing points to the network. An inconsistent neutral earthing policy (specifically on MV networks) has critical safety implications.

For the purposes of the implementation of this policy, it is critical that the existing neutral earthing arrangement of transformers and capacitor banks is accurately reflected on single-line diagrams, switching diagrams and information systems such as Smallworld.
Annex A – Impact Assessment
(Normative)

Impact assessment form to be completed for all documents.

1 Guidelines

- All comments must be completed.
- Motivate why items are N/A (not applicable)
- Indicate actions to be taken, persons or organisations responsible for actions and deadline for action.
- Change control committees to discuss the impact assessment, and if necessary give feedback to the compiler of any omissions or errors.

2 Critical points

2.1 Importance of this document. E.g. is implementation required due to safety deficiencies, statutory requirements, technology changes, document revisions, improved service quality, improved service performance, optimised costs.

This document has been written in fulfilment of a requirement of the Distribution Code, as well as in response to a number of safety incidents relating to incompatible earthing practices having been applied on Eskom networks.

2.2 If the document to be released impacts on statutory or legal compliance - this need to be very clearly stated and so highlighted.

This documents relates specifically to Eskom’s compliance to the Distribution Code.

2.3 Impact on stock holding and depletion of existing stock prior to switch over.

Not applicable.

2.4 When will new stock be available?

Not applicable.

2.5 Has the interchangeability of the product or item been verified - i.e. when it fails is a straight swop possible with a competitor’s product?

Not applicable.

2.6 Identify and provide details of other critical (items required for the successful implementation of this document) points to be considered in the implementation of this document.

A specification and accepted product(s) must be established for suitable Neutral Earthing Resistors (NERs) for application with MV/MV star-star transformers. This task is in progress.

2.7 Provide details of any comments made by the Regions regarding the implementation of this document.

Richard Krusekopf from Eastern region asked for clarification on some aspects of MV network earthing. This has been addressed through the inclusion of an additional comment and sentence. Other suggested (minor) changes to headings were incorporated.
3 Implementation timeframe

3.1 Time period for implementation of requirements.

Most of the requirements should be implemented immediately. It may take up to five years from the date of publication of this document for all MV/MV star-star transformers without delta tertiaries to be normalised in terms of their earthing arrangements.

3.2 Deadline for changeover to new item and personnel to be informed of DX wide change-over.

Not applicable.

4 Buyers Guide and Power Office

4.1 Does the Buyers Guide or Buyers List need updating?

Not applicable.

4.2 What Buyer’s Guides or items have been created?

Not applicable.

4.3 List all assembly drawing changes that have been revised in conjunction with this document.

None.

4.4 If the implementation of this document requires assessment by CAP, provide details under 5

4.5 Which Power Office packages have been created, modified or removed?

Not applicable.

5 CAP / LAP Pre-Qualification Process related impacts

5.1 Is an ad-hoc re-evaluation of all currently accepted suppliers required as a result of implementation of this document?

Not applicable.

5.2 If NO, provide motivation for issuing this specification before Acceptance Cycle Expiry date.

Not applicable.

5.3 Are ALL suppliers (currently accepted per LAP), aware of the nature of changes contained in this document?

Not applicable.
5.4 Is implementation of the provisions of this document required during the current supplier qualification period?

Not applicable.

5.5 If Yes to 5.4, what date has been set for all currently accepted suppliers to comply fully?

Not applicable.

5.6 If Yes to 5.4, have all currently accepted suppliers been sent a prior formal notification informing them of Eskom’s expectations, including the implementation date deadline?

Not applicable.

5.7 Can the changes made, potentially impact upon the purchase price of the material/equipment?

Not applicable.

5.8 Material group(s) affected by specification: (Refer to Pre-Qualification invitation schedule for list of material groups)

Not applicable.

6 Training or communication

6.1 Is training required?

No, except for formalised information sharing.

6.2 State the level of training required to implement this document. (E.g. awareness training, practical / on job, module, etc.)

On job

6.3 State designations of personnel that will require training.

NS Planners, Substation designers and EDM staff, which includes EDNO, Settings, Project Engineering staff as well as EDFS Protection staff.

6.4 Is the training material available? Identify person responsible for the development of training material.

No. This policy and the associated references could, however, be used directly as training material.

6.5 If applicable, provide details of training that will take place. (E.G. sponsor, costs, trainer, schedule of training, course material availability, training in erection / use of new equipment, maintenance training, etc).

None.
Annex A (continued)

6.6 Was Technical Training Section consulted w.r.t module development process?

No.

6.7 State communications channels to be used to inform target audience.

Via the Change Control Processes followed by intra-regional communications, such as the Technical Evaluation and or Project Review Forums etc.

7 Special tools, equipment, software

7.1 What special tools, equipment, software, etc will need to be purchased by the Region to effectively implement?

Not applicable.

7.2 Are there stock numbers available for the new equipment?

Not applicable.

7.3 What will be the costs of these special tools, equipment, software?

Not applicable.

8 Finances

8.1 What total costs would the Regions be required to incur in implementing this document?

Identify all cost activities associated with implementation, e.g. labour, training, tooling, stock, obsolescence

This document will likely bring about cost savings as a result of the more effective management of earth fault levels. Apart from stand-alone Neutral Earthing Resistors required for MV/MV star-star transformers, this policy has no influence on equipment or stock holding. A suitable specification/accepted product(s) for NERs must, however, be established.

Impact assessment completed by:

Name: Stuart van Zyl

Designation: Chief Engineer – IARC Protection Specialist