CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

ELECTRICITY GENERATION AND DISTRIBUTION DEPARTMENT

STANDARD FOR STANDBY SUPPLY SOFT LOAD TRANSFER SCHEME

2023-08-089 EGD

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1 OBJECTIVE

This document describes the requirements of the City of Cape Town for the application of Soft Load Transfer schemes and supersedes CTES 074.

2 SCOPE

The document applies to all LV and MV generators of nominal capacity greater than 100kVA connecting to the network of the City of Cape Town.

3 REFERENCE / RELATED DOCUMENTS

Identifier	Title
SANS 10142-1	Wiring of Premises Part 1: Low-Voltage Installations – Section 7.12 and Annexure S – Alternative Supplies (Low Voltage Generating Sets)
SANS 10142-2	Wiring of Premises Part 2: Medium-Voltage Installations above 1 kV a.c. and up to and including 3 MVA installed capacity.
IEEE 1547.1 Section 5.2	IEEE Standard for Interconnection and Interoperability of Energy Resources with Associated Electric Power System Interfaces - Over and Under Voltage protection requirements
IEEE 1547.1 Section 5.3	IEEE Standard for Interconnection and Interoperability of Energy Resources with Associated Electric Power System Interfaces - Over and Under frequency protection requirements
IEEE 1547.1 Sections 5.4.2, 5.4.3 or 5.4.4	IEEE Standard for Interconnection and Interoperability of Energy Resources with Associated Electric Power System Interfaces - Synchronisation requirements
IEEE 1547.1 Section 5.8	IEEE Standard for Interconnection and Interoperability of Energy Resources with Associated Electric Power System Interfaces - Reverse Power protection requirements
IEEE 1547.2 Section 5.3	IEEE Standard for Interconnection and Interoperability of Energy Resources with Associated Electric Power System Interfaces - Loss-of-Grid protection requirements
IEC 60255-1	Measuring Relays and Protection equipment – Part 1 Protection relay accuracy requirements
IEC 60255-151	Measuring Relays and Protection Equipment – Part 151 Protection relay accuracy requirements
ESKOM Standard 240-6128576 Section 3.5.4	Standard for the Interconnection of Embedded Generation

4 DEFINITIONS, ABBREVIATIONS AND TERMS

AC: Alternating Current
CB: Circuit Breaker
CCT: City of Cape Town
EGD: Electricity Generation and Distribution
Gen: Generator
LV: Low Voltage, voltage levels up to and including 1 kV
MV: Medium Voltage, voltage levels greater than 1 kV up to and including 33 kV
PUC: Point of Utility Connection
PGC: Point of Generator Connection
SLT: Soft Load Transfer
Sync: Synchronisation

5 INTRODUCTION

A SLT scheme is a stand-by generator system that operates in a ‘make before break’ mode with the utility supply so as to allow uninterrupted transfer of the customer’s load from the utility grid supply to the back-up generator supply and vice versa.

It is the intention of this document to describe the requirements of the CCT in this regard. This document will be subject to review following any changes to Statutory Legislation or National/International requirements.

These requirements and standards permits the CCT to only consider applications from customers who have a three-phase connection with the CCT. The intention is to grant approval to SLT schemes to customers with critical loads that are vulnerable to supply interruptions or load shedding.

Approval of the SLT scheme shall only be granted for generating plant that is designated for own use and not for commercial purposes. Each application shall be evaluated on its merits.

The CCT reserves the right to retrospectively require customers whom permission has been granted to connect a SLT scheme to the network, to comply with new or revised national standards when it is adopted. The customer shall be responsible for any costs associated with the changes required.

6 TECHNICAL DETAIL

6.1 Types of load transfer schemes

Examples of typical applications of SLT schemes are shown in Figures 1, 2 and 3. It is likely that most applications encountered in practice may be variations of these examples.

Figure 1: MV or LV SLT Scheme
MV Customer with MV connected Load

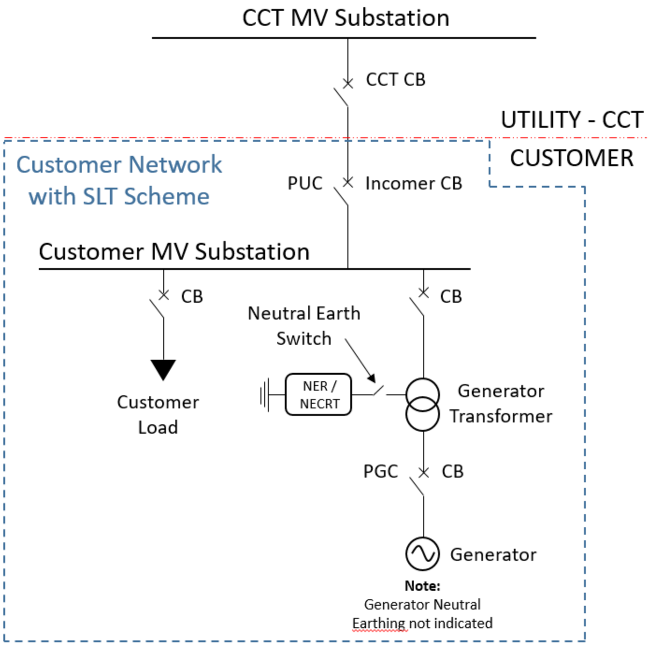


Figure 2: LV SLT Scheme
LV Customer

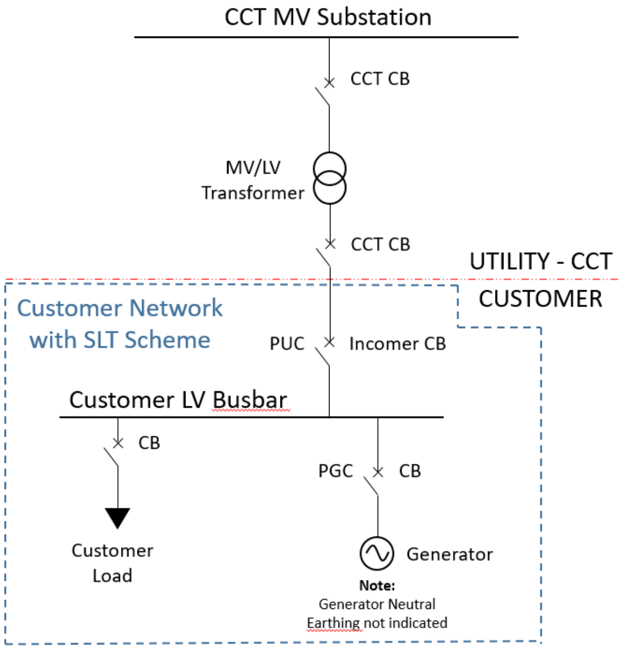
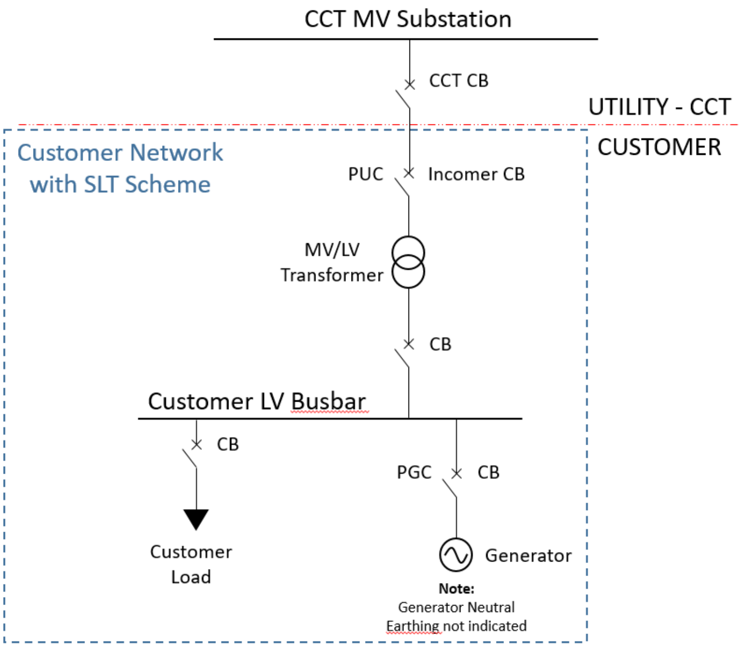


Figure 3: LV SLT Scheme
MV Customer with LV connected load



In Figures 1, 2 and 3 the customer's generator is synchronised to the utility grid via the PGC. Once synchronised, the real and reactive power outputs of the generator are increased in order to reduce the real and reactive power imported by the customer's facility from the CCT distribution network.

In Figure 1, the customer facility includes loads or transformers supplied from MV. The automatic control system of the generator serves to minimise the power imported at the customer incomer or the CB at the PUC. Once the real and reactive power imported at the PUC have been reduced to near zero. The MV neutral earth switch is closed and the CB at the PUC is opened, thereby islanding the customer's facility with the generator. The sequence of events for restoration of the grid supply includes, synchronising the customer network to the grid, closing the CB at the PUC, opening of the neutral earth switch, reduction of the generator's power output to zero and disconnection of the generator via the PGC.

The sequence of events for synchronising and load transfer from the CCT network to standby supply generation is shown in Figure 4 below:

Figure 4 – Transfer from CCT Network to Standby Supply Generator

PUC Closed & PGC Open [ready to start sync]

↓

Sync Gen across PGC

↓

Close PGC

↓

Ramp Up Gen Output = Customer load [within 2 min]

↓

Close switched neutral earth

↓

Open PUC [within 500 ms]

The sequence of events for synchronising and load transfer from standby generation to the CCT network is shown in Figure 5 below:

Figure 5 – Transfer Standby Supply Generator to CCT Network

PUC Open & PGC Closed [ready to start sync]

↓

Sync Gen across PUC

↓

Close PUC

↓

Open switched neutral earth [within 500 ms]

↓

Ramp Down Gen Output to 0 [within 2 min]

↓

Open PGC

NOTE: Customer to monitor the CCT network stability (system frequency and voltage) between the first two stages shown in the sequence above)

In Figures 2 and 3, the customer's load is at LV and the PUC circuit breaker is at the LV and MV level respectively. The operating sequences for these configurations are similar to the sequences described above with the exception that the LV neutral earth connections will not usually be switched.

6.2 Technical requirements for the implementation of SLT schemes

This standard serves to clarify the minimum technical requirements at the PGC, PUC and the neutral earthing requirements of the customer generator and generator transformer. Parallel operation of the customer's generator with the CCT network shall be governed by the requirements and or exemptions as indicated in Table 1 below.

Table 1: Additional requirements and/or exemptions

Item/Description	***Minimum requirement/exemption***
1.1 Legal Requirements	a) Generating plant operating at Low Voltage shall comply with the requirements of SANS 10142-1 *Wiring of Premises Part 1: Low-Voltage installations*, and in particular Section 7.12 and Annex S - *Alternative supplies (Low voltage generating sets)*. b) For MV supplies, SANS 10142-2 *Wiring of Premises Part 2: Medium-voltage installations above 1 kV a.c. not exceeding 22 kV a.c. and up to and including 3 MVA installed capacity* c) Occupational Health and Safety Act (Act 85 of 1993)
1.2 Synchronisation	The generator shall only be operated in parallel with the CCT's network for as long as is required to conduct the load transfer. This time shall not exceed 2 minutes after synchronising with CCT Network. If the PUC fails to open 2 minutes after synchronising, the generator will cease to generate and shall disconnect within 2 seconds, at the PGC. Similarly, if the MV neutral earth switch fails to close after 2 minutes when the full customer load has been transferred to the generator, the generator will cease to generate and shall disconnect within 2 seconds, at the PGC.
1.3 Neutral Earthing	For schemes operating at MV (as in Figure 1), whilst operating in parallel with the CCT network, the generator transformer shall not provide a permanent point of neutral earthing for the CCT MV network. The customer shall ensure that the scheme includes a mechanism to switch in the neutral earthing device for the customer's MV network, immediately prior to the separation between the CCT and customer's network. The neutral earthing philosophy may be either resistance or impedance earthed, as preferred by the customer. The neutral earthing devise shall be installed to control the earth fault current contribution to the limits specified in section 6.2.3.1. The CCT and customer networks shall be separated at the PUC within 500 ms of the MV neutral earth being closed at the customer's premises. The neutral earth shall be opened within 500 ms of the customer re-synchronising and connecting to the CCT network. The scheme shall include an interlock whereby it is not possible to island the generator(s) and the customer's plant with the MV neutral earthing switch open. It shall equally not be possible to run the generator in parallel with the CCT's network for longer than 500 ms with the MV neutral earthing switch closed. For schemes operating at LV (as in Figure 2 and 3), the customer shall provide a permanent point of neutral earthing to the LV network. The application of earth leakage protection as required by SANS 10142-1 shall not be compromised by the application of a generator earth connection.

1.4 Prevention of out-of-synchronisation closure	The SLT facility shall include loss-of-grid protection, to detect unintended islanding of the customer's facility with a portion of the CCT's network (see 1.6 below). Loss-of-grid protection and the limited duration for which the customer's generator operates in parallel with the CCT's network, is considered sufficient to mitigate the risk of an out-of-synchronism closure of a CCT circuit breaker onto an islanded SLT generator. As a result, the CCT shall not install synchronism check or live-line close blocking functionality on its circuit breakers connected to customers who have installed a SLT scheme. In the event of an unplanned supply failure, the scheme shall operate in a break-before-make (i.e. conventional stand-by generator in terms of SANS 10142-1) mode whereby the PUC is opened prior to the PGC closing.
1.5 Sensitive Earth-Fault protection	The CCT does not require that Sensitive Earth Fault and/or Residual over-voltage protection be applied at the PGC or PUC. The customer may require these protection methods during periods of islanded operation.
1.6 Loss-of-Grid protection	Loss-of-grid protection at the PUC may take the form of a reverse power relay preventing excessive power export to the CCT's network or Rate-of-Change of Frequency (ROCOF) with settings as per Table 3. The reverse power relay shall be set to 10% of the generator's rated capacity.
1.7 DC Systems	LV circuit breakers operated by SLT schemes may share a common DC system, provided the scheme includes suitable interlocks to prevent synchronisation of the generator to the CCT's network, should any abnormal condition be detected on the DC system.
1.8 Metering	Application of a SLT scheme at a customer premises does not necessitate any changes to the existing tariff metering installation, or any special requirements with regard to new installations (as compared to conventional "load" metering).
1.9 SCADA	The requirements for Supervisory indications, alarms, controls and measurements shall not be applicable to SLT schemes.
1.10 Tests	For schemes operating at MV (as in Figure 1), an additional commissioning test shall be conducted. The MV neutral current at the customer premises shall be measured during the time after switching-in the customer's neutral earth connection, but before separation of the facility from the CCT's network. The results of this test shall be used to determine the risk of nuisance operation of the CCT's earth fault or sensitive earth fault feeder protection should the customer fail to switch out the point of MV neutral earthing when operating in parallel with the City's network (e.g. during load transfer).

6.2.1 Synchronisation

All SLT generating plants, other than mains excited asynchronous machines, must be synchronised with the CCT's supply prior to making the parallel connection.

The parameters between the unit and the system prior to synchronising shall not differ by more than the values specified in Table 2. Where the mode of operation of generating equipment is such that synchronising of a machine or machines will occur at intervals of less than two hours, the voltage fluctuation at the PGC resulting from the generation capacity being connected shall not exceed 1 %.

Automatic synchronising equipment shall be the preferred method of synchronising. However, manual synchronisation of customer generator units is permissible on condition that synchronising check relays (three phase comparators) are used by the customer in conjunction with the manual synchronising, and that this switching is performed by the customer's own representative, authorised by the customer in writing to do so.

It is the responsibility of the customer to provide synchronising facilities. Typical limits for synchronising parameters are given in Table 2 below:

Table 2: Typical synchronising parameter limits (IEEE 1547 p.12)

1	2	3	4
Aggregate rating of EG (kVA)	Maximum Frequency Difference Δf (Hz)	Maximum Voltage Difference ΔV (%)	Maximum Phase Angle Difference ΔØ (Degrees)
S < 500	0,3	10	20
500 ≤ S < 1500	0,2	5	15
S ≥ 1500	0,1	3	10

6.2.2 Unintentional islanded operation

For unintentional islanding, where a generator is synchronised with the CCT's network at the time that an upstream CCT circuit breaker opens, severing the connection between the generator supply and the grid supply, the generator shall cease to generate within 2 seconds by opening the PUC customer incomer circuit breaker.

Table 3: Typical Rate-of-Change-of Frequency settings

ROCOF	Δf	0,2 – 1,0 Hz/s (0,4 Hz/s typical)
	Δt	40 ms – 2 s
	Time delay	200 ms – 500 ms

6.2.3 Requirements for the utility network interface

6.2.3.1 Fault infeed

Should the customer's generator(s) result in the increase of fault levels to such an extent that the CCT's or the customer's plant at the PUC is placed at risk, the customer shall apply fault current limiting measures to ensure that the fault levels are maintained at acceptable levels. The fault limiting solution applied shall be presented to the CCT for acceptance prior to implementation.

For MV customers operating a switched neutral earth, the earth fault or zero-sequence current contribution from the customer facility shall not exceed 400A.

6.2.3.2 Quality of supply

Voltage quality parameters, i.e. voltage regulation, unbalance, flicker and harmonic distortion, at the PUC and other customer points of supply, may not exceed the compatibility levels or limits as prescribed in NRS 048-2 due to operation of the installed generators. The rapid rate of voltage change limits, as set out in NRS 048-4, shall also not be exceeded.

6.2.3.3 Earthing

Adequate earthing of networks at other voltage levels within the customer's plant is the responsibility of the customer, and is not stipulated herein.

The CCT's networks may use effective, resistance or impedance earthing methods depending on the voltage level and local requirements. The magnitude of the possible earth fault current will depend on which of these methods is used. The customer's earthing arrangement must therefore be designed as follows:

a) In consultation with the CCT, such that the customer's system is compatible with the CCT's system.

b) Such that the customer's plant safety is not compromised due to the above requirement.

Customer earthing may be achieved by the use of a busbar earthing transformer (e.g. NEC/R), the use of the star point of the generator, or by earthing the star point of the generator transformer.

The customer should consider the circulating third harmonic currents between multiple generators. To avoid excessive circulating third harmonic currents, it may be necessary to restrict the earthing to the star point of a single machine and provide automatic transfer facilities of the generator star point earth to another machine in the event of the selected machine being tripped. The use of suitable generator transformers with delta windings may provide a means of avoiding excessive circulating harmonic currents.

Where generator transformers with delta windings are used, the winding configuration of the generator transformer (e.g. Delta-Star, Star-Delta etc.) shall be such that zero sequence currents on the CCT's network and the customer's systems are decoupled from one another.

Where transportable or mobile generating plant is used, it is essential that all earthing connections to the generator shall be made prior to connecting any phase connections or running the generator.

Under conditions of separation between the CCT's network and the customer's network, the customer shall ensure that its network is not operated unearthed.

The customer shall also ensure that the customer MV generator earth grid is not connected to CCT network earth grid.

6.2.3.4 Isolating Transformer

No MV generators will be connected directly to the CCT network. This means an isolation transformer is required at the PUC. An auto-transformer is not acceptable, as it does not provide isolation. This is primarily to protect the CCT network from any disturbances created by the customer's generator(s).

For MV generators, the customer must ensure a switchable earth point is available on the CCT network side of the isolation transformer and shall conform to the requirements listed in 1.3 and 6.2.3.1. This is to allow the detection of an earth fault current during islanded operation.

A generator transformer will serve as an isolating transformer for MV generators.

7 APPLICATION PROCESS

Any customer wishing to operate or install a SLT scheme on the CCT's supplied network is required to apply to CCT for acceptance of the proposal. Customer may contact the EGD Department to obtain an application form, which is also available on the EGD page of CCT website at:

http://www.capetown.gov.za/elecserviceforms

The contact details for EGD Customer Support Services East (Bloemhof), South (Wynberg) and North (CBD) are available on the application form.

Before submitting a SLT application the applicant must ensure that all the requirements of other departments of the CCT regarding the erection/installation of the proposed generators (e.g. diesel generator) must be met (e.g. Planning and Building Development Management and City Health Specialised Services). Statements of compliance and clearance by the respective departments must be reflected on the EGD application form for the connection of the standby supply (GEN/ELEC 1).

Customers who have already obtained permission from the other departments of the CCT to operate a low voltage standby supply who wish to install a SLT system, do not have to re-apply for the connection of standby supply. A new GEN/ELEC 1 application is required in writing, stating the reasons for the proposed SLT system as well as references to the existing and approved standby supply applications.

Applicant will be cost responsible for both in-house and outsourced engineering studies conducted as part of the application, should these be required. A quotation for such work can be provided, giving the applicant the opportunity to cancel or modify the application should it be required.

7.1 Information required for SLT applications

The following must be provided by the customer:

a) A single line diagram indicating the PUC and PGC as well as MV and LV switchgear, transformers nameplate information, cables, earthing arrangements and the proposed connection of the synchronisation/protection equipment.

b) A detailed technical specification of the proposed synchronisation equipment. This document must confirm that the synchronising relay(s) have been manufactured and tested in accordance with international standards (i.e. type tested and comply with IEC 60255 and EN 50263).

c) The proposed synchronisation settings as referred to in Table 2 of this document.

d) The proposed settings of the reverse power blocking / loss of grid protection.

e) The written switching procedures during SLT operations.

f) Operations and Maintenance procedures and Installation Responsibilities after commissioning.

g) A certified copy of Certificate of Compliance in terms of OHS Act - Electrical Installation Regulations

h) Standby supply generation compatibility with CCT network fault levels.

i) A commissioning check-list indicating that all SLT associated plant and protection functions have been tested and commissioned in accordance with manufacturers standards and that the correct calculated relay settings have been applied.

j) A declaration by an ECSA registered Professional Engineer or Professional Engineering Technologist certifying that the SLT design and installation complies with this document and GEN/ELEC 1 - Application for the connection of a low voltage standby supply.

k) Standby supply generation decommissioning confirmation once applicable (GEN 2).

l) A Competent Person, in terms of the OHS Act, must be declared.

8 PROTECTION STANDARDS APPLICABLE TO SLT SCHEMES

All protection relays and control equipment (synchronising equipment) shall comply with the following standards:

a) Protection relay accuracy requirements shall comply with IEC60255 -1 and 151.

b) Overcurrent and earth fault protection shall provide Inverse Definite Minimum Time (IDMT) time current characteristics. IDMT curves shall be in accordance with the requirements of IEC-60255-151: Type A, B and C curves (i.e. IEC Normal Inverse, Very Inverse and Extremely Inverse).

c) Over and Under Voltage protection shall operate in accordance with the requirements of IEEE-1547.1 section 5.2.

d) Over and Under Frequency protection shall operate in accordance with the requirements of IEEE-1547.1 section 5.3.

e) Loss-of-grid protection shall be in accordance with the requirements of IEEE-1547.2 Section 5.3 using appropriate frequency ramps.

f) Synchronisation as per the requirements of IEEE-1547.1 sections 5.4.2, 5.4.3 or 5.4.4 as appropriate.

g) Reverse power as per the requirements of IEEE-1547.1 section 5.8.

h) Standard for the Interconnection of Embedded Generation as per the requirements of ESKOM Standard 240-6128576 Section 3.5.4