NRS 097-2-3:2023

Edition 2

GRID INTERCONNECTION OF EMBEDDED GENERATION

PART 2: SMALL-SCALE EMBEDDED GENERATION

SECTION 3: SIMPLIFIED UTILITY CONNECTION CRITERIA FOR LOW-VOLTAGE CONNECTED GENERATORS

This document is not a South African National Standard

NRS Association

N R S

This rationalized user specification is issued by
the Technical Governance Department, Eskom,
on behalf of the
User Group given in the foreword
and is not a standard as contemplated in the Standards Act, 1993 (Act No. 29 of 1993).

Table of changes

Change No.	Date	Text affected

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Foreword

This section of NRS 097-2 was prepared on behalf of the NRS Management Committee and approved by it for use by supply authorities.

This section of NRS 097-2 was prepared by a working group which, at the time of publication, comprised the following members:

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An industry interest group was consulted on the contents of this section of NRS 097-2 and its comments were incorporated where the working group was in agreement. The industry interest group comprised the following members:

Anderson A	Trackos
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Yeshaya A	Solaredge

Acknowledgements

This section of NRS 097-2 is based on the work of Clinton Carter-Brown, who was instrumental in developing the content of this specification.

Foreword (continued)

This guideline was approved by the NRS Management Committee which, at the time of publication, comprised the following members:

Padayachee V (Chairman)	Association of Municipal Electricity Utilities of Southern Africa (AMEU)
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NRS 097 consists of the following parts and sections, under the general title Grid interconnection of embedded generation:

Part 1: Distribution standard for the interconnection of embedded generation.

The specification sets out the minimum technical and statutory requirements for the connection of embedded generators to medium-voltage and high-voltage utility distribution networks. The specification applies to embedded generators larger than 1 MVA. (To be developed in the future.)

Part 2: Small-scale embedded generation.

The specification sets out the technical requirements for the utility interface, the embedded generator and the utility distribution network with respect to embedded generation. The specification applies to embedded generators smaller than 1 MVA connected to low-voltage networks.

Section 1: Utility interface.

Section 2: Embedded generator requirements. (To be developed in the future.)

Section 3: Simplified utility connection criteria for low-voltage connected generators.

Section 4: Procedures for implementation and application. (In development).

In the definition of “utility”, reference is made to the “electricity distribution supply authority”. In South Africa this may be Eskom, or the municipal electricity service provider.

Annexures A and B are for information only.

Introduction

This section of NRS 097 is intended to guide South African distributors in terms of simple rules to be applied when applications for LV connected embedded generators are being assessed. The proposed criteria indicate the conditions under which LV connected generators can be connected to the utility grid without having to perform detailed network studies. Applications that do not meet these criteria will need to follow an alternative process, which may require detailed network studies.

Keywords

generator, utility, shared, dedicated

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GRID INTERCONNECTION OF EMBEDDED GENERATION

Part 2: Small- scale embedded generation

Section 3: Simplified utility connection criteria for low-voltage connected generators

1. Scope

This section of NRS 097-2 covers the requirements for simplified utility connection criteria for low-voltage connected generators. The requirements differentiate between customers supplied by shared and dedicated LV networks, but explicitly exclude lower income domestic electrification networks i.e. shared LV networks supplying customers with a Living Standard Measure of less than seven.

2. Normative references

The following documents contain provisions which, through reference in this text, constitute provisions of this section of NRS 097-2. All documents are subject to revision and, since any reference to a document is deemed to be a reference to the latest edition of that document, parties to agreements based on this specification are encouraged to take steps to ensure the use of the most recent editions of the documents listed below. Information on currently valid national and international standards can be obtained from the SABS Standards Division.

NRS 048-2, *Electricity supply – Quality of supply – Part 2: Voltage characteristics, compatibility levels, limits and assessment methods.*

NRS 048-4, *Electricity supply – Quality of supply – Part 4: Application practices for licencees.*

NRS 097-2-1, *Grid interconnection of embedded generation – Part 2: Small-scale embedded generation – Section 1: Utility interface.*

Grid Connection Code for Renewable Power Plants (RPPs) connected to the electricity Transmission System (TS) or the Distribution System (DS) in South Africa.

Grid Connection Code for Battery Energy Storage Facilities (BESF) connected to the electricity Transmission System (TS) or the Distribution System (DS) in South Africa.

3. Terms, definitions and abbreviations

For the purposes of this document, the following terms, definitions and abbreviations apply.

3.1 Terms and definitions

utility: electricity distribution supply authority (see foreword) responsible for the low-voltage electricity network infrastructure in the area of the installation

notified maximum demand: notified maximum demand is the contracted maximum demand, notified in writing by the customer and accepted by the utility at the point of supply

utility installed capacity: the utility's apparent power installed capacity, that is the minimum of the notified maximum demand stated on the billing system, breaker size, or transformer size

dedicated network: a section of the utility network that exclusively supplies a single customer/generator

NOTE A dedicated network can be a dedicated LV feeder, or a dedicated MV/LV transformer.

shared network: section of the utility network that supplies more than one customer/generator

hybrid installation: a hybrid installation consists of generation and energy storage, often used as an embedded generator and a backup power source when the main power supply is interrupted

NOTE Since the backup power requirement from energy storage is typically much higher than the power export capacity, two power ratings are defined.

maximum export capacity: the maximum aggregative active power the installation is capable to export towards the network at the point of connection set by either the generator rating (e.g., PV array) or a limit set in the power conversion equipment

nameplate power rating: the aggregated maximum nameplate AC apparent power rating of the power conversion equipment, e.g., inverters, synchronous machines, or asynchronous machines.

maximum charging current: the maximum per phase charging current setting of a system equipped with an energy storage system

3.2 Abbreviations

ADMD: after diversity maximum demand
EG: embedded generator
LV: low voltage
MCC: maximum charging current
MEC: maximum export capacity
MV: medium voltage
NMD: notified maximum demand
NPR: nameplate power rating
OLTC: on-load tap changing
RVC: rapid voltage change
SSEG: small-scale embedded generator
UIC: utility installed capacity

4. Requirements

4.1 General

NOTE 1 The NRS 097-2 series of specifications specify the minimum technical requirements for LV generators connected to the South African grid, as aligned to the requirements of the grid connection code for renewable power plants connected to the electricity transmission system or the distribution system in South Africa.

NOTE 2 Requirements given in this section of NRS 097-2 should be used to evaluate LV generator grid interconnection applications. LV (< 1kV) connected generators that fall within these criteria are proposed to follow a simplified connection process that will not require detailed network studies.

NOTE 3 Simplified criteria rules are subject to the following:

a) An individual Maximum Export Capacity (MEC) limit of 25% of UIC will typically support a penetration level (percentage of customers that install a generator) of 30% to 50%, which is considered a reasonable and acceptable compromise between restricting individual MECs versus restricting penetration levels.

b) The network feeder design After Diversity Maximum Demand (ADMD) is unknown.

c) The size of plant (nameplate power rating), type of generation, export or non-export, storage or no storage, location of plant and date of installation of ALL generating plants should be captured and documented by the utility CONTINUALLY.

4.1.1 All LV grid connected generator interconnection equipment should be type-test certified complying with the minimum technical requirements of NRS 097-2-1.

4.1.2 Simplified connection of generators is limited to a Nameplate Power Rating (NPR) of less than 1 MVA.

4.1.3 The MEC of an individual LV customer is dependent on:

a) the type of LV network. This depends on whether the LV network that supplies the customer is shared (supplies other customers) or dedicated (only supplies the customer in question directly from the transformer busbar), and

b) the utility installed capacity (UIC).

4.1.4 Additional requirements linked to the size of the MV/LV transformer and maximum loading of the associated MV feeder are discussed in this section of NRS 097-2.

4.1.5 This edition of NRS 097-2-3 does not explicitly provide guidance on utility protection and fault level implications. Fault level related issues are not anticipated for inverter-based generators as the fault current contribution is typically limited to the converter current rating. Equipment fault current ratings should be checked for synchronous or asynchronous generators greater than 13.8 kVA.

4.1.6 If the criteria in this specification are not met it does not imply that the proposed generator cannot be connected. Rather, more detailed studies are required to assess if the generator can be connected i.e. a simplified connection process cannot be followed (see annex A).

4.1.7 Utilities may modify the criteria, or add additional criteria, to meet their specific requirements considering their network characteristics.

4.2 Shared LV feeders

4.2.1 The individual MEC limit in a shared LV feeder (see figure 1) is limited to 25% of the customer's UIC.

4.2.2 The NPR of the installed power conversion equipment is limited to 100% of the customer's UIC.

4.2.3 For systems equipped with energy storage systems, the charging current measured on the AC terminals of the power conversion equipment is limited to a value equivalent to 25% of the customer's UIC.

4.2.4 The resulting limits for common supply sizes are summarized in table 1.

Table 1 — Maximum individual installation limits in a shared LV (400 V/230 V) feeder

1	2	3	4	5
No. of Phases	**Service CB [A]**	**MEC = 0.25 UIC [kVA]**	**NPR = UIC [kVA]**	**MCC @ 0.25 UIC (per phase) [A]**
1	40	2.3	9.2	10
1	60	3.45	13.8	15
1	80	4.6	18.4	20
3	40	7	28	10
3	60	10	41	15
3	80	14	55	20
3	100	17	69	25
3	125	22	86	31
3	150	26	104	38
3	175	30	121	44
3	200	35	138	50
3	225	39	155	56
3	250	43	173	63
3	275	47	190	69
3	300	52	207	75
3	325	56	224	81
3	350	60	242	88
3	375	65	259	94
3	400	69	276	100

4.2.5 When the MEC is higher than 4.6 kVA, the supply should be three-phase. On the three-phase supply, the power unbalance between phases should not exceed 4.6 kVA. The unbalanced MEC should take into account other contributing factors, such as the load distribution between phases.

4.2.6 If the MEC limit is exceeded, the customer could potentially be connected through a dedicated LV feeder, such that the generator is supplied through a dedicated LV feeder (and the dedicated LV feeder limits apply). Alternatively, the customer can apply for an increased UIC e.g., if a customer with a single-phase 60 A supply wants to install a generator with a MEC greater than 3.5 kVA, then the customer could apply for an upgraded supply to three-phase 60 A whereby the maximum export capacity increases to 10 kVA.

4.2.7 In addition, the total generation exported to a shared LV feeders should be limited to 25% of the MV/LV transformer rating. For example, a 200 kVA MV/LV transformer can supply up to 50 kVA of generation supplied through shared LV feeders connected to that transformer.

4.3 Dedicated LV feeders

4.3.1 In a dedicated feeder (see figure 1) the MEC is limited to 75% of the customer's UIC.

4.3.2 The NPR of the installed power conversion equipment is limited to 100% of the customer's UIC.

4.3.3 For systems equipped with energy storage, the charging current measured on the AC terminals of the power conversion equipment is limited to a value equivalent to 25% of the customer's UIC.

4.3.4 The resulting limits for common supply sizes are summarized in table 2.

Table 2 — Maximum individual installation limits in a dedicated LV (400 V/230 V) feeder

1	2	3	4	5
No. of Phases	**Service CB [A]**	**MEC = 0.75 UIC [kVA]**	**NPR = UIC< 1MVA [kVA]**	**MCC @ 0.25 UIC (per phase) [A]**
3	125	65	86	31
3	150	78	104	38
3	175	91	121	44
3	200	104	138	50
3	225	116	155	56
3	250	129	173	63
3	275	142	190	69
3	300	155	207	75
3	325	168	224	81
3	350	181	242	88
3	375	194	259	94
3	400	207	276	100
3	500	259	345	125
3	630	326	435	158
3	800	414	552	200
3	1000	518	690	250
3	1250	647	863	313
3	1500	776	999	375

4.3.5 When the MEC is higher than 4.6 kVA, the supply should be three-phase. On the three-phase supply, the power unbalance between phases should not exceed 4.6 kVA. The unbalanced MEC should take into account other contributing factors, such as the load distribution between phases. Customers with dedicated single-phase supplies, supplied by a dedicated MV/LV transformer (e.g., 16 kVA MV/LV dedicated supplies in rural areas), should be allowed to connect up to 100% of their UIC on the available phases with a MEC limit of 75%.

4.3.6 The dedicated feeder cable size is limited such that the voltage rise between the point of supply and transformer busbar is limited to 1%.

4.3.7 If the dedicated LV feeder cable size is the constraint, it could be upgraded.

4.4 Additional requirements

4.4.1 The total MEC (i.e. shared LV generation and dedicated LV generation) supplied by a MV/LV transformer should be less than 75% of the MV/LV transformer rating, and

4.4.2 The total MEC supplied by a MV feeder should be less than 15% of the MV feeder peak load.

4.4.3 In the case of non-compliance to the additional requirements, the generator cannot be connected to the network without further detailed studies.

4.5 Simplified connection criteria

A summary of the connection criteria is shown in figure 1, and a flow chart that illustrates the simplified connection technical evaluation criteria is given in figure 2.

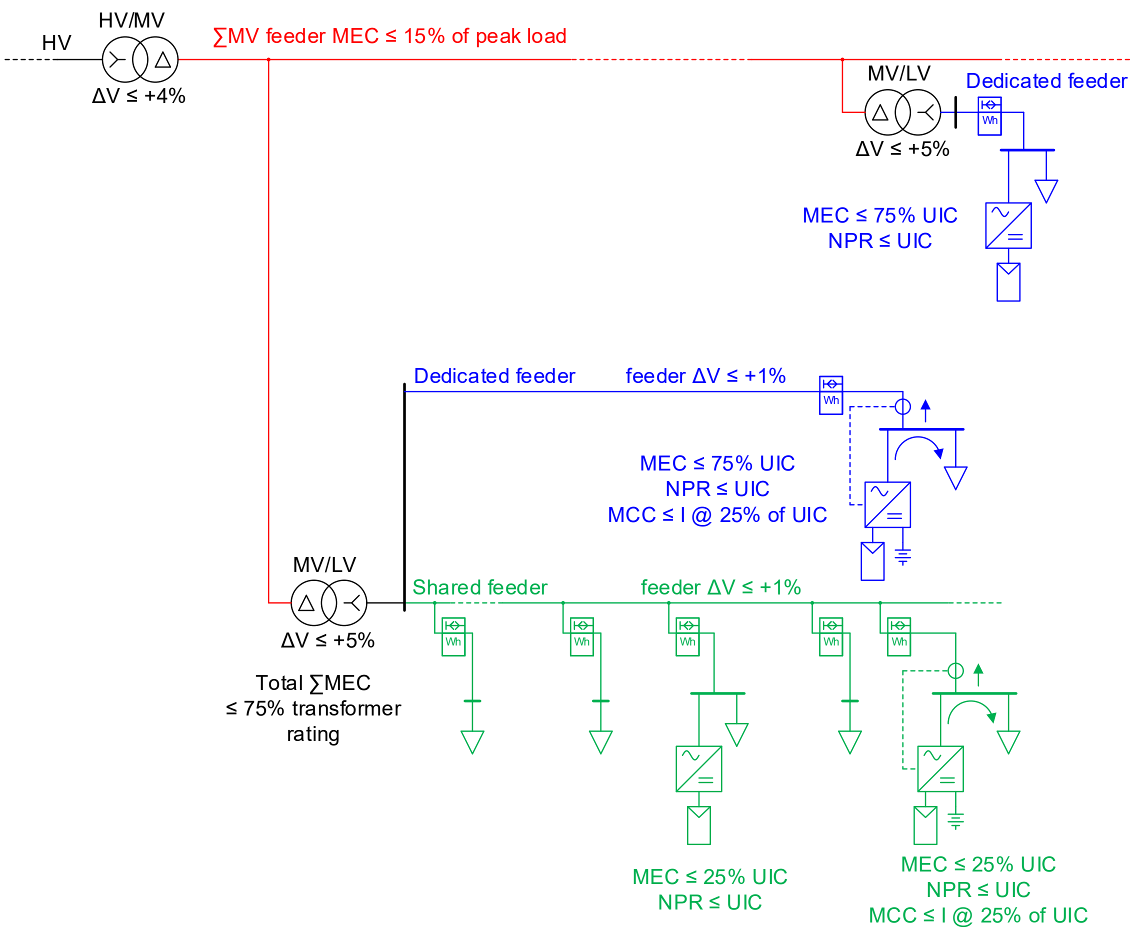

Figure 1 — Summary of simplified connection criteria

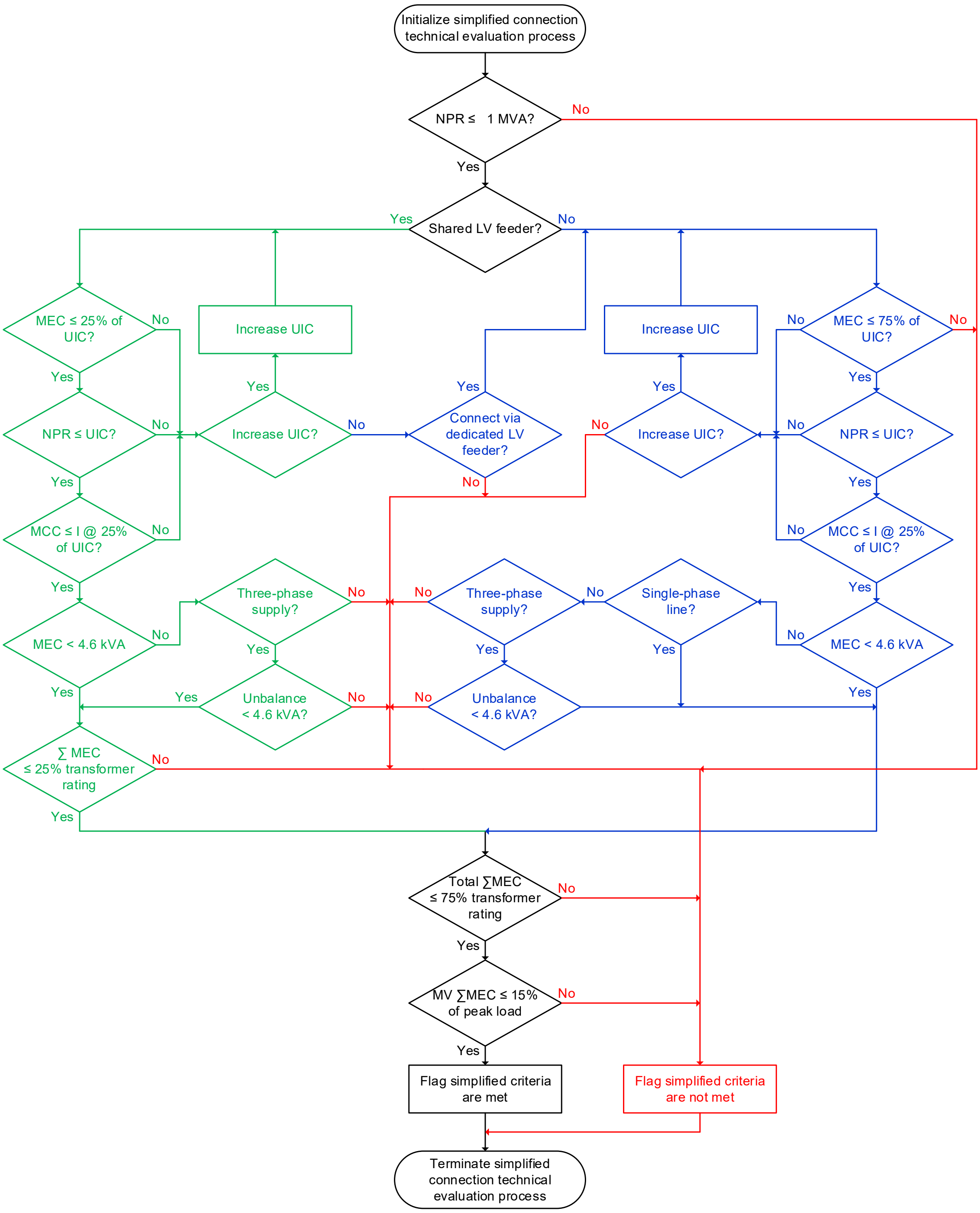

Figure 2 — Flow chart of simplified connection technical evaluation criteria

Annex A – Notes on more detailed studies
(informative)

NOTE 1 This annex gives guidelines on additional studies that may be required when customers are connected in situations where criteria other than the simplified connection criteria apply. These guidelines are not intended to be exhaustive, but only to guide planners on additional criteria.

NOTE 2 It may be beneficial to evaluate the quality of supply on the network for a period (a minimum of seven days) before concluding on the suitability of the connection point.

A.1 Fault level at customer point

Determine the short-circuit level (fault level) at the customer point to the desired accuracy. The fault level determines the potential impact that the generator will have on the network.

A.2 Fault level at SSEG connection point

Compare the fault level at the SSEG connection point to the test fault level of the SSEG (as given in the test certificate). A basic rule of thumb is that the impact of the connected device would vary inversely proportional to the ratio of the fault level. This will be regarded as an equivalent expected impact on the network.

A.3 Voltage rise

A.3.1 Calculate the expected voltage rise due to the connection of the SSEG at full capacity and the normal operating power factor. Confirm that the voltage rise due to the SSEG is acceptable.

A.3.2 According to VDE-AR-N 4105, the maximum voltage rise due to all generators connected to an LV network should not exceed 3%.

A.3.3 The acceptable voltage rise due to any single generator should be designed in line with the specific network.

A.3.4 Care should be taken on typical residential feeders that any single-phase generator is connected to a phase that is loaded heavier during expected generation periods.

A.4 Unbalance

A.4.1 Generators should generally improve any unbalance experienced on a network. The potential contribution should be confirmed.

A.4.2 The equivalent expected contribution to voltage unbalance should be less than that specified by NRS 048-4 (See annex D, Generic emission limits evaluated under stage 1).

A.4.3 Care should be taken on typical residential feeders that any single-phase generator is connected to a phase that is loaded heavier during expected generation periods.

A.4.4 Larger units may have to be apportioned under stage 2 in accordance with NRS 048-4.

Annex A
(continued)

A.5 Flicker

A.5.1 Although flicker is becoming less of a problem, flicker still needs to be managed;

A.5.2 Any start-up voltage change should be limited to 5% (RVC limit on MV networks for up to four events per day);

A.5.3 The equivalent expected contribution to voltage flicker should be less than that specified by NRS 048-4 (See annex D, Generic emission limits evaluated under stage 1).

A.5.4 Larger units may have to be compared against apportioned under stage 2 in accordance with NRS 048-4.

A.6 Harmonics

A.6.1 Contribution to harmonic distortion is a major concern for any inverter-based generator, including units with power electronic devices connected for control or other operational reasons.

A.6.2 The equivalent expected contribution to voltage harmonics should be less than that specified by NRS 048-4 (see annex D, Generic emission limits evaluated under stage 1).

A.6.3 The recommended current harmonic emission limits can be calculated according to the apportioning stage 2 procedure in NRS 048-4, or can be compared to A.1 (see VDE-AR-N 4105).

A.7 Protection equipment

A.7.1 Confirm that the fault level contribution of the SSEG will not exceed the ratings of circuit-breakers installed in the system(i.e. the customer that connects the SSEG, neighbouring customers and upstream circuit-breakers). The fault level contribution can be obtained from the SSEG test certificate.

A.7.2 If the fault level contribution from the SSEG is unavailable, the following should be assumed:

a) in the case of synchronous generators: eight times the rated current;

b) in the case of asynchronous generators: six times the rated current; and

c) in the case of inverter-based generators: one time the rated current.

A.7.3 Further protection checks may be necessary, for example recloser settings, protection coordination.

Annex A
(concluded)

Table A.1 — Maximum harmonic current emissions
(Source: VDE-AR-N 4105)

1	2	3	4	5	6
Harmonic number h (odd)	**Permissible maximum current** Ampere per MVA of fault level	**Harmonic number h** (even)	**Permissible maximum current** Ampere per MVA of fault level	**Inter-harmonic number h** (all)	**Permissible maximum current** Ampere per MVA of fault level
3	3	2-40	1.5/h	2-41	1.5/h
5	1.5				
7	1				
9	0.7				
11	0.5				
13	0.4				
15	0.25[a]				
17	0.3				
19	0.25				
21	0.18[a]				
23	0.2				
25-41	0.15 × 25/h				
42-178	4.5/h				
NOTE Group all components above 40th in bands of 200 Hz as in SANS 61000-4-7, where "h" indicates the mid-band (harmonic or inter-harmonic component).					
[a] Not defined in VDE-AR-N 4105.					

Annex B – Basic for the calculations

(informative)

B.1 General

NOTE 1 The proposed criteria in this section of NRS 097-2 have been guided by

a) the approaches used in other countries and utilities, as informed by work within Cigre, and specifically Cigre working group C6.24. The intention is to adopt best practice as already applied in other utilities that have considerable experience with LV connected generators; and

b) the application of specific technical criteria on models that represent typical South African LV networks.

NOTE 2 It is intended that the criteria will be enhanced and revised as more detailed studies are performed in the future and that the industry can learn from the application of these criteria.

B.2 The technical limits that constrain the amount of generation are as follows:

a) thermal ratings of equipment (lines, cables and transformers) may not be exceeded.

b) LV voltage regulation should be within the limits specified in NRS 048-2 (LV voltages at the customer point of supply should be within ± 10%).

c) the maximum change in LV voltage (due to voltage drop/rise in the MV/LV transformer and LV feeders) due to embedded generators is limited to 3%.

d) the fault level at the customer point of supply should be greater than 210 A, or the minimum fault level at which the generator is rated.

B.3 The application of the limits above resulted in the following proposed criteria:

a) Voltage rise on LV feeders should be limited to a maximum of 1%. This value is informed by the NRS 048 voltage limits, MV voltage control practices and the MV/LV transformer voltage ratio and tap settings.

b) Voltage rise across the MV/LV transformer should be limited such that the NRS 048-2 voltage limits are not exceeded. The maximum generation connected to a MV/LV transformer is limited to 75% of the transformer rating understanding that this may result in overvoltage problems on LV feeders where there is further voltage rise. The 75% limit is hence high but in reality the net flow through the transformer into the MV network is expected to be significantly less due to the customer loads. A 75% limit will also ensure that the transformer will not be overloaded during periods of maximum generation and minimum loading.

c) The individual customer limit of 75% of UIC on dedicated LV feeders is informed by the MV/LV transformer limit of 75%. This approach provides customers with equitable access to the available generation capacity as limited by the MV/LV transformer rating. It will also ensure that service cables will not be overloaded under conditions of maximum generation and low loading.

d) The dedicated LV feeder minimum size is based on a maximum voltage rise of 1%.

Annex B
(continued)

e) The individual customer limit of 25% of UIC on shared LV feeders is informed by an analysis of typical LV feeder designs whereby the individual MEC was scaled as a function of the design ADMD and the generation penetration level (percentage of customers that install a generator). The voltage rise and change in voltage were calculated assuming that the installed generation is reasonably balanced (connected to the same phases as the load). Setting the individual customer maximum generation limit requires that the penetration level value be established such that technical limits are complied with. An individual limit of 25% of UIC will typically support a penetration level of 30% to 50%, which is considered a reasonable and acceptable compromise between restricting individual MECs versus restricting penetration levels. It shall be noted that a primary limitation is the maximum voltage change of 3%.

f) The total generation connected to a MV feeder is limited to 15% of the MV feeder maximum loading. This value is informed by practices in the United States and Europe and is based on the ratio of maximum to minimum feeder loading for typical consumer load profiles. A limit of 15% will ensure a low probability of reverse power flow into the MV feeder source, thereby preventing voltage rise in the MV feeder and reducing the possibility of an island for operation of MV switches and protection.

Table B.1 — Calculation of maximum LV voltage rise

1	2	3
Parameter	**Value**	**Comment**
Maximum MV voltage for normal operating condition	104%	This is the typical maximum MV voltage based on normal MV OLTC settings.
Transformer nominal voltage in nominal tap	105.0%	This is the built-in boost of the standard MV/LV transformer in nominal tap i.e., transformers with a nominal secondary voltage of 420 V are installed.
Minimum transformer loading pu no generation	30%	This is the minimum transformer loading as a percentage of the transformer rating, and it is the load at the time of maximum MV voltage.
Maximum generation pu of transformer rating	25%	This is the maximum generation to be connected, as expressed as a percentage of the transformer rated capacity, i.e. 25% would mean that 25 kVA can be connected to a 100 kVA transformer.
Transformer Z	6%	Rated impedance of transformer.
Transformer X/R	5	X/R ratio of transformer.
Maximum LV no load no generation for normal operating	109.2%	This is the calculated maximum LV voltage at the transformer under maximum MV voltage, no load and no generation.
Net transformer loading, minimum load, maximum generation	5%	This is the calculated difference between the minimum load and maximum generation. It assumes that both are at unity power factor. A negative value means that power is flowing back into the MV network.
Transformer R	1.2%	This is the transformer resistance as calculated from the rated impedance and X/R ratio.
Transformer V drop	0.1%	This is the calculated voltage drop over the transformer. Negative value is a voltage rise.
Transformer LV voltage at minimum load, maximum generation	109.1%	This is the calculated maximum LV voltage at the LV terminals of the transformer under the condition of maximum MV, minimum LV load and maximum generation. It should be restricted to 110%.
Maximum LV voltage allowed	110%	In accordance with NRS 048-2.
Maximum LV voltage rise	0.9%	Difference between maximum LV voltage at transformer and maximum limit allowed.

Annex B
(continued)

B.4 The calculated result is 0.9%, but given the uncertainty in the input parameters, a value of 1% is proposed. In accordance with table 5, the application of the 1% voltage rise and maximum generation limit of 75% of the MV/LV transformer size may result in cases of voltage levels in excess of NRS 048-2 limits.

Table B.2 — Calculation of maximum generation connected to a MV/LV transformer

1	2	3
Parameter	**Value**	**Comment**
Maximum MV voltage for normal operating condition	104%	This is the typical maximum MV voltage based on normal MV OLTC settings.
Transformer nominal voltage in nominal tap	105.0%	This is the built-in boost of the standard MV/LV transformer in nominal tap, i.e. transformers with a nominal secondary voltage of 420 V are installed.
Minimum transformer loading pu no generation	0%	This is the minimum transformer loading as a percentage of the transformer rating, and it is the load at the time of maximum MV voltage.
Maximum generation pu of transformer rating	75%	This is the maximum generation to be connected, as expressed as a percentage of the transformer rated capacity, i.e. 50% would mean that 50 kVA can be connected to a 100 kVA transformer.
Transformer Z	6%	Rated impedance of transformer
Transformer X/R	5	X/R ratio of transformer
Maximum LV no load no generation for normal operating	109.2%	This is the calculated maximum LV voltage at the transformer under maximum MV voltage, no load and no generation.
Net transformer loading, minimum load, maximum generation	- 75%	This is the calculated difference between the minimum load and maximum generation. It assumes that both are at unity power factor. A negative value means that power is flowing back into the MV network.
Transformer R	1.2%	This is the transformer resistance as calculated from the rated impedance and X/R ratio.
Transformer V drop	- 0.9%	This is the calculated voltage drop over the transformer. Negative value is a voltage rise.
Transformer LV voltage at minimum load, maximum generation	110.1%	This is the calculated maximum LV voltage at the LV terminals of the transformer under the condition of maximum MV, minimum LV load and maximum generation. It should be restricted to 110%.
LV voltage rise in LV feeder	1%	Maximum allowed LV feeder voltage rise (see table 4)
Maximum LV voltage	111.1%	Maximum LV voltage due to voltage rise in MV/LV transformer and LV feeder

B.5 At a generation level of 75% of the MV/LV transformer rating, the maximum LV voltage at the MV/LV transformer LV terminals rises to 110.1% which is at the upper limit of 110%. If the LV voltage is allowed to rise by a further 1% in the LV feeders, then the maximum LV voltage is 111.1% which is above the NRS 048-2 limit. However, in reality there will be load that will reduce the effect of the voltage rise. As such, a generation limit of 75% is proposed, noting that in some situations the voltage limit will be exceeded, and remedial action will be necessary.

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VDE-AR-N 4105, *Generators connected to the low-voltage distribution network – Technical requirements for the connection to and parallel operation with low-voltage distribution networks.*