

Network Standard

Document No.

NS194

Title:

Embedded generation

Approved Date	6/09/2023	Revision	3	
Lifecycle Stage	Design	Internal Use	<input checked="" type="checkbox"/>	External Use <input checked="" type="checkbox"/>
Technical Approver		Authorised By		
Name	Glenn Cooper	Name	Brett Hawkeswood	
Designation	Control and Protection Engineering Manager	Designation	Head of Engineering	

Revision

No	Date	Description	Technical Approver	Authorised By
0	3/10/2018	Initial	Manager Secondary Systems	Head AEP&S
1	17/12/2021	Conversion to new template and inclusion of new requirements from AS/NZS 4777.2 2020	Glenn Cooper	Brett Hawkeswood
2	6/09/2023	Remove requirement for installation inspector to inspect every IES prior to permanent electrification.	Dean Starkey	Glenn Cooper
3	30/03/2026	Updated to reflect changes in AS/NZS 4777.1:2024. Restructured to group by size of system. Fully separated inverter-based systems from rotating machinery, which is now in NS194B.	Matthew Cupples	Evan Riddell

DISCLAIMER

This document is bound to the conditions set out in NS002 Network Standards Disclaimer.

Ausgrid maintains a copy of this and other Network Standards together with updates and amendments online at www.ausgrid.com.au. This document is considered uncontrolled once printed.

Table of Contents

Scope	3
Reference Documents	3
Ausgrid Documents	3
Other Standards and Documents	3
Acts and Regulations	4
1 Fault Levels, Loading and Scheduling	5
2 Sydney CBD Network	5
3 Standby Generators	5
4 Registered Generators	5
5 Inverter Energy Systems	5
6 Rotating Machines	7
7 Anti-Islanding protection	7
8 Protection Design Review and Commissioning	10
9 Earthing	12
10 Multiple Embedded Generator Systems	12
11 Alteration to Approved Design	13

List of Annexures

Annexure A: IES Protection Summary	A-1
Annexure B: Rotating Machine Protection Summary	B-2
Annexure C: Protection Set Point Limits	C-3
Annexure D: Concept Design Pack (for > 200 kVA IES and Rotating Machines)	D-4
Annexure E: Detailed Design Pack	E-5
Annexure F: Instrument Transformer Requirements	F-6
Annexure G: Examples of Residential Cluster Installations	G-7
Annexure H: Examples Single Line Diagrams	H-9
Annexure I: Multi-tenanted Site Examples	I-12

Scope

This document outlines the requirements for connecting embedded generation to the Ausgrid network. Embedded generators are capable of being connected in parallel to Ausgrid's network and may include inverter energy systems (such as solar PV and batteries), as well as rotating machines (such as synchronous and asynchronous turbines/alternators).

The primary focus of this standard is on anti-islanding protection requirements, along with select other technical requirements related to protection such as voltage and power quality control. Requirements vary depending on generator type and rated capacity.

This standard also covers earthing requirements for embedded generators and establishes the technical review and approval requirements based on the type of generator connection.

Short circuit protection systems for embedded generators are not covered in this standard; for those requirements, refer to AS/NZS 3000, the NSW Service & Installation Rules and the National Electricity Rules.

Standby generators which will never operate in parallel with the Ausgrid's network are covered in Section 8.3 of the NSW Service & Installation Rules and AS/NZS 3010 Electrical Generating Sets Safety. No additional requirements are outlined for standby generators.

This standard defines specific requirements for the connection of Inverter Energy Systems (IES) to the Ausgrid network, including variations or additions to AS/NZS 4777.1 and AS/NZS 4777.2. However, the AS/NZS 4777.1 and 4777.2 standards do not apply to rotating machines

Reference Documents

All work covered in this document must conform to all relevant Legislation, Standards, Codes of Practice and Network Standards.

Ausgrid Documents

Ausgrid Deemed Standard Connection Contract

Ausgrid Universal Connection Contract

Negotiated Ongoing Connection Contract: Embedded Generators

NS116 Design Standards for Distribution Earthing

NS194B Guidelines for Rotating Machines Connected to Ausgrid Network

NS238 Supply Quality

Other Standards and Documents

AS 2467:2008 Maintenance of electrical switchgear

AS/NZS 3000:2018 Electrical installations

AS/NZS 3835 Earth potential rise – protection of telecommunication network users, personnel and plant

AS/NZS 4853 Electrical hazards on metallic pipelines

AS/NZS 4777.1:2024 Grid connection of energy systems via inverters

Part 1: Installation requirements

AS/NZS 4777.2:2020 Grid connection of energy systems via inverters

Part 2: Inverter requirements

AS/NZS 5139:2019 Electrical installations – Safety of battery systems for use with power conversion equipment

Australian Clean Energy Council website (<https://www.cleanenergycouncil.org.au>)

ENA DOC 025-2010 EG-0 Power System Earthing Guide Pt 1: Management Principles

ENA Guideline for the preparation for connection of Embedded Generation within Distribution Networks – 2011

IEC 60255 Measuring relays and protection equipment – multiple parts

IEC 61869-3 Instrument transformers – Part 3: Additional requirements for inductive voltage transformers

National Electricity Rules

Service & Installation Rules of NSW.

Acts and Regulations

Electricity Supply (General) Regulation 2014 (NSW)

Electricity Supply (Safety and Network Management) Regulation 2014

Work Health and Safety Act 2011 and Regulation 2017

Clause Standard Requirements**1 Fault Levels, Loading and Scheduling**

- 1.1 Ausgrid shall prohibit the connection of a generator where Ausgrid's network may become compromised under high-fault level or abnormal conditions or curtail the generation level to ensure Ausgrid's network is not overloaded.
- 1.2 In some locations, connection may be allowed with the additional provision of a control signal from Ausgrid that results in the generating unit being either taken off-line (i.e. a 'soft-trip') or inhibited from starting up. Also see Clause 7.7– Inter-tripping (and Communications Link).
- 1.3 Upon assessment of the proposed connection, Ausgrid will advise the proponent if any fault level or loading issues exist whereby scheduling may be required as part of the installation.

2 Sydney CBD Network

- 2.1 It is unlikely large rotating machine generators can be connected to Ausgrid's Sydney CBD triplex network due the fault level contribution. Generator proponents shall consult with Ausgrid early in the connection planning process to investigate feasibility of generator connections in Sydney CBD.

3 Standby Generators

- 3.1 Where standby generation and transfer switch is installed upstream from an inverter energy system the installation or control system shall be designed to prevent the inverter energy system synchronising with the standby generator.
- 3.2 Standby generation that cannot parallel with the Ausgrid network (such as systems that use break-before-make contacts) do not require a connection application to be submitted to Ausgrid.
- 3.3 Standby generators which are paralleled with Ausgrid's network for a short time before the installation is disconnected from the grid shall comply with Section 8.4 of the NSW Service & Installation Rules as Synchronise Close Transfer Trip (SCTT) generators (sometimes referred to as bumpless transfer generators, or short time transfer generators). SCTT generators that parallel with the grid for greater than 1s shall be assessed as parallel generation under this standard.
- 3.4 For SCTT generators above 30 kVA a technical review by Ausgrid is required to confirm that the possible fault level contribution will not result in equipment ratings being exceeded in the surrounding network.

4 Registered Generators

- 4.1 For generators intended to connect to the Ausgrid network under the NER Chapter 5 framework, subject to a detailed application and offer to connect, the installation (point of connection/private installation incoming supply) may be required to comply with this Network Standard where not in conflict with Schedule 5.2 of the NER.

5 Inverter Energy Systems**5.1 General**

- 5.1.1 Inverter Energy Systems (IES) are comprised of one or more power sources (e.g. solar PV, wind energy or batteries) connected through one or more inverters to the same electrical installation. IES to be connected to Ausgrid's network shall be compliant with AS/NZS 4777.1., Inverters shall be approved by the Clean Energy Council or otherwise have explicit written approval from Ausgrid. A list of Clean Energy Council approved equipment can be found at: <https://cleanenergycouncil.org.au/industry-programs/products-program/inverters>. Designers and installers of IES systems shall be accredited by Solar Accreditation Australia (SAA).

5.2 Inverter power quality settings

5.2.1 Inverter power quality settings shall be enabled and configured in accordance with AS/NZS 4777.2

5.2.2 The Region setting shall be set to “Australia A”. For all other modes and operation that are not covered by a regional setting then default settings of AS/NZS 4777.2:2020 apply.

5.3 Single phase IES

5.3.1 Up to 30 kVA of total inverter capacity (including AC-coupled battery inverters) may be connected to a single phase supply point, but export to the grid shall be limited to 10 kW (varying from the 5 kW indicated in AS/NZS 4777.1:2024 Appendix C.2).

5.3.2 A design shall be provided with the connection application showing how export limiting will be configured.

5.3.3 The above variation also applies to single phase child metered connections within an embedded network, with the export beyond the child meter not to exceed 10 kW.

5.4 Interface protection – general requirements

5.4.1 Where interface protection is required by AS/NZS4777.1:2024 for IES up to 200 kVA, the protection requirements shall be as per requirements of that standard.

5.4.2 All IES with an aggregate inverter capacity of greater than 200 kVA connected to a single network supply point shall use interface protection, unless exempt under section 5.5.

5.4.3 Interface protection for sites greater than 200 kVA shall be set as per the requirements of Clause 7 Anti-Islanding protection and Annexure A: IES Protection Summary.

5.4.4 Interface protection shall obtain its measured input values (e.g. voltage, current) upstream (i.e. closer to the point of connection) than all inverters connected at the electrical installation.

5.4.5 The IES or interface protection shall be designed to prevent synchronisation with island generation sources (e.g. standby generation).

5.4.6 Suitable test and isolation links shall be provided on all inputs and outputs of the interface protection device or devices to allow secondary injection testing without the need to disconnect and then re-terminate wires.

5.5 Interface protection – Residential Clusters

5.5.1 A Residential Cluster refers to a group of residential premises connected to a single network supply point and includes embedded networks and multi-NMI sites that share a network connection. They are typically comprised of lifestyle or retirement villages, standalone houses on community title, townhouses, units, villas or multi-dwelling units, or other residential embedded networks.

5.5.2 Interface protection is not required for an individual installation within a Residential Cluster if:

- The installation is residential and part of a cluster sharing a common Ausgrid low voltage supply point; and
- The installation has independent retail metering or child metering and its own switchboard; and
- The aggregate inverter capacity behind the independent metering is no more than 30 kVA; and
- All inverters behind the independent metering comply with AS/NZS 4777.2:2020; and
- Upon exceeding 200 kVA inverter capacity, export limiting behind the independent meter shall be commissioned for all new and upgraded sites connected to a single network supply point. The limit shall be set to no more than 10 kW per phase (or an alternate value if required by Ausgrid). Once commissioned, the export limit shall have the ability be adjustable down to zero through a software settings change.

- 5.5.3 Interface protection shall be implemented for individual installations within a Residential Cluster where:
- The aggregated inverter capacity behind the common supply point exceeds 200 kVA; and
 - The individual installation aggregate inverter capacity exceeds 30 kVA.
- 5.5.4 Ausgrid, at its sole discretion, may specifically require interface protection to be installed at a site regardless of the conditions above being satisfied.
- 5.5.5 Examples of Residential Cluster installations and how these rules are applied are given in Annexure G:.
- 5.6 [Sites greater than 30 kVA and no more than 200 kVA inverter capacity which choose to export limit to 30 kW or less](#)
- 5.6.1 Sites with up to 200 kVA of connected inverter capacity, that limit export to no more than 30 kW will not require a network capacity assessment.
- 5.6.2 If more than 30 kW can be exported from a site, Ausgrid will need to complete a network capacity assessment for any network supply point that will have, a total IES capacity of more than 30 kVA connected.

6 Rotating Machines

6.1 General

- 6.1.1 In the first instance, synchronous and asynchronous rotating machines to be connected to Ausgrid's network shall comply with the protection requirements of the Service and Installation Rules of NSW, Section 8 – Alternative Sources of Supply.
- 6.1.2 For additional guidance on the connection of rotating machine generators, see NS194B - Guidelines for Rotating Machines Connected to the Ausgrid Network.
- 6.1.3 For embedded rotating generators of above 30 kVA, Ausgrid's requirements for anti-islanding protection shall apply as per Chapter 7 – Anti-Islanding Protection, and Annexure B: – Rotating Machine Protection Summary.

6.2 Check synchronisation

- 6.2.1 Synchronous machines shall only be able to be paralleled to Ausgrid's network if their control device performs Check Synchronisation (CS) to verify the machine is in synchronism with Ausgrid's network. See also Section 7.10– Connection, Reconnection and Synchronisation.

7 Anti-Islanding protection

7.1 General

- 7.1.1 The following anti-islanding protection design requirements are applicable to all Inverter Energy Systems of greater than 200 kVA (except for those exempt from interface protection in section 5.5), and for all rotating machines of greater than 30 kVA in accordance with Annexure A: – IES Protection Summary, and Annexure B: – Rotating Machine Protection Summary.
- 7.1.2 Embedded generation anti-islanding protection shall be designed to prevent parallel generation from synchronising with island generation sources e.g. standby generation.

7.2 Redundancy and circuit breaker fail

- 7.2.1 The anti-islanding protection system shall include sufficient redundancy to ensure that the generator/s disconnect from the network with any single protection element out of service. This may include but is not limited to relays, circuit breakers, and power supplies.
- 7.2.2 This will typically require 'Main' and 'Backup' protection schemes. The system shall also make allowance for Circuit Breaker Fail (CBF) scenarios in their design.
- 7.2.3 CBF protection may be achieved by having the Main and Backup schemes operate independent circuit breakers/contactors. See also Section 7.9– Fail-Safe.
- 7.2.4 AS4777.2 compliant inverters are considered to provide the 'Main' protection.
-

- 7.2.5 Main and Backup anti-islanding protection should disconnect the generator only, and not isolate other loads in the electrical installation.
- 7.3 **Voltage and frequency limits**
- 7.3.1 Ausgrid's allowable ranges for voltage and frequency elements for Inverter Energy Systems and rotating machines are detailed in Annexure C: – Protection Set Point Limits.
- 7.3.2 Suitable voltage settings for HV operating generators must be negotiated on a case-by-case basis.
- 7.3.3 For HV connections, sustained overvoltage protection is not required to protect Ausgrid's network.
- 7.4 **Export embedded generators**
- 7.4.1 For generators that are intended to export power to Ausgrid's network, refer to the requirements of Annexure A:, Annexure B: and Annexure C:.
- 7.4.2 Inter-tripping is the preferred anti-islanding protection (see also Section 7.7) for export embedded generators and may be mandated as a requirement for some sites as part of a technical review by Ausgrid¹.
- 7.5 **No-export embedded generators**
- 7.5.1 For generators which are not intended to export power to Ausgrid's network, refer to the requirements of Annexure A:, Annexure B: and Annexure C:.
- 7.5.2 Duplicate Low Forward Power or Inter-trip is the preferred anti-islanding protection for no-export embedded generators.
- 7.5.3 Settings and details of Grid Low Forward/Reverse Power protection must be negotiated with Ausgrid on a case-by-case basis².
- 7.6 **Neutral voltage displacement**
- 7.6.1 Embedded generator installations with a HV connection point to Ausgrid's network with generation greater than 30 kVA for rotating machine or 200 kVA for IES should implement Neutral Voltage Displacement (NVD) protection.
- 7.6.2 Neutral Voltage Displacement shall use Voltage Transformers (VT's) connected at the High Voltage connection point voltage. (i.e. 11kV for an 11kV connection). Particular attention is needed to confirm that the VT's are of the correct configuration/type for use with this form of protection.
- 7.6.3 Refer to Annexure F for Voltage Transformer technical requirements when used for NVD protection.
- 7.6.4 Suitable NVD settings shall be negotiated with Ausgrid on a case-by-case basis. Refer to Annexure C: Protection Set Points Limits.
- 7.6.5 For embedded generator installations with a low voltage connection point, NVD is typically not required. Where NVD is identified as a site specific condition by Ausgrid as part of technical review the location and responsibility of installing VTs shall be negotiated during the assessment process.
- 7.7 **Inter-tripping (including Communications Link) between Ausgrid and Customer**
- 7.7.1 Where inter-tripping is the anti-islanding protection, it shall be appropriate for all credible islanding scenarios as determined by Ausgrid.
- 7.7.2 Inter-tripping shall meet the requirements of fail-safe as per Clause 7.9.

¹ If the proponent implements Vector Shift and ROCOF protection, they must accept that the anti-islanding protection may trip for system disturbances and fault events both within and external to the local network that the generator is connected to. Experience has shown setting of these schemes to be difficult to avoid nuisance tripping while providing adequate protection.

² Grid Reverse Power Protection is not the same as Generator Reverse Power Protection.

- 7.7.3 A communications link shall be continuously monitored for integrity.
- 7.7.4 In the event that the communication link fails, the generator shall be automatically disconnected within 1 second and remain disconnected until the link is restored.
- 7.7.5 Inter-tripping and communications between Ausgrid and the generator facility shall be provided over dedicated dark fibre cores.
- 7.8 **Inter-tripping and Communications within a Generator Facility**
- 7.8.1 Where the customer is using communications to provide remote tripping to meet the requirements of this standard, this shall be fail safe in accordance with Clause 7.9.
- 7.8.2 In the event that the communication link fails then the generator shall be automatically disconnected within 2 seconds and remain disconnected until the link is restored.
- 7.8.3 A relay trip signal to a remote contactor/CB over communications link shall be via a dedicated signal, i.e. cannot trip the remote CB/contactor by disrupting the comms and waiting for the loss of comms operation.
- 7.9 **Fail-Safe**
- 7.9.1 Relay power supplies, tripping, communications link and circuitry associated with the anti-islanding protection systems shall be fail safe. That is any failure of any part of the system shall result in the generator being disconnected and unable to be re-connected to Ausgrid's network.
- 7.9.2 Circuit breakers with shunt trips shall not be used. Where AC (or DC) supplies are proposed to be used, normally open contactors held in by healthy AC (or DC) volts or undervoltage release of circuit breakers on loss of AC (or DC) supply, relay fail and system fail shall be required.
- 7.9.3 Alternate arrangements to clause 7.9.1 and 7.9.2 will be considered providing the following 2 points are met.
- The proponent has an approved Installation Safety Management Plan.
 - Requirements for the ongoing inspection, maintenance and testing of the network and anti-islanding protection systems are specified within the Connection Agreement.
- 7.10 **Connection, reconnection and synchronisation**
- 7.10.1 The device controlling generator connection to the grid shall verify normal supply conditions on the grid for all connected phases (i.e. all three phases for a three phase connection) for a period of at least 1 minute prior to the device enabling connection.
- 7.10.2 Synchronisation or zero voltage on the generator side of the switching point shall be confirmed before the generator is paralleled to Ausgrid's network. When these conditions are met, automatic reconnection is permitted.
- 7.10.3 Where there are multiple points of automatic reconnection in the installation, each point shall independently monitor and verify normal supply conditions on the grid for all connected phases for a period of at least 1 minute before enabling automatic reconnection.
- 7.10.4 Where a manual reset has been nominated as required by Ausgrid, the generator will not be allowed to be automatically reconnected to the network. Ausgrid will negotiate the requirements of these proposals on a case by case basis with the proponent.
- 7.11 **Relay requirements**
- 7.11.1 Relays used to meet the requirements of Section 7 of this standard shall be approved by Ausgrid. A list of pre-approved relays and their available functions can be found on Ausgrid's website 'NS194 Approved Protection Relay List'.
- 7.11.2 For HV connected installations, at least one layer of protection (backup or main) shall be compliant with the appropriate severity class of IEC 60255.
- 7.12 **Testing and verification facilities**
- 7.12.1 Inputs and outputs of anti-islanding protection relays shall be provided with suitable facilities to allow secondary injection testing of the relay to be undertaken without the need to disconnect and re-terminate wires. This includes:
-

- Isolation links on protection relay AC measurement inputs,
- Isolation links in series with protection relay contact outputs,
- Test injection and measurement points compatible with 4 mm banana plugs. Measurement points must be available on both sides of relay contacts, and
- Separate relay fail contact to allow testing

- 7.12.2 All protection cabling shall be appropriately labelled, and the labels shall corroborate with all drawings and documentation provided in the Protection Design Pack.
- 7.12.3 Anti-islanding devices that are to undergo secondary injection testing shall also be capable of indicating locally what protection element has operated – this can be done via Human Interface Devices such as screens, LEDs or via a locally connected computer.
- 7.12.4 Prior to the installation being energised, it shall be possible to check the operation of any CBs & contactors operated by the anti-islanding protection. This is to be done without the generator/IES being in operation.

8 Protection Design Review and Commissioning

8.1 General

Ausgrid has different requirements for anti-islanding protection design review and commissioning depending on the embedded generator size and type. The following review and testing requirements are in addition to testing to applicable Australian Standards and the Service & Installation Rules of NSW.

8.2 Embedded generation of 30 kVA or less

System design is not requested by Ausgrid for review. Installation inspection is conducted on Audit basis.

8.3 IES of greater than 30 kVA and less than or equal to 200 kVA

8.3.1 Design approval

8.3.1.1 The design shall be produced in accordance with AS/NZS 4777.1, and this standard (NS194).

8.3.1.2 Where interface protection is required, a complete Protection Design Pack (see Annexure E – Protection Design Pack) shall be submitted as part of the connection application for record keeping and auditing.

8.3.2 Commissioning

8.3.2.1 In addition to all testing and commissioning requirements of AS/NZS 4777.1, and AS/NZS 4777.2, secondary injection testing of the interface protection relay shall be carried out on-site to confirm the system meets the requirements of this standard, including but not limited to failsafe, tripping logic, and protection element accuracy.

8.3.2.2 The secondary injection testing shall be carried out by a qualified electrical tester with calibrated test equipment, and the results shall be recorded in a test report along with the results of testing detailed in AS/NZS 4777.1, 7.6 – Commissioning.

8.3.2.3 The test report shall be signed by the qualified electrical tester. This report shall be provided to Ausgrid for record keeping.

8.3.3 Inspections and compliance auditing

8.3.3.1 Ausgrid reserves the right to audit any designs and testing used for embedded generation connection to its network. In accordance with Ausgrid's Customer Installation Safety Plan an embedded generator may be inspected for electrical safety, compliance with the relevant standards and consistency with supplied design information at any time.

8.3.3.2 Where a major defect is identified, the IES shall be disconnected until the defect is rectified and the installation is reinspected to the satisfaction of Ausgrid. Where a minor defect is identified Ausgrid's standard defect process shall be followed.

8.3.3.3 If reinspection of an IES is required, it will incur a reinspection fee in accordance with Ausgrid's Alternative Control Services Fee Schedule.

8.4 IES of above 200 kVA (where interface protection is required) and rotating machines above 30 kW

8.4.1 Conceptual approval

8.4.1.1 As part of the application for connection, a Conceptual Design Information Pack is required to be submitted to Ausgrid to define the generator connection details and demonstrate how it complies with this standard.

Refer to Conceptual Design Information Pack (see Annexure D:)

8.4.2 Design approval

8.4.2.1 Following receipt of the proponent's complete Protection Design Pack (see Annexure E:), Ausgrid will conduct a technical review to confirm compliance with this standard, and to identify the need for any site specific conditions.

8.4.3 Commissioning

8.4.3.1 Following design approval, the proponent shall provide Ausgrid with an appropriate test plan to be used for commissioning. Ausgrid must inform the proponent if the plan is adequate, or if any changes are needed to confirm that the generator's anti-islanding protection systems are adequately tested.

8.4.3.2 The proponent shall arrange with Ausgrid for an Ausgrid representative to be present for all testing relating to the anti-islanding protection. The testing shall include at a minimum:

- Secondary injection testing of relay logic, failsafe, and set point accuracy,
- Correct operation of all disconnection devices (tested prior to generator connection to the grid),
- Scheme logic, synchronisation, and reconnection procedure, and
- Primary anti-islanding testing in accordance with Clause 8.5.

8.4.3.3 Proponents shall allocate sufficient time to allow test plan review and resource allocation by Ausgrid. Ausgrid accepts no liability or warranty for any designs or equipment as part of the design approval or witness testing process.

8.5 Primary Anti-islanding testing

8.5.1 Primary anti-islanding testing is required to confirm the adequacy of the Vector Shift and ROCOF settings.

8.5.2 The requirements of primary anti-islanding testing will depend on the characteristics of the generator and the electrical installation. Proponents should note that primary anti-islanding testing will often require the switching of a significant amount of active load, which may necessitate disruptions to normal electrical supply in the electrical installation. For example, opening off the generator installation from the Ausgrid network to simulate a 'real world' event.

8.5.3 Details on all primary anti-islanding testing configurations and requirements are to be discussed and agreed with Ausgrid.

8.5.4 Where primary testing of anti-islanding testing does not confirm positive operation, more sensitive Vector Shift and/or ROCOF settings may be required.

9 Earthing

9.1 General

- 9.1.1 The proponent is required to demonstrate that the generator installation has an earthing system that has been designed to limit any step, touch and transferred potentials to safe values using the principles detailed in “ENA DOC 025-2010 EG-0 Power System Earthing Guide Pt1: Management Principles”.
- 9.1.2 Equipment used to interface to the distribution network (e.g. step up transformer or circuit breaker) shall comply with NS116 – Design Standards for Distribution Earthing.
- 9.1.3 Additionally, the earthing system of the Generator shall be designed to limit the voltages impressed onto surrounding utility infrastructure under earth fault conditions. For metallic pipelines the tolerable voltages (or acceptable assumptions to determine them) are presented in AS/NZS 4853 and for telecommunications assets the voltage limits should comply with AS/NZS 3835.
- 9.1.4 Generation schemes working in parallel with the distribution network in effect become an integral part of the electricity distribution network. Therefore, neutral earthing arrangements for the private generators and any interconnection transformers shall be designed to suit the requirements of both the distribution network and the electrical installation and details provided to Ausgrid.

9.2 Low voltage generators

- 9.2.1 Generators connected to the network via a delta/star transformer with the delta on the network side may have their neutral directly connected to earth (i.e. via an MEN link).
- 9.2.2 Effective isolation of this neutral may be required to inhibit the flow of harmonics through the neutral and the generator’s method to limit harmonics may be discussed and agreed to by Ausgrid. The use of 4-pole switching may be required if the generator can operate in standby mode.

9.3 High voltage generators

- 9.3.1 The generator’s high voltage star point shall be effectively isolated from earth (i.e. isolated or earthed via a high impedance) to avoid any earth fault contributions flowing into the Ausgrid system and to inhibit the flow of harmonic currents through the neutral. Each case will be discussed with the proponent on its merits.

10 Multiple Embedded Generator Systems

10.1 Mixed embedded generator systems

- 10.1.1 Where a combination of embedded IES and rotating machines are connected at an electrical installation, they shall meet the requirements of this standard for the respective generator type of capacity equal to the total nameplate rating of all embedded generator types connected there³.

10.2 Centralised backup protection

- 10.2.1 Where multiple generator units are embedded in an electrical installation with a total capacity of greater than 30 kVA, there shall be at least one layer of anti-islanding protection meeting the relevant requirements of this standard (Clause 5.4 for IES of up to 200 kVA or Section 7 for other types), the operation of which results in the disconnection of all embedded generators in the electrical installation.

10.3 Existing embedded generators

- 10.3.1 Where an electrical installation already has embedded generation installed, and new generating sources are proposed to be connected, the entire installation shall comply with this standard. This may require upgrading or retrofitting existing protection systems.

³ For example, if a 150 kVA rotating machine is to be connected to an electrical installation which already has a 60 kVA IES installed, the anti-islanding protection for the rotating machine and IES must meet the requirements of this standard for a rotating machine greater than 200 kVA, and an IES greater than 200 kVA, respectively.

11 Alteration to Approved Design

- 11.1 The premises owner or occupier shall not modify the approved design, change protection equipment or protection settings of the embedded generator equipment without informing and receiving prior written authorisation from Ausgrid.
- 11.2 Upon receipt of a written request to modify the approved design and/or settings, Ausgrid will advise the proponent if it is considered necessary to undertake a new technical assessment on the impact on Ausgrid's network.
- 11.3 If a new technical assessment is required then it will be charged in accordance with Ausgrid's alternative control services fee schedule.

Annexure A: IES Protection Summary

A1 Table A1: IES greater than 200 kVA protection requirements

Backup Protection and Associated Requirements	Reference Section
Mandatory backup protection requirements	Annexure C and
Neutral Voltage Displacement (For HV connections only)	7.6
Under voltage and Overvoltage	As per 4777.1
Under frequency and Over frequency	As per 4777.1
At least 1 of the following 4 backup anti-islanding protections	
Grid Reverse Power	7.5
Grid Low Forward Power	7.5
Inter-tripping	7.7, 7.8
ROCOF and Vector Shift (Note 1)	7.4

¹ If Vector Shift and ROCOF protection are implemented, it must accept that the anti-islanding protection may trip for system disturbances and fault events both within and external to the local network that the generator is connected to. Experience has shown setting of these schemes to be difficult to avoid nuisance tripping while providing adequate protection.

Annexure B: Rotating Machine Protection Summary

B1 Table B1: Rotating machines greater than 30 kVA protection requirements

Protection and Associated Requirements	Reference Section
Mandatory Protection Requirements	
Neutral Voltage Displacement (For HV connections only)	7.6
Duplicate Under voltage and Overvoltage	7.3
Duplicate Under frequency and Over frequency	7.3
Check Synchronisation*	7.10
At least 1 of the below sets of anti-islanding protections	
Grid Low Forward Power (main) and Grid Reverse Power (backup) implemented in separate relays.	7.5
Duplicate Grid Low Forward Power implemented in separate relays	7.5
Inter-tripping	7.7, 7.8
Duplicate ROCOF and Vector Shift (Note 1)	7.4

* Asynchronous machines do not require synchronising facilities.

¹ If Vector Shift and ROCOF protection are implemented, it must accept that the anti-islanding protection may trip for system disturbances and fault events both within and external to the local network that the generator is connected to. Experience has shown setting of these schemes to be difficult to avoid nuisance tripping while providing adequate protection.

Annexure C: Protection Set Point Limits

C1 The following table defines the outer limits that will be considered acceptable for Main or Backup anti-islanding protection. Set-points may be chosen as required to suit the proponent's generator/installation within these limits. Tested accuracy should be based on manufacturer's specification, however it must not exceed +/- 2% for voltage based elements, +/- 1% for Under frequency and Over frequency elements, and +/- 5% for time delays (smaller accuracy tolerances may be required in some instances for grading purposes).

Appropriate settings for HV OV/UV protection must be negotiated with Ausgrid when required.

Main protection settings are to be at least as sensitive and at least as fast as the Backup protection settings.

Table C1: Protection elements and set point limits

Protection Element	Pickup	Delay
Rotating Machines		
Over Voltage (OV)	265 V	2 s
Under Voltage (UV)	180 V	2 s
Over Frequency (OF)	52 Hz	2 s
Under Frequency (UF)	47 Hz	2 s
All generator types as required		
Rate of Change of Frequency (ROCOF) for IES greater than 30kVA and less than 200kVA	As per AS/NZS 4777.2 Clause 4.5.6	
Rate of Change of Frequency (ROCOF) for IES greater than 200 kVA and Rotating machines	1 Hz/s	1 s
Vector Shift (VS) for IES greater than 200 kVA and Rotating machines	8 degrees (strong/urban network)	0 s
	12 degrees (weak/rural network)	
Grid Reverse Power (GRP)	Negotiated during assessment	
Grid Low Forward Power (GLFP)	Negotiated during assessment	
Neutral Voltage Displacement (NVD)	10%-20% of Phase to Neutral Voltage	2s

Annexure D: Concept Design Pack (for > 200 kVA IES and Rotating Machines)

D1 A Conceptual Design Information Pack must be supplied as part of the connection process to facilitate a conceptual review of the proposed generator connection.

The Conceptual Design Information Pack does not replace the need for a Detailed Design Pack as per Annexure E: to be provided for approval of the connection.

The Conceptual Design Information Pack must include.

- A statement on whether the generator will operate in parallel with Ausgrid's network, including details on.
 - If the connection will be a Synchronised Closed Transfer Trip arrangement as per Section 8.4 of the NSW Service and Installation Rules, including the frequency and duration of paralleling
- Confirmation on whether the generator is a rotating machine or Inverter Energy System connection
- A statement confirming whether the generator is intending to export
- Single Line Diagram detailing.
 - Generator size and location
 - Synchronisation points
 - Location of all CTs and VTs and CB's providing the protection required to meet the requirements of this standard
 - The connection of VTs, CTs to relay and tripping sequence of relays being proposed to meet the requirements of this document
 - Clear identification of 'A' and 'B' or 'No.1' and 'No.2' protection where the protection is required to be duplicated
 - Clear identification of the back-up protection locations for IES connection, including CT, VT and tripping arrangement
 - Specification, ratio and class of CTs and VTs being used for protection requirements of this documents
- List of protection functions being proposed to meet the requirements of this standard, referring to Annexure A or Annexure B including the make and model of each relay
- If Inter-tripping is used as the anti-islanding protection, clear statement and identification of how the inter-trip and communications link will meet the requirements of fail safe in Section 8.8.
- A description on the proposed modes of operation of the generator
- Details of any existing generators connected to Ausgrid's network within the same connection point

Annexure E: Detailed Design Pack

- E1 The following anti-islanding protection details and drawings must be submitted to Ausgrid for all embedded generation connections greater than 30 kVA:
- Single Line Diagram
 - A 3 phase AC schematic diagram of protection and control systems. Main and backup protection set-points should also be tabled on this drawing for ease of comparison (this includes relevant inverter set-points).
 - DC schematic diagram (where applicable) of all protection schemes and associated logic.
 - Details of primary and secondary interfaces to the network.
 - Details of all protection and metering CTs and VTs, including:
 - Connections to protection relays and other equipment.
 - Available ratios (eg 1000-500/1).
 - Connected ratio (eg 500/1).
 - Class (eg 10P20, 5 VA on 500/1)
 - Applicable standard (eg AS1675, AS60044.1, AS60044.2).
 - Details of the protection relay(s) being proposed, including:
 - Manufacturer.
 - Full model number / order code showing selected options.
 - Full settings list of all configurable set-points as intended to be programmed.
 - Details of all circuit breakers and contactors which form part of the scheme, including:
 - Manufacturer.
 - Model number.
 - Coil burden(s).
 - Continuous contact rating.
 - Fault break rating (circuit breakers).
 - Inverter details (if used), including at a minimum:
 - Manufacturer.
 - Model number.
 - Compliance with AS/NZS4777.2 and any adjusted settings.

It must be possible from review of the Detailed Design Pack to determine the full behaviour of the scheme without ambiguity. The relationship between protection device inputs, protection device elements, protection device output contacts and switchgear must be clear and readily apparent.

All drawings must be appropriately titled, revision controlled, and marked with the name and contact details of the responsible suitably qualified person.

Annexure F: Instrument Transformer Requirements

F1 Magnetic Voltage Transformers as per IEC.61869-3:

Voltage transformers used for Neutral Voltage Displacement must meet the following criteria;

- Ratio: Primary Voltage/110V (line to line voltages), For example on an 11kV system, 11,000V/110V.
- Protection class VT (3 x single-phase or 5 limb 3-phase),
- Rated accuracy class \leq 5%, e.g. 3P,
- Rated voltage factor of 1.9 for isolated neutral systems; and
- Rated burden that is suitable for the relay installation (including secondary wiring, etc).

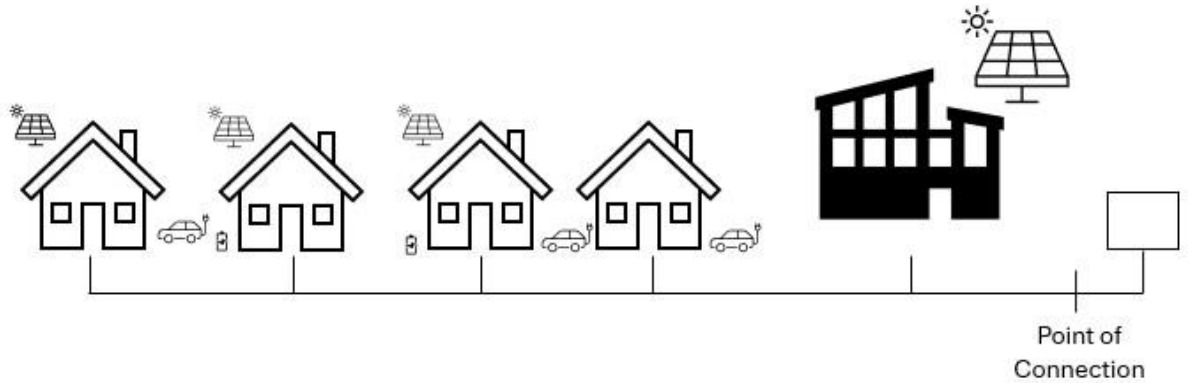
F2 Current Transformers as per IEC.61869-3:

Current transforms for Low Forward Power and Reverse Power Protection must meet the following criteria;

- Metering Class with 5% accuracy

Annexure G: Examples of Residential Cluster Installations

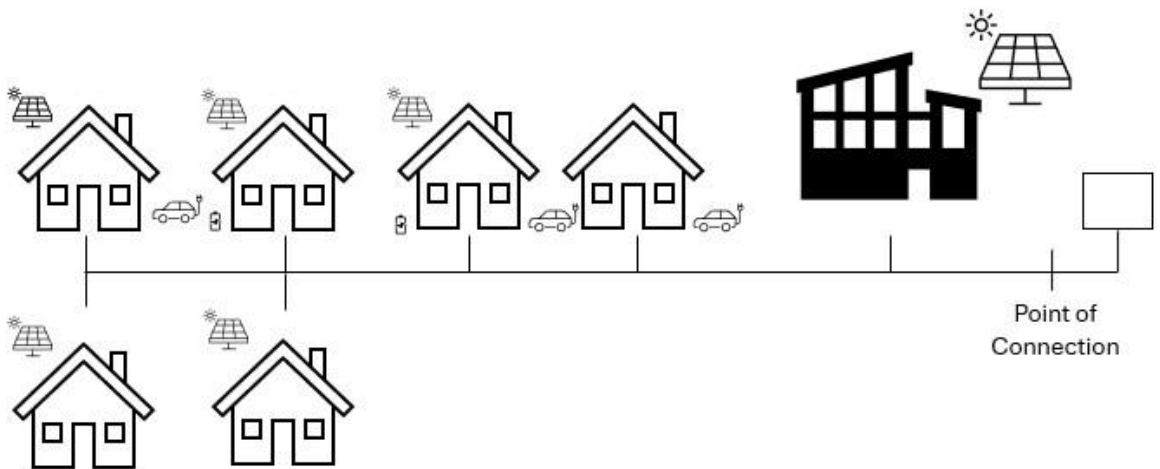
G1 4 x 30 kVA IES systems comprising of solar, batteries or V2G. 1 x 50 kVA system (such as a club house).



Total = 170 kVA inverter capacity and hence Assessed as <200 kVA

No requirement for interface protection under NS194 or AS4777.1 on any system

G2 6 x 30 kVA IES systems comprising of solar, batteries or V2G. 1 x 50 kVA system (60 kVA added to example G1)



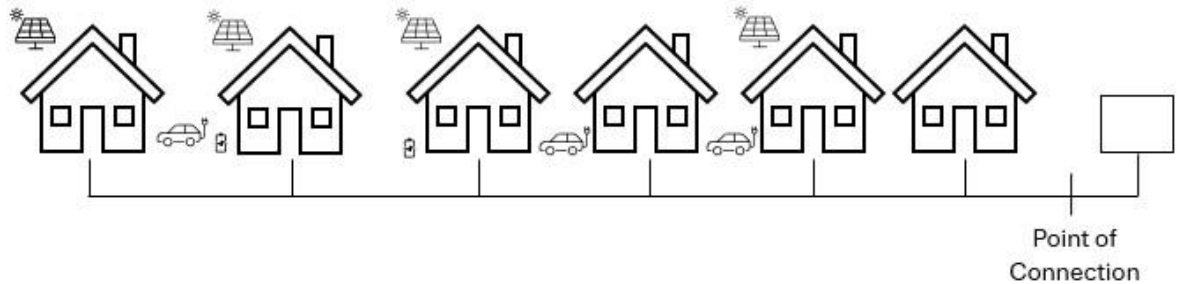
Total = 230 kVA inverter capacity and hence assessed as >200 kVA

Dispensation applies to all installations up to 30 kVA

Interface protection shall be added to any new and existing >30 kVA installations.

Note: Installations approved prior to November 2025 will not be required to install interface protection until there is an alteration or addition to the >30 kVA installation.

G3 Residential Cluster – Aggregate >200 kVA. 50 x 10 kVA IES systems comprising of solar, batteries or V2G

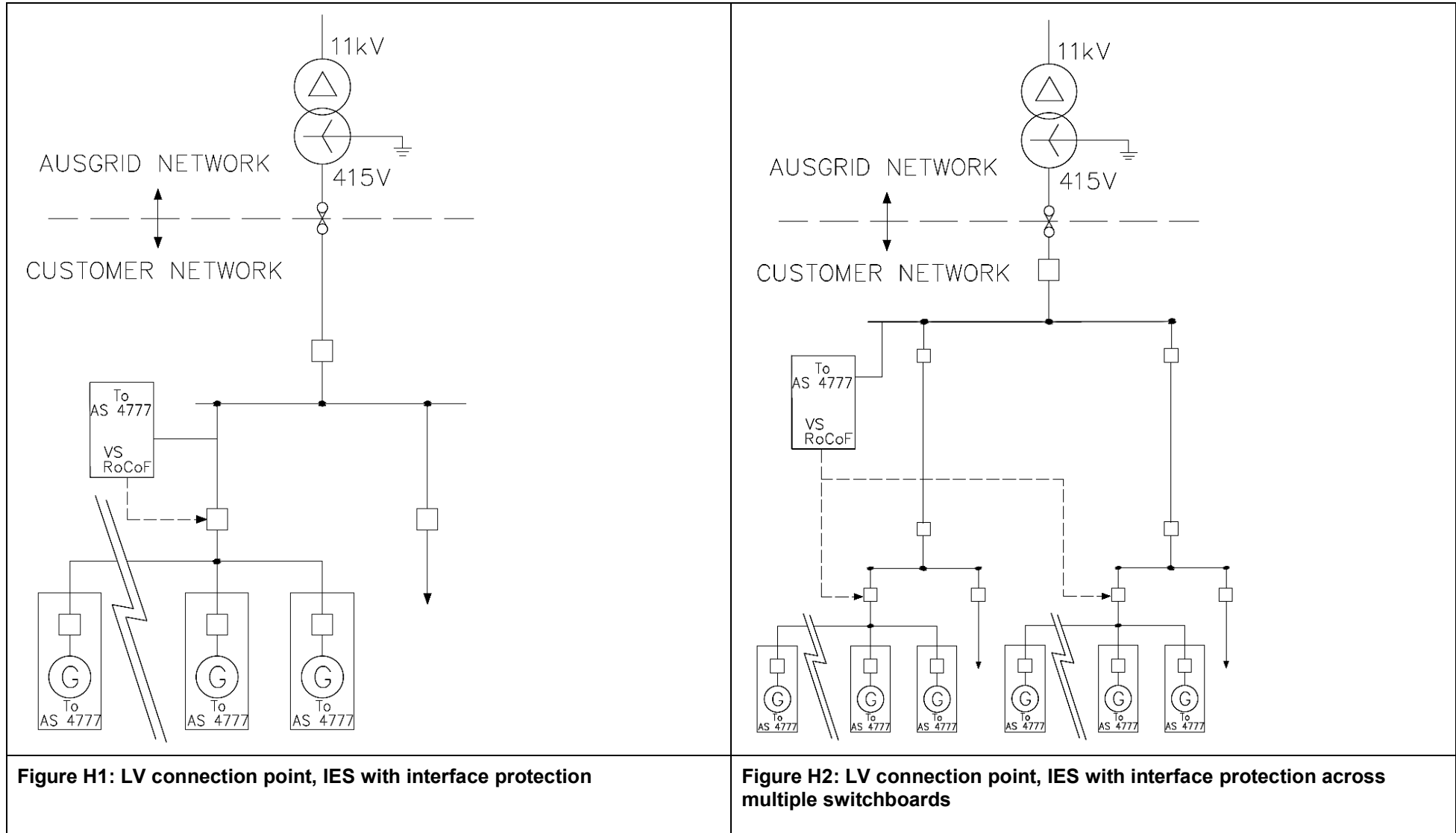


Aggregate >200 kVA

No installation >30 kVA

Dispensation applies: No requirement for interface protection

Annexure H: Examples Single Line Diagrams



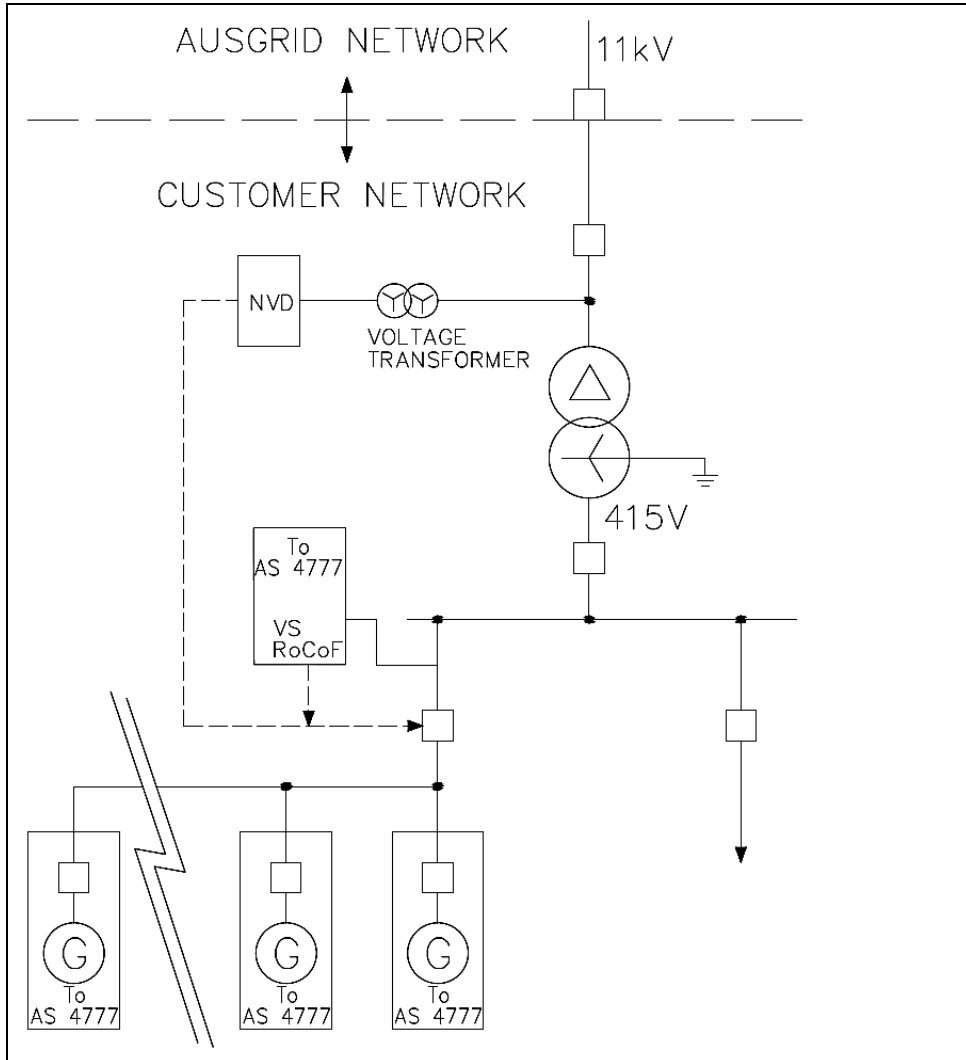


Figure H3: HV connection point, >200 kVA IES with interface protection

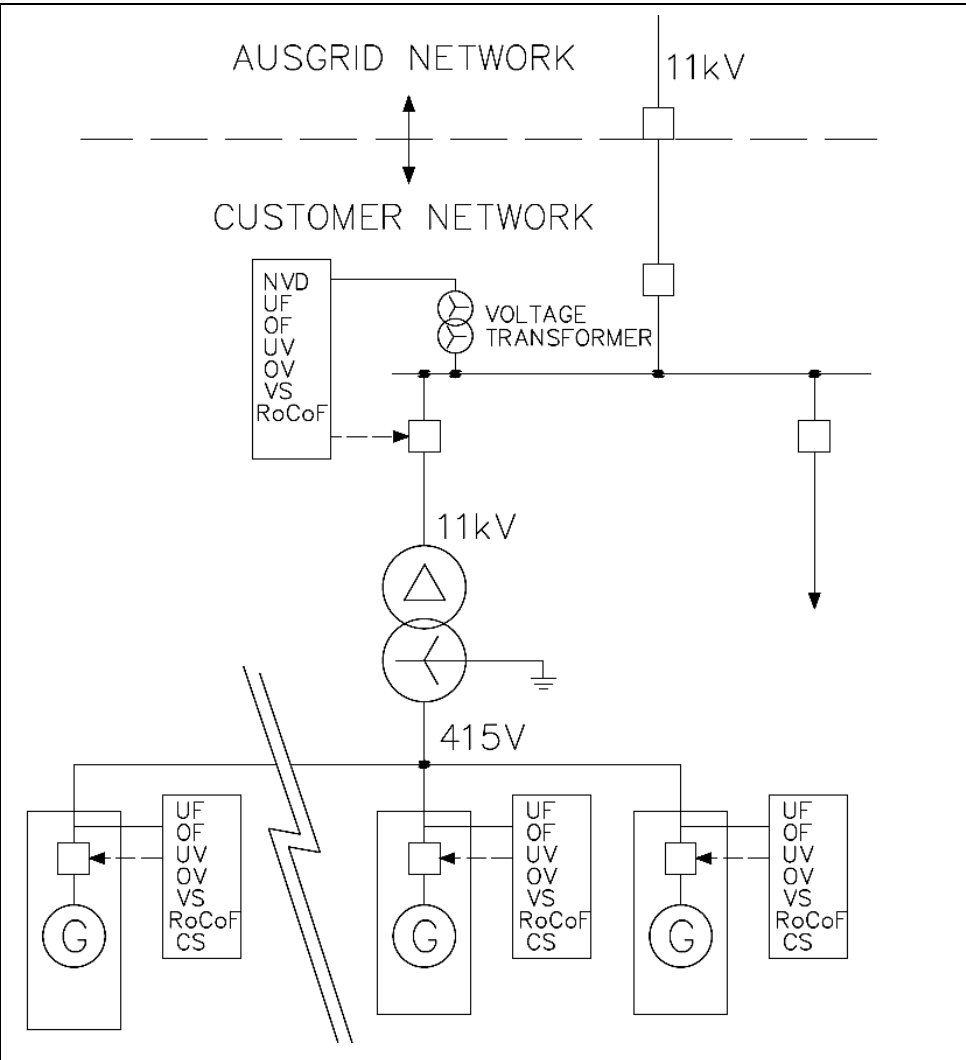


Figure H4: HV connection point, Export Rotating Machines

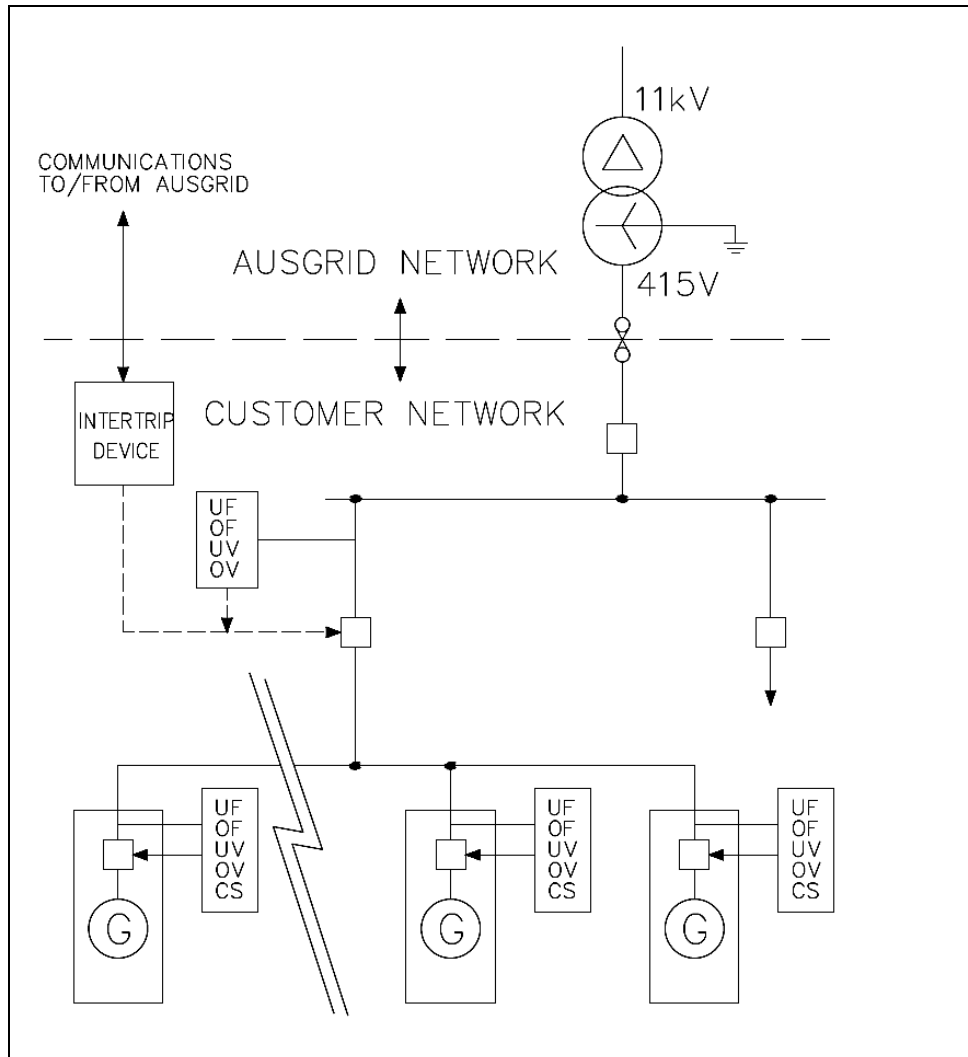


Figure H5: LV connection point, Export Rotating Machines with Inter-tripping

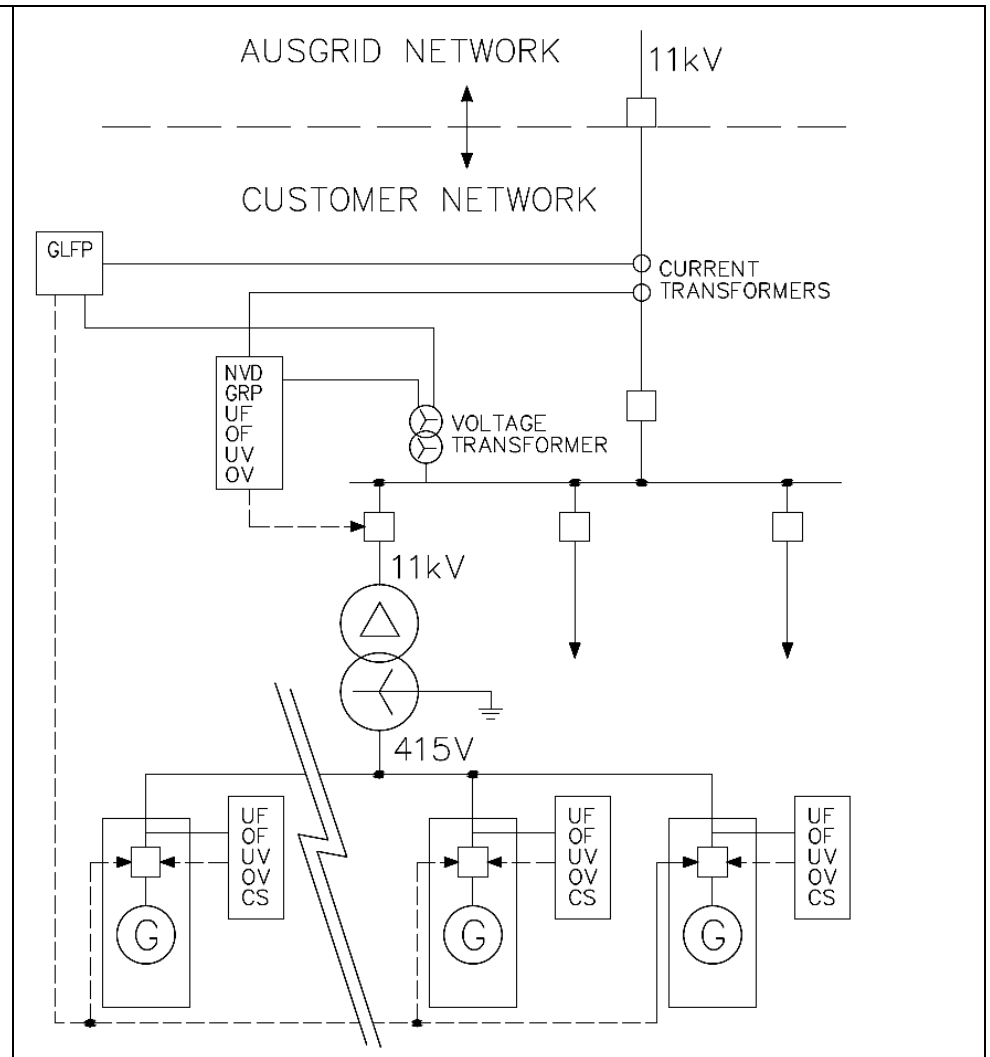


Figure H6: HV connection point, No-Export Rotating Machines tripping

Annexure I: Multi-tenant Site Examples

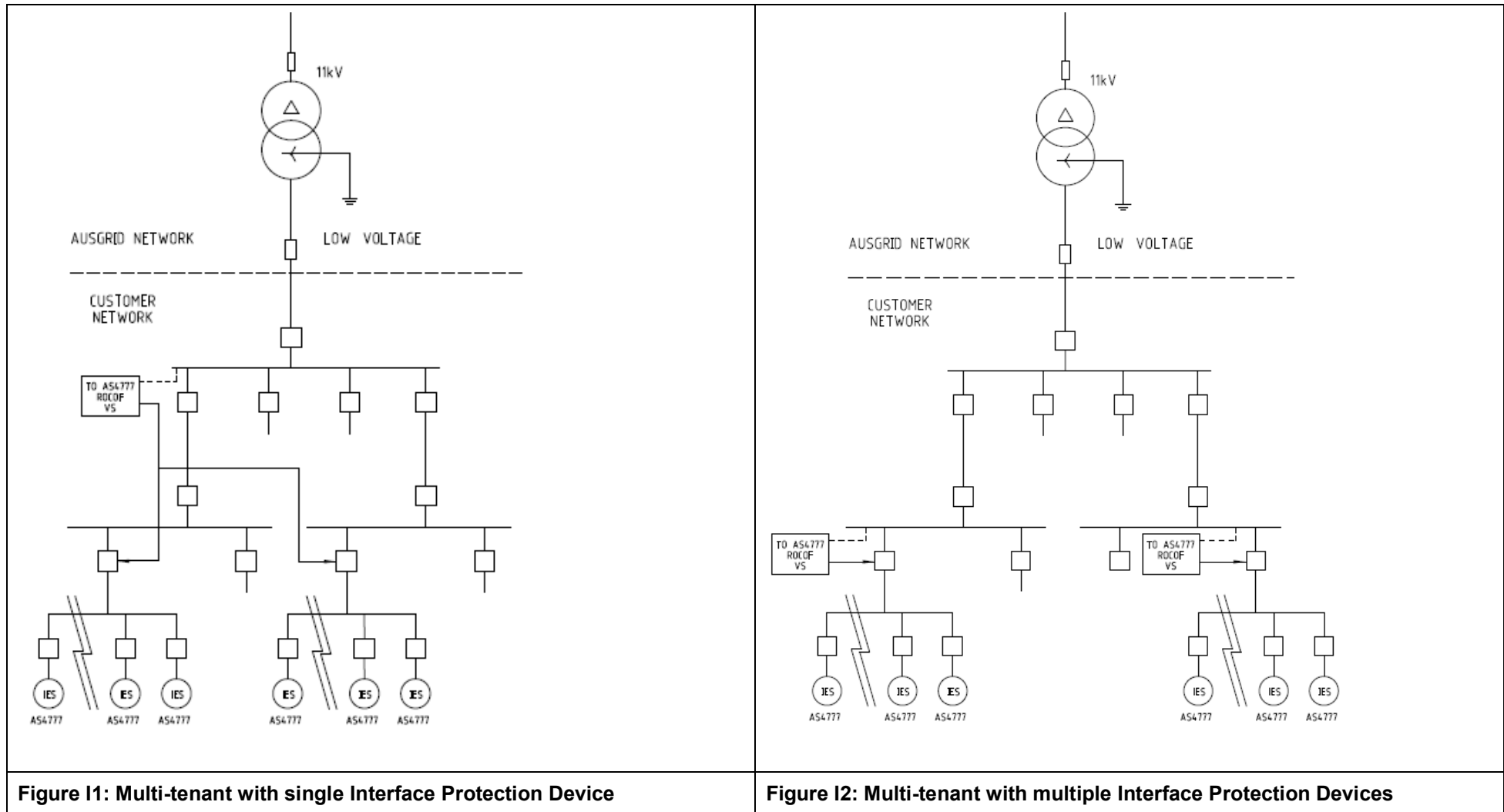


Figure 11: Multi-tenant with single Interface Protection Device

Figure 12: Multi-tenant with multiple Interface Protection Devices

