ESP005 Technical Requirements for the connection of distributed generation

Standard

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Appendices

I. DOCUMENT CONTROL

Document Author	Jacques de la Bat a Bat	Senior Engineer Network Planning
Document Owner	Steve Heinen	Future Networks and Planning Manager
Reviewed By:	Steve Heinen	Future Networks and Planning Manager
Approved By:	Richard Pearce	Head of Network Performance - Electricity
MUSA Change Control Approvers: (if applicable)	NA	
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1.0	June 2018	First Release
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2.1	November 2022	Updated references to AS/NZS 3000 and 4777.2

II. ROLES AND RESPONSIBILITIES

Roles	Responsibility
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Document Author	Determining and ensuring: • Accurate, complete and up-to-date content • Document layout and formatting (using a standardised template)
Document Contributors	• People responsible for content/sections within a controlled document
Reviewed By:	• Validating accurate and complete content

Roles	Responsibility
MUSA Change Control Approvers	• Only applicable if MUSA Related • Name and details of parties who have approved the document on behalf of Vector (same as Document Owner), Electrix and Northpower

III. DOCUMENT CONTRIBUTORS

Name	Position	Content Provided	Page #
Jacques de la Bat	Senior Engineer Network Planning	All	All
Harvey Richards	Design Engineer	All	All
Haydar Abdulmohsen	Manager Protection & Automation	All	All
Steve Heinen	Future Networks and Planning Manager	All	All

IV. RELATED DOCUMENTS

Internal Document No.	Document Title (Title & Description)
ESP009	Technical Requirements for small scale inverter connected DG
ESA002	Network Connection Standards

External Document	Title & Description
Electricity (Safety) Regulations	Electricity (Safety) Regulations 2010
AS/NZS 3000	Electrical Installations, known as the Australian / New Zealand Wiring Rules
AS/NZS 4777.1:2016	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 3010:2017	Electrical installations – Generating sets
Vector's Network Connection Standards	Technical requirements for the connection to Vector's electricity network (published on the Vector website)
AS/NZS 61000 / IEC 61000 suite of standards	Electromagnetic compatibility (EMC), Suite of Power Quality Standards

External Document	Title & Description
Guide for the Connection of Small-Scale Inverter Based Generation	Guideline for the Connection of inverter based distributed generation less than 10kW capacity published by the EEA.
Power Quality (PQ) Guidelines	Published by the EEA to provide guidance and advice on power quality to meet the requirements of Electricity (Safety) Regulations 2010
Guide for the Connection of Generation Plant	Published by the EEA to provide guidelines for connecting generators to the distribution network
IEC 60255 suite of standards	Measuring relays and protection equipment (All relevant Standards)
IEC 60068 suite of standards	Environmental testing
The Code	Electricity Industry Participation Code 2010

V. DOCUMENT METADATA

Document Security Level	Internal Use Only Information that is available to all authorised users at Vector and can be distributed within Vector and its Partners. No loss of reputation or embarrassment will result from disclosure but Vector people may suffer inconvenience. In addition external parties may find this information useful as a stepping-stone to gather more sensitive information	
Enterprise Asset	***Check one from the following:*** ☐ Information ☒ Network ☐ Products	☐ Systems ☐ Facilities
Asset Class	***Check one from the following:*** **Vector Wide** ☐ Non-Network Asset ☒ General **Electricity** ☐ Subtransmission Switchgear ☐ Power Transformer ☐ Underground Cables ☐ Overhead Lines ☐ Distribution ☐ Auxiliary Systems ☐ Infrastructure and Facilities ☒ PAC **Other:** Insert details	**Gas** ☐ Gate Station ☐ Cathodic Protection ☐ District Regulator Station ☐ Mains ☐ North Harbour Pipeline ☐ Service Regulators ☐ Services ☐ Special Crossings ☐ Syphons ☐ Telemetry ☐ Valves
Purpose	***Check as many as appropriate:*** ☒ Planning ☐ Engineering Design ☐ Maintenance	☒ Operation ☐ Retirement/Disposal ☐ Information

1. INTRODUCTION

1.1 Purpose

The purpose of this standard is to define the technical requirements for consumers who wish to connect their distributed generation to Vector's distribution network.

This standard also defines the minimum protection and control requirements for connecting distributed generation.

A distributed generator meeting the minimum requirements as set out in this document does not exempt the generator owner from any statutory responsibilities.

1.2 Scope

The scope of this standard includes:

a) This standard applies to all distributed[1] generation with capacities greater than 30kVA, or 5kVA single phase, (except those specified in Section 1.2b of this standard) connected or proposed to be connected to the Vector distributed network either directly or via customers' installations and includes the following:

- Distributed generation connected directly, or via inverters.
- Distributed generation that is capable but does not export to the grid e.g. generation only used to offset customer load.
- Intermittent generators (e.g. wind generators) that are connected to the distribution network but not always generating.
- Distributed generation, including non-exporting generation, that has the potential to continue energising any part of Vector's distribution network (for example, due to failure of protection system to operate correctly).
- Battery energy storage systems connected to the Vector distribution network.
- Generation embedded within third party networks.

The following are excluded from the scope of this standard:

a) The connection of distributed generation via inverters with capacities 30kVA three phase or less, or 5kVA single phase or less. The requirements for connection of these distributed generators are addressed in the Vector Standard ESP009.

b) Connection of standby (or backup) generation as these generation do not operate in parallel with Vector's distribution network. The Code excludes generation that is only momentarily synchronised with Vector distribution network from the definition of distributed generation.

[1] Distributed Generation is defined in Section 1.3 of this standard.

1.3 Definitions

Term	Description
Active Anti Islanding protection	Is a method used to detect a network island when the network load matches the generator output (or multiple generators) output. AS/NZS 4777.2 describes three methods.
Distributed Energy Resources	A Distributed Energy Resource (DER) is any device connected to the distribution network that generates (produces), stores or consumes electricity and can be controlled locally or remotely to alter its electricity production, storage or consumption pattern.
Distributed Generation	Distributed generation as defined in the Code means generating plant connected to a distribution network or to a consumer installation that is connected to a distribution network. Distributed generation excludes generating plants that are not normally connected or prevented from connecting to the distribution network or are only momentarily synchronised with the distribution network. For the purposes of this document distributed generation includes traditional synchronous or asynchronous generation and inverter connected generation. Distributed generation includes generation that are capable of exporting electrical energy into the distribution network irrespective of whether they are exporting or not.
Non-Exporting Generation	Generation connected to and synchronised with the distribution network used for offsetting customer load. Non-exporting generation has the ability to inject electrical energy (such as fault energy in the event of network faults) into the distribution network but does not normally export electricity into Vector's distribution network. Technical requirements for non-exporting generators are the same as distributed generators.
High Risk Generation	Is any generation connected to Vector's network that has the potential (including combined with existing generation) to sustain a network island on any part of Vector's overhead network for longer than 2 seconds.
Network island or islanding	A condition in which a portion of the Vector's network while electrically isolated from the rest of the Vector's distribution network remains energised by one or more generators.
Neutral voltage displacement protection (NVD)	Also known as residual voltage protection (ANSI code 59N). Used to detect single phase to earth faults on an unearthed neutral network, there being no zero sequence current contribution from the energising source for conventional current based (residual current) protection to detect an earth fault.
Point of supply	Is the point at which the distributed generator is connected to Vector's distribution network either directly or via a consumer's installation.

Term	Description
ROCOF	Rate of Change of Frequency protection similar to Vector Shift.
Synchronised or Synchronising	Synchronised is when two network points have the same voltage magnitude and frequency and zero phase difference. Synchronising is the act of bringing two separated points of the network into synchronism. A generator synchronised with the network is connected to the network.

2. HEALTH, SAFETY AND ENVIRONMENT

No distributed generation shall be connected to Vector's distribution network, including temporary connection, addition of capacity to exiting generation without the prior written approval of Vector. Distributed generation connected to Vector's distribution network (either directly or via an inverter) poses a public safety risk and could potentially damage other customers' equipment.
The responsibility for safe generation operation and avoiding damages to Vector's network remains that of the generator owner. All distributed generator owners need to be aware of their responsibility regarding public safety and potential damage to other customers' equipment.

Directly connected rotating distributed generation (i.e. Synchronous or Asynchronous machines) poses a significantly higher risk than equivalent size inverter connected generation due to generator inertia and the significantly higher fault current contribution. Inverter connected distributed generation meeting AS/NZS 4777.2 requirements have active anti islanding protection that conventional generation do not have thereby providing an additional risk mitigation factor. Inverters which are not AS/NZS 4777.2 certified are expected to have the same functionality if connected to the Vector network.

2.1 Public Safety Risk

The potential for generation to continue to energise Vector's network (particularly a faulted network) after Vector's upstream circuit breaker has opened (or tripped) creates a potential public electrocution risk. This risk is higher on overhead networks. The following risk factors need to be evaluated for each prospective distributed generation connection and mitigation measures implemented:

a) Public safety (downed conductor) risk for distributed generation connected to Vector's overhead network (includes upstream overhead, and likely back-feed overhead).

b) Sustained Network Islanding risk. If the distributed generation or the distributed generation in combination with other network generation can sustain an island of part of Vector's network.

c) A combination of the above two factors poses increased risk.

2.2 Customer Equipment Damage Risk

Should a distributed generation (or a distributed generation in combination with a cluster of other distributed generation) not trip out immediately following the onset of a network island, a resultant unchecked extreme over-voltage transient could result in widespread equipment damage to customers connected to Vector's network in the immediate vicinity of the generator.

The following are risk factors for distributed generation output (or the combination of a cluster of generation output) that may result in network over-voltages:

a) Over-voltage due to large distributed generation connected to rural overhead 11kV networks particularly during low network load periods.

b) Large solar generation connected to the network during an unusually low network midday summer load (too low to offset the generation output) e.g. during holidays.

Growth of inverter-based generation connected to Vector's network is anticipated, particularly solar generation and battery storage. Therefore, when evaluating a generator's ability to sustain a network island, allowance must be made for the addition of future generation and prudent future proofing measures should be included to safeguard against a significant future risk.

Table 1: Summary of risks addressed in this Standard

Lifecycle Stage	Risk	Risk Rating	Control	Section Ref
Operational	Generation continues energising a downed conductor. Public electrocution risk.	Very High	Ensure adequate dual independent protection. Vector independent protection and SCADA required for the point of supply circuit breaker. Ensure residual voltage protection. Ensure robust commissioning and ongoing maintenance of the Protection and Control systems.	3.7 3.8 8 9
Operational	Generator/s cause transient over-voltage during onset of a network island. Customer equipment damaged by network transient over-voltage.	High	Ensure fast main and fast backup tripping of the generator for severe over-voltages. Ensure robust commissioning and ongoing maintenance of the Protection and Control systems.	3.7 8 9

Lifecycle Stage	Risk	Risk Rating	Control	Section Ref
Operational	Generators continue exporting unconstrained power and reactive power output during a network sustained elevated voltage resulting in the local network voltage exceeding regulatory maximum limits and the sustained over-voltage causing customer equipment failure and complaints.	High	Ensure sustained over-voltage tripping is implemented in independent protection systems. Ensure generators have Volt-VAr (Voltage influence) and Volt-Watt (Over-voltage load curtailment) controls enabled and correctly configured.	3.7 8 9
Operational	Out of Sync closing damaging Vector network equipment and generation.	Low (low risk to Vector, high risk to the generator owner)	Ensure the generator/s site has robust and documented operational procedures to connect generation to Vector's network and robust interlocking systems to prevent out of sync closing.	3.4

3. COMPLIANCE

The design, installation and operation shall comply with the latest editions of the following standards and guides listed below.

REFERENCE No	DESCRIPTION
Electricity (Safety) Regulations	NZ Electricity (Safety) Regulations
AS/NZS 3000	Electrical Installations, known as the Australian / New Zealand Wiring Rules
AS/NZS 4777.1:2016	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 3010:2017	Electrical installations – Generating sets
Vector's Network Connection Standards	Technical requirements for the connection to Vector's electricity network published on the Vector official website.
AS/NZS 61000 / IEC 61000 suite of standards	Electromagnetic compatibility (EMC), Suite of Power Quality Standards
EEA (NZ) Connection of Small-Scale Inverter Based Generation	Guideline for the Connection of Small-Scale Inverter based Distributed Generation
EEA (NZ) Power Quality Guidelines	Guidance and advice on power quality to meet the requirements of Electricity (Safety) Regulations 2010
EEA (NZ) Connection of Generation Plant	Guide for the Connection of Generation Plant
IEC 60255 suite of standards	Measuring relays and protection equipment (All relevant Standards)
IEC 60068 suite of standards	Environmental testing
The Code	Electricity Industry Participation Code 2010

4. TECHNICAL REQUIREMENTS

All distributed generation (with capacities >5kVA single phase and >30kVA three phase) connected to or proposed to be connected to Vector's distribution network shall comply with the requirements of this standard and Vector's Network Connection Standards.

Single phase inverter generation ≤5kVA and three phase inverter generation ≤30kVA connected to or proposed to be connected to Vector's distribution network shall comply with Vector's standard ESP009 "Technical requirements for connection of small capacity distributed generation via inverters to Vector's network". This standard is published on the Vector official website.

All distributed generation must meet all relevant statutory requirements including all applicable safety codes and standards.

Any distributed generation system of 1MVA or greater will be required to meet Transpower's set of requirements. This includes distribution generation which has been grouped together to form one system of 1MVA or greater. Additional information can be at New generation connecting to a distribution network FAQ.pdf (transpower.co.nz).

4.3 Network capacity headroom to host new or increased generation capacity

Distributed generation may be connected if the required network capacity to host (support) the distributed generation is available. As a minimum, the following criteria must be met:

a) Maximum network design fault ratings are not exceeded.

b) Equipment fault ratings are not exceeded.

c) Equipment thermal ratings are not exceeded.

d) Will not result in sustained over-voltage to the Vector distribution network and its customers.

e) Power quality must comply with all relevant NZ Electricity Regulations, NZ Electrical Codes of Practice and AS/NZS 61000 series of Standards and Technical Reports.

The assessment of headroom capacity to host the distributed generation is the first step in approving a distributed generator connection. Depending on the size of the distributed generation, a further detailed capacity study may be required.

Should reinforcement or changes to Vector's distribution network be required to allow the connection of the distributed generation then the generator owner may be required to bear the cost of these changes.

4.4 Network Islanding

The distributed generator must not energise any part of Vector's distribution network that is disconnected from the rest of Vector's distribution network or disconnected from Transpower's grid. The distributed generation may remain operating as an island to supply the customer's internal load, but only after any connection with Vector's distribution network is disconnected and remain disconnected for the duration when the customer's installation is operated in an island mode.

The distributed generator shall cease to energise the Vector distribution network within two (2) seconds of the formation of an island.

4.5 Availability of Protection

The distributed generator owner shall ensure that all its equipment is adequately protected for generation risks (refer to minimum requirements table in appendix A) and that all elements of the protection system, including associated inter-tripping, and DC supplies are available at all times. The health of the tripping supply shall be continuously monitored (i.e. trip circuit supervision) and maintained.

Any unavailability of the protection system and associated equipment shall require the distributed generation to be immediately taken out of service.

4.6 Synchronising

All distributed generators synchronising to the distribution network shall be the sole responsibility of the generator owner. Vector will not be responsible for any damages resulting from out-of-synchronised closing. The distributed generator owner must always assume the Vector distribution network is energised at all times, and if momentarily de-energised (such as during an outage), can be re-energised at any time.

The distributed generator owner shall provide and install automatic synchronising checking facilities on all distributed generator circuit breakers and any other circuit breakers that are capable of connecting the distributed generator to the network.

Prior to the initial connection of a generator to the Vector distribution network, the distributed generator owner and Vector shall agree on the operational procedures necessary for synchronisation.

Vector owned circuit breakers must not be used for the final connection of the distributed generation to Vector's distribution network (sync closing). Sync closing should be carried out by the distributed generation owner's circuit-breaker.

4.7 Power Quality

Distributed generators shall not inject DC current greater than 0.5% of full rated inverter output current into the point of supply.

The distributed generator shall not cause voltage flicker levels greater than the emission level allocations based on AS/NZS 61000 suite of standards including AS/NZS 61000 technical reports. The capacity of the distributed generator shall be considered as the equivalent load capacity for the purposes of applying these standards.

All exporting distributed generation greater than 1MVA requires Vector to install Power Quality Metering (PQM) at the point of supply. Besides providing Power Quality recordings this metering is required for Vector to determine its total response during under-frequency transient events to prove Vector's compliance to the Electricity Authority's load shedding requirements.

4.8 HV Network (11kV or 22kV) Neutral Earthing

Vector does not allow additional neutral earth points on its HV network. Additional neutral earth points on the network result in increased earth fault current and may cause mal-operation of network protection.

A customer's HV neutral earth-point may be required in addition to the existing Vector neutral earth point if the customer wants to energise part of their internal HV network (11kV or 22kV) when disconnected from the Vector distribution network. In such cases the neutral connection to earth needs to be implemented by customer switching and will require robust interlocking by the customer to ensure the customer's neutral earth-point is disconnected when re-connecting back to Vector's network. The robustness of the interlocking will need to meet Vector's requirements.

The distributed generator must apply to Vector for approval to install its HV earth point.

4.9 Generator Protection and the Independent Protection requirements

The protection requirements for distributed generators are presented in this section. Connected generation >30kVA shall provide two independent network protection levels. A summary distinguishing between the requirements for different installation sizes is provided in Appendix A.

Each distributed generator shall meet the passive anti islanding settings requirements for :

a) Over-voltage (>V)

b) Under-voltage (<V)

c) Over-Frequency (>F)

d) Under-Frequency (<F)

Each distributed generator or within the distributed generator's central protection shall have at least one of the following anti islanding protection methods:

a) Active anti islanding method as per AS/NZS 4777

b) ROCOF or Vector Shift.

c) Communication based method to actively detect the formation of an upstream island by the upstream circuit breakers open status

d) Reverse Power (Only applicable to Non-Exporting Generation to detect power flow into Vector's network)

Anti-islanding protection methods are not fail safe and therefore in addition to the above HV (11kV) Neutral Voltage Displacement (NVD) protection will be required if any part of the upstream HV network including any alternative network is overhead line and can be livened by the generation.

Suitable protection settings shall be determined as part of the Study Report. In instances where a study report is not required, suitable protection settings shall be advised (at the generator owners cost) by a Protection Consultant meeting the same requirements as is required of the protection study (refer to section 5).

If a Vector owned point of supply circuit breaker is installed having the required protection elements (>V.<V.>F,<F,>I,NVD) and SCADA then the customer does not need to provide central protection in addition to distributed generator protection. Note, the Vector point of supply protection does not exclude the customer-required generator protection that contains at least one active anti islanding protection method.

4.10 Distributed Generator Power and Reactive Power automated controls

The risk of the network voltage exceeding the statutory maximum limit of 6% above nominal voltage is increasingly likely as additional distributed generation is connected to the distributed network. For inverter connected distributed generation, implementing Volt-VAr and Volt-Watt response modes provides a means of maximising the connection of generation without compromising upper voltage limits.

Volt-Watt and Volt-VAr response modes shall be set on all distributed generators newly connected to the Vector distribution network as described in in this section. For HV (11kV, 22kV, 33kV) connected distributed generation (via HV point of supply) the voltage response shall respond to the HV voltage and more stringent Volt-Watt requirements to ensure the effects on the LV network are minimised.

Volt-VAr response modes shall be sufficiently smooth so as not to cause voltage fluctuations or voltage flicker. During increasing voltage events distributed generators shall endeavour to supress the high voltage by importing reactive power (VAr), this will enable increased generation capacity to be connected to Vector’s network.

For LV (400V/230V) connected distributed generation if the point of connection exceeds +6%, the generator shall curtail generation down to a maximum of 20% and shall import maximum reactive power (power factor less than 0.95).

For HV (11kV, 22kV or 33kV) connected distributed generation (typically generation >200kVA) the generation output shall start curtailing when the HV voltage exceeds +2.5% and if the HV voltage exceeds 3% the generation output shall be no more than 20% and shall import maximum reactive power (power factor less than 0.95). On voltage constrained networks generators may operate at 30% VAr import (0.95 power factor) at +3% Voltage.

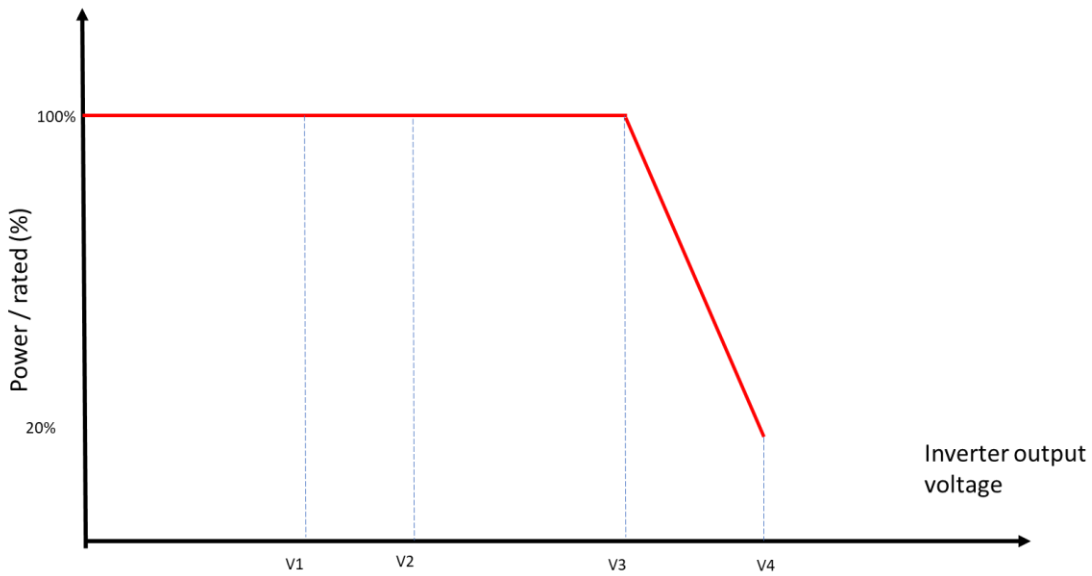
The following table shows the volt response reference values for setting Volt-Watt response modes:

Reference	Single Phase Voltage (LV)	Three Phase Voltage (LV)	HV Connection (%)
V1	207	360	-
V2	220	383	-
V3	244	423	2.5%
V4	255	442	3%

The following table defines the required Volt-Watt response setting for LV (230V/400V) and HV connected generation:

Reference	Power (kW) Control
V1 to V3	No power output restriction (stays at 100%)
V3 to V4	Shall decrease power output from 100% down to 20% of generator rating
>V4	Power output limited to maximum 20% of generator rating

The following graph demonstrates an example of the Volt-Watt response setting for LV (230V/400V) and HV connected generation:



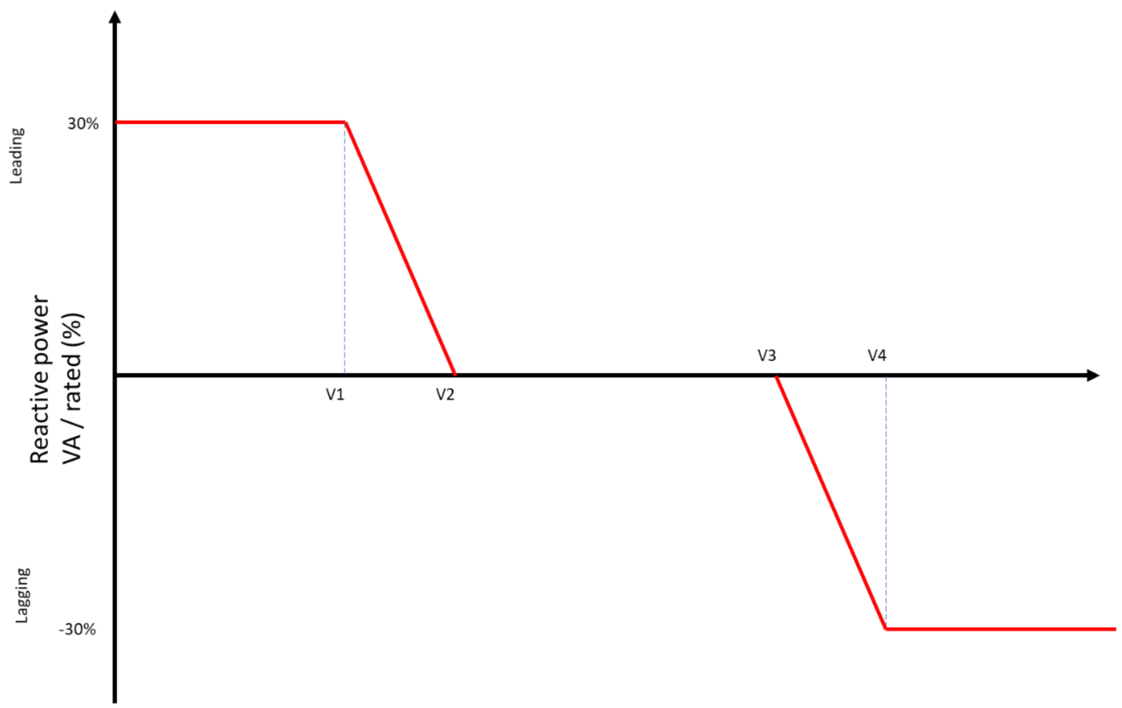
The following table shows the volt response reference values for setting Volt-VAr response for LV (230V/400V) and HV connected generation:

Reference	Single Phase Voltage (LV)	Three Phase Voltage (LV)	HV Connection (%)
V1	207	360	-2.5%
V2	220	383	-2%
V3	235	409	2%
V4	244	424	2.5%

The following table defines the required Volt-VAr response setting for LV (230V/400V) connected generation:

Reference	Power Control
<V1	VAr max export (equivalent of 30% of generator VA rating)
V1 to V2	Shall ramp smoothly from unity to maximum VAr export (to maximum capacitive equivalent)
V2 to V3	Shall operate at unity power factor
V3 to V4	Shall ramp smoothly from unity to maximum VAr import (to maximum Inductive equivalent)
>V4	VAr max import (equivalent of 30% of generator VA rating)

The following graph demonstrates an example of the Volt-VAr response setting for LV (230V/400V) connected generation:



Volt-VAr response mode for HV connected generation:

AS/NZS 4777.2 Reference	Power (kW) Control
<V1	VAr max export (maximum capacitive equivalent)
V1 to V2	Shall ramp smoothly from unity to maximum VAr export (to maximum capacitive equivalent)
V2 to V3	Shall operate at unity power factor
V3 to V4	Shall ramp smoothly from unity to maximum VAr import (to maximum inductive equivalent)
>V4	VAr max import (maximum inductive equivalent)

4.11 Vector’s SCADA requirements

For deemed high risk distributed generation referred to in Appendix A, Vector requires a SCADA interface of either the Vector owned point of supply circuit breaker or of the distributed generator central protection. The following minimum remote SCADA points are required:

- Circuit breaker Open command (i.e. Emergency trip command).
- Circuit breaker status open indication.
- Circuit breaker closed indication.
- Analogue Voltage per phase indication.
- Analogue Current per phase indication.
- Real Power (kW) import (-) and export (+).
- Reactive Power (kVAr) import (-) and export (+).
- Protection relay health indication.
- Trip circuit health indication.
- Protection trip issued indication.

5. NETWORK STUDY REPORT REQUIREMENTS

All distributed generators posing a significant safety risk on Vector’s distribution network will require a network protection study report to be completed (refer to Appendix A). A Network study report will also be required if a neutral earth is added to Vector’s network and may also be required for extended (3 second) closed transition standby generator applications. The DG applicant is responsible for producing this report.

The network report shall be:

a) Undertaken by a Vector Approved Electrical Engineering Consultancy having specialist network modelling, protection and generation experience and is accredited to undertake protection setting for Vector or Transpower.

b) Subject to Vector's acceptance.

The scope of the Network study report shall cover the impact the distributed generation will have on Vector's distribution network and shall include but not limit to the following:

a) A single line diagram overlapping into Vector's network and including at least two upstream Vector circuit breakers for the main and all alternative network supply options. The single line diagram shall include all network earth points and include all network equipment types and ratings.

b) Precautions taken against network islanding to any part of Vector's distribution network by way of a risk assessment.

c) Include proposed protection elements and settings to be used in the distributed generator/inverter and protection elements and settings to be used in the central protection and/or in the Vector owned point of supply circuit breaker/s. These can be included in the Relay and Instrumentation (R&I) diagram.

d) Showing all protection settings co-ordinate with existing Vector protection network settings.

e) Demonstrate the power quality issues will not arise especially if the generation output power or the generator output reactive power output is highly variable.

f) Demonstrate no interference to Vector's ripple control.

g) Include operational procedures necessary for generation synchronisation and the return of Vector supply following a Vector outage.

h) If applicable to include operational procedures for customer islanding including switching of neutral earth points and the reconnection to Vector's network.

i) Include a summary table of all the risk and consequence of each risk including but not limited to the risks stated in this document. Each risk shall have assigned mitigation actions.

j) Providing recommendations on any Network changes required.

The distributed generator owner will be responsible for the cost of any protection or network changes Vector needs to make on its network as a consequence of connecting the generation.

6. PRE-COMMISSIONING (PRE-CONNECTION) REQUIREMENTS

Vector may decline connection of distributed generation to Vector's distribution network if the equipment does not meet the specified technical requirement (as stated in this document).

The distributed generator owner shall provide Vector full details of the protection settings to be applied at least two months prior to the expected commissioning date.

All the testing and associated costs are the responsibility of the distributed generator owner.

Vector or Vector's representative reserves the right to witness the testing.

The distributed generator shall use a contractor who is experienced in commissioning generator and network protection equipment and who are accredited to do work on either Vector's or Transpower's networks.

All rotating generation and all inverter-based generation >200kW shall provide the following information to the satisfaction of Vector's Protection and Control team prior to connecting to Vector's distribution network:

a) Testing and commissioning of the protective equipment shall be agreed between the distributed generator owner and Vector prior to commissioning.

b) The distributed generator owner shall provide Vector a testing and commissioning plan 1 month before commissioning

c) Protection settings sheets, signed and dated for all the implemented protection elements.

d) A signed As Built complete set of SLD's and R&I drawings.

e) Signed confirmation that the complete protection system is in a serviceable state and appropriately set and tested.

f) Signed confirmation that all the customer requirements as required in the protection study report have been completed.

g) The distributed generator owner shall keep written records of test results and protection settings. A copy of the records must be sent to Vector.

h) The distributed generator owner shall provide 24-hour telephone numbers of contact personnel.

7. POST-COMMISSIONING AND ONGOING MAINTENANCE REQUIREMENTS

Distributed generator owners shall ensure that all associated protection equipment and independent protection, including associated inter-tripping:

a) Is available at all times. Unavailability of the protection will require the distributed generation to be immediately taken out of service.

b) Any failure of the distributed generator protection circuit breakers or failure of the circuit breaker secondary circuits or failure of the trip circuits shall be alarmed within the distributed generator owner's installation. Operating procedures shall be put in place to immediately switch out the generation. A copy of the authorised procedure must be sent to Vector for records.

c) Regularly maintained in accordance with good electrical industry practice. Records shall be kept of such maintenance and these may be reviewed by Vector when requested.

d) No changes (including settings changes) shall be made to the generator protection or the central protection without Vector's prior written approval.

APPENDIX A. TABLE OF MINIMUM REQUIREMENTS

Risk Category: Generation Type and Capacity and Generation ability to liven Vector overhead network		Network study required	Dedicated transformer required	Protection on each Inverter/Generator	Independent network connection protection (Central Protection device)	Vector owned HV circuit breaker and associated SCADA & protection required
Transition Switch connected less than 100milli seconds	**HV underground network**	**-**	**Yes**	**>V,<V,>F,<F,>I**	**-**	**-**
	Ability to liven HV overhead network	**Yes**	**Yes**	**>V,<V,>F,<F,>I**	**AS/NZS 4777.1:2016 + 11kV NVD**	**-**
	Ability to liven LV network (but not liven HV overhead)	**-**	**NA**	**>V,<V,>F,<F,>I**	**AS/NZS 4777.1:2016**	**-**
Transition Switch connected up to 3 seconds	**This requirement or Connected generation requirements**	**Yes**	**Yes**	**>V,<V,>F,<F,>I**	**-**	**AS/NZS 4777.1, + NVD, >I >I unbalance >V unbalance, SCADA interface**
Connected Inverter ≤200kVA	**HV underground network**	**-**	**Yes**	**AS/NZS 4777.2 + Volt - Watt and Volt-VAr control**	**AS/NZS 4777.1:2016**	**-**
	Ability to liven HV overhead network	**Yes**	**Yes**	**AS/NZS 4777.2 + Volt - Watt and Volt-VAr control**	**AS/NZS 4777.1:2016 + 11kV NVD + Vector SCADA**	**-**
Connected Inverter >200kVA <600kVA	**Underground HV network**	**-**	**Yes**	**AS/NZS 4777.2 + Volt - Watt and Volt-VAr control**	**AS/NZS 4777.1:2016 + 11kV NVD + Vector SCADA**	**-**
	Ability to liven HV overhead network	**Yes**	**Yes**	**AS/NZS 4777.2 + Volt - Watt and Volt-VAr control**	**-**	**AS/NZS 4777.1, + NVD, >I >I unbalance >V unbalance, SCADA interface**
Connected Inverter ≥600kVA	**All**	**Yes**	**Yes**	**AS/NZS 4777.2 + Volt - Watt and Volt-VAr control**	**-**	**AS/NZS 4777.1, + NVD, >I >I unbalance >V unbalance, SCADA interface**
Connected Rotating ≤30kVA	**HV underground network**	**-**	**Yes**	**>V,<V,>F,<F,>I, ROCOF/Vector Shift, Volt - Watt, Volt - VAr**	**>V,<V,>F,<F,>I, ROCOF/Vector Shift,**	**-**
	Ability to liven HV overhead network	**Yes**	**Yes**	**>V,<V,>F,<F,>I, ROCOF/Vector Shift, Volt - Watt, Volt - VAr**	**>V,<V,>F,<F,>I, ROCOF/Vector Shift, + 11kV NVD + Vector SCADA**	**-**
Connected Rotating >30kVA	**All**	**Yes**	**Yes**	**>V,<V,>F,<F,>I, ROCOF/Vector Shift, >V unbalance, >I unbalance Volt - Watt, Volt - VAr**	**-**	**>V,<V,>F,<F,>I, ROCOF/Vector Shift, + NVD, >I unbalance >V unbalance, SCADA interface**
Connected Inverter/Rotating ≥1000kVA	**All**	**In addition to the above requirements, please contact Transpower -** [New generation connecting to a distribution network FAQ.pdf (transpower.co.nz)]				

When AS/NZS 4777.2 protection requirements are referenced, it only refers to the settings. For installations >10kVA, the inverter itself does not need to be AS/NZS 4777.2 certified but needs to have the same functionality so that the settings can be used.

NVD = Neutral Voltage Displacement (or Residual Voltage) protection.

AS/NZS 4777.1:2016 = Requirements for the central protection as stated in section 3.4.4 of AS/NZS 4777.1:2016.

The ability to liven Vector's overhead network is deemed if the total installed generation capacity exceeds the minimum any time connected load between the generator and the overhead.