Northpower
Electricity Network

Technical Requirements for Large Scale Distributed Generation Standard

APL.S.01.07 | General Assets

Document summary

This document details Northpower's technical requirements for the connection of large-scale (>10kW) Distributed Generation ("DG") systems to Northpower's electricity distribution network.

Document approval

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Controlled Document

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1.0 Introduction

1.1 Purpose

This Standard provides Northpower's requirements relevant to the performance, power quality, network capacity, testing, safety and maintenance of generation connected to Northpower's network.

This Standard also defines the minimum protection and control requirements.

A Distributed Generator Owner meeting the minimum requirements as set out in this document does not exempt the Distributed Generator Owner from the associated safety responsibilities and mandatory responsibilities under New Zealand regulations or under New Zealand Codes of Practice.

1.2 Scope

The scope of this Standard details Northpower's core technical requirements for the connection of 'large-scale' (>10kW) Distributed Generation (DG) systems, including battery storage systems.

This Standard applies only to generation covered under part 6 of the Electricity Industry Participation Code. Typically this does not include standby generation, which cannot feed power into Northpower's network – covered by AS/NZS 3000.

Exclusions:

The connection of generation via inverters with capacities less than 10kVA (small-scale DG) connected to Northpower's network.

For connections, less than 10kW refer to:

- APL.S.01.06 Technical Requirements -Connection of Small Scale Distributed Generation (Standard).

1.3 Application

This document applies to Northpower network staff involved in processing DG applications and the approval process. Furthermore, it applies to all operators of DG within the scope mentioned above, which is to be connected to Northpower's electricity network.

2.0 References

Internal Reference	Details
APL.S.01.06	Technical Requirements - Connection of Small-Scale Distributed Generation (Standard)
APL.T.01.01	Initial Application Form for Connection of Distributed Generation Greater than 10kW (Form)
APL.T.01.02	Final Application Form for Connection of Distributed Generation Greater than 10kW (Form)
CST.S.00.02	New LV Service Connections (procedure) **Note:** Section 10 details Distributed Generation
ENS 02.01.115	Power Quality Guidelines
NET.NP.00.03	Congestion Management Policy – Distributed Generation

External Reference	Details
Electricity (Safety) Regulations	NZ Electricity (Safety) Regulations as updated
AS/NZS 3000	Electrical Installations, known as the Wiring Rules as updated
AS/NZS 4777.1:2016	Grid connection of energy systems via inverters, Part 1: Installation requirements
AS/NZS 4777.2:2015	Grid connection of energy systems via inverters, Part 2: Inverter requirements
AS/NZS 3010:2017	Electrical installations – Generating sets
NZECP 35	Power Systems Earthing
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 as updated

3.0 Definitions

Terminology	Definition
Active Anti-Islanding protection	It 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 resource connected to the distribution network that generates (produces) electricity, typically from renewable energy resources, e.g. generation from solar or wind.
Distributed Generation (DG)	Means equipment used, or proposed to be used, for generating electricity that is: • connected, or proposed to be connected, to the network or to a Customer installation which is connected to the network; and • is capable of injecting electricity into the network. This includes electric vehicles (EV) or battery storage systems capable of exporting (injecting) electricity into the network.
Distributed Generator Owner	A customer becomes a DG owner and is responsible for ensuring their DG system is safe and compliant for generation.
Generation	For this document, generation includes all types of generation, including traditional synchronous generation, inverter-based generation, Distributed Energy Resources, standby generation, emergency generation, energy storage, e.g. battery and Non-Exporting Generation.
High Risk Generation	Includes any generation connected to Northpower's network, that has the potential (including combined with existing generation) to sustain a network island on any part of Northpower's network for longer than 2 seconds.
Network island or islanding	A condition in which a portion of the Northpower's network, while electrically separated from the rest of the Northpower's 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.
Non-Exporting Generation	A generation used to offset customer load that does not export electricity into Northpower's network.
Point of Common Coupling (PCC)	Also known as point of common connection. This is the point at which the generator is connected to Northpower's network.
ROCOF	Rate of Change of Frequency protection.
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 not necessary connected to the network.
System Operator	The system operator is responsible for coordinating electricity supply and demand in real-time in a manner that avoids fluctuations in frequency or disruption of supply.

4.0 Health, Safety and Environment

Written approval must be obtained before any generation can be connected to Northpower's network, whether permanent, temporary, or upgrading existing generation capacity (including Distributed Energy Resources and energy storage).

Generation connected to Northpower's network (either directly or via an inverter) poses a potential public safety risk and presents additional risk of damaging another customer or network equipment.

4.1 Public Safety Risk

The potential for a generation to continue generating on Northpower's network (particularly on a faulted network) after Northpower's upstream circuit breaker/s have 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 generation connection and mitigation measures implemented for each risk:

a) Public safety (downed conductor) risk for generation connected to Northpower's Overhead Network (includes upstream overhead and likely back-feed overhead).
b) Sustained Network Islanded risk. If the generation or the generation in combination with other network generation can sustain an island of part of Northpower's network.
c) A combination of the above two factors poses an increased risk.

4.2 Customer Equipment Damage Risk

In the event where generation (or when generation in combination with a cluster of other Distributed Energy Resources) does not trip out immediately following the onset of a network island (generation continues to power a location when the electrical grid is no longer present), an unchecked extreme over-voltage transient fault could result in widespread equipment damage to customer's connected to Northpower's network in the immediate vicinity of the generator.

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

a) Over-voltage due to large DG 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 Northpower's network is anticipated, particularly solar and battery storage-related generation. 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.

5.0 Technical Requirements

All generation must:

- Meet all relevant statutory and regulatory requirements and comply with all applicable safety codes, standards and guides
- Comply with Northpower's requirements in this standard

5.1 Network headroom capacity to host new or increased generation capacity

Generation can only be connected if the required network capacity can host (support) the generation capacity.

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

This network assessment is based on whether the existing network has sufficient margin to accommodate proposed generation, this includes:

- The thermal rating of network assets and fittings
- The impact on the network voltage (steady state and dynamic) – for inverter based DG, Volt Var and Volt Watt compensation is required in accordance with AS/NZS 4777.2
- The fault rating of the network assets and fittings
- Compatibility of the proposed generation
  - Frequency
  - Voltage
  - Number of phases

The capacity assessment will also consider prior generation applications not yet connected to the network.

5.2 Network Islanding

The generation shall not energise any part of Northpower's network that is disconnected from the rest of Northpower's network. The only exception would be specific network assets or fittings on the generation side of the synchronising point. There is nothing to preclude the generation self- supplying load that is part of the generation plant or installation that the generation is connected into.

Anti-islanding protection should be capable of disconnecting the generation within 2 seconds.

5.3 Protection systems

The Distributed Generator Owner shall ensure that all their equipment is adequately protected from the generation risks (mentioned above) and that all elements of the protection 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). Unavailability of the protection and associated equipment shall require the generation to be immediately taken out of service.

The protection systems need to detect and disconnect from the network for both faults in the network and in the generation system. The faults include but are not exclusive to:

- Phase – Phase faults
- Phase – Earth faults
- Loss of a phase

There is a specific requirement to coordinate the protection between Northpower's network and the generation, this will be specified in the detailed design phase.

Each generator shall meet AS/NZS 4777.1 and AS/NZS 4777.2 passive anti-islanding settings for:

- Over-voltage (>V)
- Under-voltage (<V)
- Over-Frequency (>F)
- Under-Frequency (<F)

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

- Active anti-islanding method as per AS/NZS 4777.2.
- ROCOF or Vector Shift.
- Communication based method to actively detect the formation of an upstream island by the upstream circuit breakers open status
- Reverse Power (Only applicable to Non-Exporting Generation to detect power flow into Northpower's network)

Anti-islanding protection methods are not fail safe and therefore in addition to the above, HV (11kV) Neutral Voltage Displacement (NVD) protection (or other equivalent protection) will be required if any part of the upstream HV network (including any alternative network) is overhead line and can remain livened after network feeder protection has tripped.

If a Northpower owned PCC circuit breaker is installed having the required protection elements and SCADA, then the Distributed Generator Owner does not need to provide central protection in addition to generator protection.

Note: Northpower PCC protection does not exclude the Distributed Generator Owner from the requirement of providing generator protection; their DG must contain at least one active anti-islanding protection method.

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-owner's cost) by a Protection Consultant engaged by Northpower meeting the same requirements as is required of the protection study (refer to section 8.0 for further details on Study Report).

5.4 Synchronising

All generator synchronising to the network shall be the responsibility of the generator-owner and Northpower will not be responsible for any damage resulting from out-of-synchronised closing.

The generator owner shall provide and install synchronising at the generator circuit breaker(s). Synchronism checking shall be provided on all generator circuit breakers and any other circuit breakers, unless interlocked, that are capable of connecting the generator output to the network.

Prior to the initial connection of a generator/s to Northpower's network, the generator-owner and Northpower shall agree on the operational procedures necessary for synchronisation.

Northpower owned circuit breakers shall, in general, not be used for the final connection of the generation to Northpower's network (synch closing). Synch closing should be carried out across the generation-owner's circuit-breaker. However, as part of the bespoke design process Northpower will endeavour to configure interlocking on its PCC circuit breaker/s to prevent inadvertent out-of-synch closing.

5.5 Power Quality

The generator shall not inject DC current greater than 0.5% of full rated inverter output current into the PCC.

The generation system shall comply with Northpower's 'ENS 02.01.115 Power Quality Guidelines' in regards to Voltage sag, swells, flicker and harmonics. This guide is based on AS/NZS 61000 suite of standards, NZECP 36 and other industries' practices. In addition, 'Very Large Generation' (greater than 1MW) may have ramp rate limitations based on the response of Northpower on load tap changer response at the Regional and Zone Substations.

The 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 generator's capacity shall be considered the equivalent load capacity for the purposes of applying these standards.

The interconnection system shall have a surge withstand capability, both oscillatory and fast transient, in accordance with the test levels of IEEE/ANSI C62.41 category B3. The protective function equipment shall have a surge withstand capability, both oscillatory and fast transient, in accordance IEC 60255.

The livening of the generation system's electrical network from Northpower's network can produce power quality issues, particularly when energising transformers, therefore a dynamic switching study will need to need undertaken for some generation proposals.

All exporting generation greater than 1MW requires Northpower to install Power Quality Metering (PQM) at the PCC. Besides providing Power Quality recordings this metering is required for Northpower to determine its total response during under-frequency transient events to prove Northpower's compliance to the Electricity Authority and System Operator's load shedding requirements.

5.6 Fault Ride Through

For the stability of the Grid, it is important that generation can ride through voltage and frequency disturbance caused by Grid faults or unplanned events. The requirements are set out in Part 8 of the Electricity Industry Participation Code.

5.7 Approval & Information

Generators with capacity greater than 30MW are required to submit information to the System Operator and receive prior approval before connecting. This requirement is regardless whether the generation is connecting into a distribution network such as Northpower's network or directly to the Grid. Generation greater than 1MW requires notification to the System Operator prior to connection. Where applicable, the Distributed Generator Owner is responsible for advising and ensuring they have obtained the relevant approvals from the System Operator.

Note: Transpower separates the roles and function as Grid Owner and System Operator, so agreeing with the Grid Owner regarding the technical connection arrangement is not notification to the System Operator.

5.8 HV Network Neutral Earthing

The HV network earth reference is at the zone substation for the 11kV network and for the 33kV either at a Northpower regional substation or Transpower's GXP. Northpower does not normally allow other earth references as this may cause mal–operation of Northpower's network protection.

However, an HV earth reference at the generation may be acceptable under certain conditions and Northpower's network is specifically engineered for multiple HV earth reference points. A protection study would need to include multiple earth reference points and any engineering required for multiple earth reference to be included in the 'High Level Design' section of the 'Network Study' report.

This does not prevent the generation system having an earth reference when isolated from Northpower's network for self-supply purposes.

5.9 Multiple Generators

Where the generators connect to the same point of connection and are of the same type and electrical characteristics then they can be treated as a single entity in regard to the connection to Northpower's network. Common examples are solar farms (PV's) and wind farm systems.

Where the multiple generators are different then consideration needs to be given as to the electrical behaviour of each type of generator and the interacting controls between the types

of generators. An example could be a synchronous generator working with a battery storage system, where the protection and control scheme need to consider both the characteristic of the synchronous generator and the grid tied inverter.

5.10 Generator fault and frequency decrease ride through

All generation shall ride though momentary voltage sags as defined by the Code.

6.0 Northpower's Operational requirements

The general operational requirements are:

- A Northpower owned isolation point between the network and the generation
- Northpower has 24-hour legal access to the isolation point (i.e. an easement or other relevant legal access rights)
- The isolation is at or electrically close to the PCC and does not control any other customers

The technical details of the isolation device will form part of the detailed design study.

Depending on the location of generation systems, some systems may have N security and have to be disconnected during maintenance, and for some systems from time-to-time the upstream network configuration may be temporarily changed e.g. the area supplied via a different line or line configuration. Where this configuration has a lower capacity then a 'run back' system may be required, the details of which will form part of the system study and detailed design.

For generation scheme 1MW and above there are more specific operational requirements including key parameters to be monitored by the Northpower SCADA. These specific requirements include:

Electrical Information / Monitoring at or near the point of common coupling

- Power export / import (either in kW or MW) – accuracy +/-5%
- Reactive power export / import (either kVAr or MVAr) – accuracy +/- 5%
- Current– accuracy +/- 5%
- Voltage – accuracy +/- 1.5%
- Power Quality Metering (PQM)

System Status & Events

- Position (open / closed) of controlling circuit breaker or switch
- Protection tripping information e.g. over current, earth fault, inter trip etc.

Operational Control

- Northpower maintains the right to have operational control of the connection switchgear.
- Northpower will determine the nature of the operation control, which can include remote control via the SCADA and/or manual operation
- Northpower requires there be established operational procedures relating to:

- Contact details for planned activities or unplanned events and emergencies
- Isolation to allow work on Northpower's network and the generation system to be undertaken safely
- Standard protocols for re-livening after an outage either on the Northpower or the generation system

7.0 Standby Generation

Standby generation that cannot inject power into Northpower's network is not considered Distributed Generation. These systems generally have a transfer switch that switches between 'Grid' supply and 'generator' supply. This transfer switch can be manual or automatic. Some transfer switches can provide a 'soft' transfer when switching back to the 'grid' supply to avoid a momentary interruption. As this is type of transfer switch only momentarily connects the generation with the 'Grid' it is not considered to be Distributed Generation.

8.0 Network Study Report Requirements

All generators posing a safety risk on Northpower's network will require a network protection study report to be completed (refer to Appendix A).

A network study report will also be required based on scale and complexity of the proposed generation scheme. The Distributed Generator Owner is responsible for producing this report to Northpower's satisfaction. Northpower may have this report peer reviewed, at the Distributed Generator Owner's cost.

The scope of the network study report shall cover the impact the generation will have on Northpower's network and shall include but not limited to the following:

a) A single line diagram overlapping into Northpower's network and including at least two upstream Northpower 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) A fault level impact assessment.
c) Confirmation that the design fault ratings within Northpower's network are not exceeded.
d) Confirmation that thermal ratings of Northpower's network equipment are not exceeded.
e) Demonstrate acceptable HV network (11kV, 33kV) steady state voltage level by means of load flow studies under combinations of maximum and minimum generation, and maximum and minimum network load. If +2.5% of nominal voltage is exceeded then mitigation measures need to be included to demonstrate over-voltages due to the generation will not occur.
f) Precautions taken against network islanding to any part of Northpower's network by way of a risk assessment.
g) Impact on network dynamic voltages.
h) All the above studies are to be done under normal network normal configuration and under network alternative (backstop) configurations.
i) Include proposed protection elements and settings to be used in the generator/inverter and protection elements and settings to be used in the central

protection and/or in the Northpower owned PCC circuit breaker/s. These can be included in the Relay and Instrumentation (R&I) diagram.

j) Showing all protection settings co-ordinate with existing Northpower protection network settings.
k) Demonstrate the power quality issues will not arise especially if the generation output power or the generator output reactive power output is highly variable.
l) Demonstrate no interference to Northpower's ripple control.
m) Include operational procedures necessary for generation synchronisation and the return of Northpower supply following a Northpower outage.
n) If applicable to include operational procedures for Customer islanding including switching of neutral earth points and the reconnection to Northpower's network.
o) 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.
p) Providing recommendations on any network changes required.

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

9.0 Initial Application

Once the Customer has submitted an *'Initial Application Form for Connection of Distributed Generation Greater than 10kW'* (refer to Appendix B), supplied the information about the intended connection and has paid the appropriate application fee, then the process will begin. (see Northpower's website www.northpower.com).

Northpower will advise within 5 business days of receiving the initial application whether the application is complete.

Northpower will then provide the following information within 30 business days:

(a) Information about the capacity of the distribution network, including both the design capacity (including fault levels) and actual operating levels
(b) Information about the extent to which connection and operation of the Distributed Generation may result in a breach of the relevant standards for safety, voltage, power quality, and reliability of electricity conveyed to points of connection on the distribution network
(c) Information about any measures or conditions (including modifications to the design and operation of the distribution network or to the operation of the Distributed Generation) that may be necessary to address the matters referred to in paragraphs (a) and (b)
(d) The approximate costs of any distribution network related measures or conditions identified under paragraph (c) and an estimate of time constraints or restrictions that may delay connecting the Distributed Generation
(e) Information about any further detailed investigative studies that the distributor reasonably considers are necessary to identify any potential adverse effects the Distributed Generation may have on the system, together with an indication of:

(i) whether the distributor agrees to the distributed generator, or a suitably qualified agent of the distributed generator, undertaking those studies; or
(ii) if not, whether the distributor could undertake those studies and, if so, the reasonable estimated cost of the studies that the distributed generator would be charged

(f) Information about any obligations to other parties that may be imposed on the distributor and that could affect the Distributed Generation (for example, obligations to Transpower, in respect of other networks, or under this Code)
(g) Any additional information or documents that the distributor considers would assist the distributed generator's application
(h) Information about the extent to which planned and unplanned outages may adversely affect the operation of the Distributed Generation

These requirements are generally met in Part 1 of our process below:

Part 1 Capacity and compatibility to host generation

This part would generally cover the following

- Assumption used in the network studies
- Key connection requirements
  - Isolation point under Northpower Control
  - Protection requirements for the network
  - Power quality
  - SCADA interface
- Identify the most likely point of connection to the network
- Identify the distance the proposed generation is from the most likely point of connection
- Identify any constraints in the existing network
- Identify any potential network benefits
- If requested, information will be given on the historical reliability and security of supply of the network in relation the application

Part 2 High level design report

If the Customer wishes to proceed but requires more information or firmer costings, or if studies are required, then we would generally move to a detailed design phase, which provides a design capable of being constructed, pricing, and estimated delivery timeframes based on contractor availability:

- Solutions and options to manage any constraints on the existing network
- Connection options
- Ownership demarcations
- An outline of operational protocols that will need to be developed
- Identification of issues needing more detailed engineering studies to develop solutions
- High level costings for technical options and solutions
- An estimate of time frame for the detailed design, equipment procurement and construction

10.0 Final Application

The Customer must make a final application within 12-months after receipt of information from Northpower in Part 1 Capacity and compatibility to host generation above if they intend to proceed to connect the Distributed Generation to Northpower's network. The final application is required to include the results of any investigative studies identified by Northpower as being required to be undertaken by the Customer in the initial application submitted.

If the distributor receives a final application, they must give notice within 10 business days to all individuals who have made an initial application relating to a particular part of the network that would be affected by the approval of the final application, and any other generators that might be affected by the approval.

If the distributor receives another final application within 20 business days of the first application, they may consider the final applications together as if they were competitive bids, and must consider the final applications in light of the purpose of Part 6 of the Code.

In any other case, the distributor must consider any earlier final application as a priority to other final applications.

Refer to Appendix C for *'Final Application Form for Connection of Distributed Generation Greater than 10kW.*

11.0 Notice of intention to proceed

If a distributor advises a generator-owner that its final application is approved, the generator-owner must give written notice to the distributor confirming their intention to proceed to negotiate a connection contract, and if so, confirming the details of the DG and that the generator-owner accepts the conditions specified by the distributor. The generator-owner must do so within 30 business days.

12.0 Pre Commissioning (Pre-Connecting) Requirements

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

The generator-owner shall provide Northpower 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 generator-owner. Northpower or Northpower's representative reserves the right to witness the testing.

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

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

a) Testing and commissioning of the protective equipment shall be agreed between the generator owner and Northpower prior to commissioning.
b) The generator owner shall provide Northpower a testing and commissioning plan well in advance of 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 generator-owner shall keep written records of test results and protection settings. A copy of the records shall be sent to Northpower.

The generator-owner shall provide 24-hour telephone contacts and keep records updated.

13.0 Post Commissioning and Ongoing Maintenance Requirements

The generator-owner shall ensure that all of their associated protection equipment and independent protection including associated inter-tripping:

a) Is available at all times. Unavailability of the protection will require the generation to be immediately taken out of service.
b) Any failure of the generator protection circuit breakers or failure of the circuit breaker secondary circuits or failure of the trip circuits shall be alarmed within the generator owner's installation. Operating procedures shall be put in place to immediately switch out the generation.
c) Regularly maintained in accordance with good electrical industry practice. Records shall be kept of such maintenance and these may be reviewed by Northpower upon request.
d) The protection settings shall be password protected against inadvertent changes.
e) No changes (including settings changes) shall be made to the generator protection or the central protection without Northpower's prior written approval.

14.0 After Connection

The Customer shall provide As-Built information including drawings and schematics to Northpower following connection of the Distributed Generation to the network.

15.0 Document Review History

Version Number	Date	Revision Notes (reason for change)
1.0	19/07/2021	New Document Release

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Appendix A - DG Protection Requirements

Table 1: Protection & Control Requirements

Protection	10 - 200kW			200kW - 1 MW			>1MW		
Generator Type	**Inverter**	**Sych**	**Induction**	**Inverter**	**Sych**	**Induction**	**Inverter**	**Sych**	**Induction**
Overcurrent / Short Circuit	M	M	M	M	M	M	M	M	M
Earth Fault	X1	X1	X1	X1 / P	X1 / P	X1 / P	X1 / P	X1 / P	X1 / P
Under & Over Voltage	M1	M	M	M1	M	M	M	M	M
Under & Over Frequency	M1	M	M	M1	M	M	M	M	M
ROCOF	M1	M	M	M1	M	X2	M1	M	X2
Vector Shift	M1	M	M	M1	M	X2	M1	M	X2
NVD	X1	X1	X	X1	X1	X	X1	X1	X
Dynamic Control Function									
Volt / VAR	M1	P	P	M1 / P	P	P	M1 / P	P	P
Volt / Watt	M1	P	P	M1 / P	P	P	M1 / P	P	P
Power Factor	M1	P	M	M1 / P	P	M	M1 / P	P	M
Ramp Rate	X	X	X	P	P	P	P	P	P
Run Back	M1	X	X	M1 / P	P	P	P	P	P

M Mandatory

M1 Mandatory but Incorporated into AS/NZS 4777.2: 2015 compliant inverters

X Not required

X1 Not required for generation connection into the LV network

X2 Not required where it can be determined that the generator cannot self-excite

P Possibly required depending on the situation (determined by the detailed study)

Note:

The above relates only to Northpower's requirements for the protection of network assets, system reliability and power quality issue that may impact other connected parties. It is not a completed list of protection and control functions that may be required for the safe and reliable operation of the generation equipment.

Table 2 Protection and Control Settings Guide

Protection	Setting (pick – up)	Time Delay	Notes
Overcurrent / Short Circuit	Determined in the detailed study	Determined in the detailed study	Settings depends of power and fault levels, time delay depends on the required discrimination margins with other protection 'upstream' or 'downstream'
Earth Fault	Determined in the detailed study	Determined in the detailed study	
Under & Over Voltage	+/- 10% (excluded generators)	1.0 sec (excluded generator)	See AS/NZS 4777.2 for inverter connected generation
	Generators not excluded see part 8 of the 'code'	Generators not excluded see part 8 of the 'code'	
Under & Over Frequency	+/- 2%	1.0 sec	See AS/NZS 4777.2 for inverter connected generation
	Generators not excluded see part 8 of the 'code'	Generators not excluded see part 8 of the 'code'	
ROCOF	0.5 - 1 Hz/s	0.5 - 1.0 sec	Setting will depend on a number of factors including type of generation
Vector Shift	6 – 12 degrees	No delay	Setting will depend on a number of factors including type of generation
NVD	5% - 20%	1.0 - 3.0 sec	Setting will depend on a number of factors including type of generation
Dynamic Control Function			
Volt / VAR	Determined in the detailed study	Determined in the detailed study	See AS/NZS 4777.2 for inverter connected generation
Volt / Watt	Determined in the detailed study	Determined in the detailed study	See AS/NZS 4777.2 for inverter connected generation
Power Factor	Determined in the detailed study	Determined in the detailed study	Unless needed to manage Voltage between 0.95 lagging and 0.95 leading would be the default requirement
Ramp Rate	Determined in the detailed study	Determined in the detailed study	Generally required to allow network on load tap changers to respond
Run Back	Determined in the detailed study	Determined in the detailed study	Will depend on short term overload capability of assets. May need to respond within a seconds of the triggering event occurring

Note:
The 'Code' refers to the 'Electricity Participation Code

Appendix B - Initial Application Form for Connection of Distributed Generation Greater than 10kW

Initial Application Form for Connection of Distributed Generation (>10kW)

Please complete the following information and forward to Northpower

Contact Details		
Primary Contact (who we should contact for additional information)		
Contact person		
Company name		
Contact numbers	**Daytime:**	**Cell phone:**
	Fax:	
Email address		
Postal address		
Secondary Contact		
Contact person		
Company name		
Contact numbers	**Daytime:**	**Cell phone:**
	Fax:	
Email address		
Postal address		

Site Details	
Electricity Retailer	
Customer ICP number	
Site address of proposed generator	

Proposed Installation Dates	
Proposed key dates for connection to Northpower's electricity network	

System Specifications (for all generation >10kW)	
Generating Plant Data	
Terminal volts (kV)	
Rated kVA	
Rated kW	
Maximum active power sent out (kW max)	
Reactive power requirements (kVAr), if any	
Power Factor at maximum kW	
Type of generating plant (e.g. synchronous, asynchronous)	
Type of prime mover	
Anticipated operating regime of generation e.g. continuous, intermittent, peak lopping	
Fault level contribution (for large machines this may be covered in the detailed specifications below)	
Method of voltage control	
Generator transformer details, as applicable	Attached
Fuel type	
Requirements for top-up supplies and/or standby supplies	
Interface Arrangements	
The means of synchronisation between the Distribution Network and the Generator	
Details of arrangements for connecting with earth that part of the Generator's system directly connected to the distribution system	Attached
The means of connection and disconnection which are to be employed	Attached
Ability of plant to backfeed the external system	
Protection equipment, protection schemes and protection setting	Attached
Precautions to be taken to ensure the continuance of safe conditions should any earthed neutral point of the Generator's system operated at HV become disconnected from earth	Attached

Detailed Specifications For distributed generators connected at voltages equal to or greater than 6.6kV or of capacity 1MW or greater, please also complete the following information:		
Technical Data		
Generating plant information (impedances p.u. on rating)		Attached
Type of prime mover		
Rated MVA		
Rated MW		
Generator MW/MVAr capability chart (at terminals)		
Type of excitation system		
Inertia constant MW secs/MVA (whole machine)		
Stator resistance		
Direct axis reactances	*- Sub-Transient*	
	- Transient	
	- Synchronous	
Quadrature axis reactances	*- Sub-Transient*	
	- Synchronous	
Time constants	*- Direct axis Transient*	
	- Direct axis Sub-Transient	
	- Quadrature Axis Transient	
	- Quadrature Axis Sub-Transient	
Open or short	*- Sub-Transient (stating either circuit time constant)*	
Zero sequence	*- Resistance*	
	- Reactance	
Negative sequence	*- Resistance*	
	- Reactance	

Generator transformer	*- Resistance (RI, Rø)*	
	- Reactance (XI, Xø)	
	- MVA Rating	
	- Tap arrangement	
	- Earthing	
Automatic voltage regulator		
A block diagram for the model of the AVR system including the data on the forward and feedback gains, time constants and voltage control limits		Attach
Speed governor and prime mover data		Attach
A block diagram for the model of the generating plant governor detailing the governor flyball, if applicable, and system control and turbine time constants, together with the turbine rating and maximum power		Attach
The means of synchronisation between the Distribution Network and the Generator		
Details of arrangements for connecting with earth that part of the Generator's system directly connected to the distribution system		Attached
The means of connection and disconnection which are to be employed		
Ability of plant to backfeed external system		
Protection equipment and protection setting		Attach
Precautions to be taken to ensure the continuance of safe conditions should any earthed neutral point of the Generator's system operated at HV become disconnected from earth		Attached

Capacity and standby requirements	
Registered capacity and minimum generation of each generating unit and power station in MW	
Generating unit and power station auxiliary demand (active power and reactive power) in MW and MVAr, **at registered capacity conditions**. For Users with own generation, this should include top-up requirements.	
Generating unit and power station auxiliary demand (active power and reactive power) in MW and MVAr, **under minimum generation conditions**. For Users with own generation, this should include top-up and standby requirements.	

Further information required by Transpower

Generators with large machines may be subject to the Transpower Connection Code, part C of the Electricity Governance Rules and central dispatch. Where this applies any information supplied to Northpower, and any further information requested by Transpower will be forwarded to Transpower. It will be the responsibility of the Generator to provide the information required to Northpower. Northpower will pass on the information to Transpower.

There may also be information required under the terms of any Transpower contract in respect of the transfer of energy from the Generator to the Generator's Customer.

Applicant Signature

Name	
Signature	
Date	

Appendix C - Final Application Form for Connection of Distributed Generation Greater than 10kW

Final Application Form for Connection of Distributed Generation (>10kW)

Please complete the following information and forward to Northpower

Contact Details		
Primary Contact (who we should contact for additional information)		
Contact person		
Company name		
Contact numbers	**Daytime:** **Fax:**	**Cell phone:**
Email address		
Postal address		
Secondary Contact		
Contact person		
Company name		
Contact numbers	**Daytime:** **Fax:**	**Cell phone:**
Email address		
Postal address		

Site Details	
Electricity Retailer	
Customer ICP number	
Site address of proposed generator	

Proposed Installation Dates	
Proposed key dates for connection to Northpower's electricity network	

System Specifications (for all generation >10kW)	
Generating Plant Data	
Terminal volts (kV)	
Rated kVA	
Rated kW	
Maximum active power sent out (kW max)	
Reactive power requirements (kVAr), if any	
Power Factor at maximum kW	
Type of generating plant (e.g. synchronous, asynchronous)	
Type of prime mover	
Anticipated operating regime of generation e.g. continuous, intermittent, peak lopping	
Fault level contribution (for large machines this may be covered in the detailed specifications below)	
Method of voltage control	
Generator transformer details, as applicable	Attached
Fuel type	
Requirements for top-up supplies and/or standby supplies	
Interface Arrangements	
The means of synchronisation between the Distribution Network and the Generator	
Details of arrangements for connecting with earth that part of the Generator's system directly connected to the distribution system	Attached
The means of connection and disconnection which are to be employed	Attached
Ability of plant to backfeed the external system	
Protection equipment, protection schemes and protection setting	Attached
Precautions to be taken to ensure the continuance of safe conditions should any earthed neutral point of the Generator's system operated at HV become disconnected from earth	Attached

Detailed Specifications For distributed generators connected at voltages equal to or greater than 6.6kV or of capacity 1MW or greater, please also complete the following information:		
Technical Data		
Generating plant information (impedances p.u. on rating)		Attached
Type of prime mover		
Rated MVA		
Rated MW		
Generator MW/MVAr capability chart (at terminals)		
Type of excitation system		
Inertia constant MW secs/MVA (whole machine)		
Stator resistance		
Direct axis reactances	*- Sub-Transient*	
	- Transient	
	- Synchronous	
Quadrature axis reactances	*- Sub-Transient*	
	- Synchronous	
Time constants	*- Direct axis Transient*	
	- Direct axis Sub-Transient	
	- Quadrature Axis Transient	
	- Quadrature Axis Sub-Transient	
Open or short	*- Sub-Transient (stating either circuit time constant)*	
Zero sequence	*- Resistance*	
	- Reactance	
Negative sequence	*- Resistance*	
	- Reactance	

Generator transformer	*- Resistance (RI, Rø)*	
	- Reactance (XI, Xø)	
	- MVA Rating	
	- Tap arrangement	
	- Earthing	
Automatic voltage regulator		
A block diagram for the model of the AVR system including the data on the forward and feedback gains, time constants and voltage control limits		Attached
Speed governor and prime mover data		Attached
A block diagram for the model of the generating plant governor detailing the governor flyball, if applicable, and system control and turbine time constants, together with the turbine rating and maximum power		Attached
The means of synchronisation between the Distribution Network and the Generator		
Details of arrangements for connecting with earth that part of the Generator's system directly connected to the distribution system		Attached
The means of connection and disconnection which are to be employed		
Ability of plant to backfeed external system		
Protection equipment and protection setting		Attached
Precautions to be taken to ensure the continuance of safe conditions should any earthed neutral point of the Generator's system operated at HV become disconnected from earth		Attached

Capacity and standby requirements	
Registered capacity and minimum generation of each generating unit and power station in MW	
Generating unit and power station auxiliary demand (active power and reactive power) in MW and MVAr, **at registered capacity conditions**. For Users with own generation, this should include top-up requirements.	
Generating unit and power station auxiliary demand (active power and reactive power) in MW and MVAr, **under minimum generation conditions**. For Users with own generation, this should include top-up and standby requirements.	

Further information required by Transpower

Generators with large machines may be subject to the Transpower Connection Code, part C of the Electricity Governance Rules and central dispatch. Where this applies any information supplied to Northpower, and any further information requested by Transpower will be forwarded to Transpower. It will be the responsibility of the Generator to provide the information required to Northpower. Northpower will pass on the information to Transpower.

There may also be information required under the terms of any Transpower contract in respect of the transfer of energy from the Generator to the Generator's Customer.

Supporting information attached for review

Please list any attached reports/studies that require Northpower's review (as outlined during the initial application phase).

Applicant Signature

Name	
Signature	
Date	