Northpower
Electricity Network

Network Distributed Generation Design Standard

Document summary

This document details the Design Requirements for the connection of large scale (>1MW) Distributed Generation (“DG”) systems to Northpower electricity distribution network.

Document Approval

Version	1
Document Owner	Shaun BROWN General Manager - Engineering and Delivery
Document Approver	Shaun BROWN General Manager - Engineering and Delivery
Date Published	19/02/2026
Date for Next Review	18/02/2029

Controlled Document

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1.0 Introduction

1.1 Purpose

This Standard provides Northpower's design requirements and expectations for Distributed Generation (DG) projects connecting to the network at 11kV, 33kV and above voltage levels.

It applies to all DG installations, from concept through detailed design, construction, commissioning, and handover.

This document is intended to:

- Establish a consistent and standardised approach to the design of Distributed Generation (DG) connections to the network.
- Ensure DG installations support network safety, security of supply, power quality, and operational control requirements.
- Provide a clear technical baseline and design expectations for DG developers, consultants, contractors and internal engineering teams.
- Enable effective long-term operation, maintenance and seamless integration of DG assets into the wider distribution network.

1.2 Application

This standard applies to all distributed generation systems >1MW that are intended to be connected to Northpower's network. It is mandatory for all such systems to comply with the requirements outlined in this standard to ensure safe, reliable, and efficient integration to Northpower network. For generation systems between 300kW and 1MW, a bespoke design approach will be required. The detailed technical specifications for this capacity range will follow in a subsequent update to this standard.

1.3 Scope

The scope of this Standard ensures that all DG installations are technically compliant, safe, reliable and operationally compatible with the network.

The scope extends up to the Point of Connection (POC) and covers:

- Minimum design and protection requirements.
- Communication and control system integration.
- Building, civil, and electrical infrastructure standards.
- Access, operational, safety and maintenance considerations.
- Documentation and drawing expectations.

This document does not relieve the Distributed Generator Owner of the need to read, understand and comply with its obligations set out in the Code, nor does it replace any process presently used by the system operator to commission a new generating station.

It should be read in conjunction with the below References.

2.0 References

Internal Reference	Details
APL.S.200.02 Technical Requirements for Large Scale Distributed Generation Standard	Technical Requirements for Large Scale Distributed Generation Standard
AED.G.206.01 Network Protection Design Guidelines	This document details the design and setting guidelines for all new protection systems on Northpower's HV and LV electrical network.
APL.S.206.01 Network Protection Philosophy	High-level philosophy for all new protection systems on Northpower's HV and LV electrical network.
AED.S.200.03 Network Equipment Commissioning Standard	Northpower's technical policies and minimum test requirements for the commissioning of network electrical equipment in all regions of Northpower's electricity networks.
AED.S.200.01 Northpower Approved Materials and Suppliers Standard	This document has been prepared for the use of outlining Northpower network's approved materials for use by contractors constructing electricity distribution reticulation The standard also defines the preferred supplier and alternative suppliers of the equipment.
AED.S.200.04 Electricity Reticulation Design Standard	This standard details Northpower's requirements for the design of electricity distribution infrastructure to be connected to Northpower's network.
AED.S.202.01 Electricity Reticulation Underground Design Standard	This standard defines Northpower's requirements for the design and configuration of underground distribution network and associated ground mounted equipment for voltages up to and including 11kV.
AED.S.02.01 Overhead Line Design Standard	This standard provides Northpower's requirements for overhead line design on Northpower's Distribution and Sub Transmission Network
AED.S.209.01 Zone Substation and Distribution Earthing Design Standards	The objective of this standard is to ensure that design of power systems earthing infrastructure is completed in a safe and consistent manner for staff of Northpower and for members of the public.
CST.S.100.01 Land Entry Standard	This document provides Northpower's requirements for entry to private land or other property for construction, repairs, maintenance and operation of Northpower's electricity network and includes both planned and emergency works.
AED.S.200.05 Safety Signage and Identification Labelling Standard	This standard provides Northpower's requirements for safety signage and identification labelling of electricity and telecommunications reticulation, equipment and buildings
NIM.S.203.01 Substation Equipment Data Standard	This document is intended to ensure Northpower's requirements for Substation Equipment are understood and applied to a consistent standard. These requirements cover the collection, storage and quality of data.

NIMS.S.205.01 Distribution Equipment Data Standard	This document is intended to ensure Northpower's requirements for Distribution Equipment is understood and applied to a consistent standard. These requirements include the collection, storage and quality of data.
NIMS.S.203.01 Substation Equipment Data Standard	This document is intended to ensure Northpower's requirements for Substation Equipment are understood and applied to a consistent standard. These requirements cover the collection, storage and quality of data.
APL.S.200.03 Legal Protection Requirements for Electricity Reticulation Standard	This standard summarises the legal protections for Northpower's electricity Assets; and details Northpower's requirements for implementing and using those legal protections.

External Reference	Details
	Electricity Industry Act 2010
	Electricity Act 1992
	Electricity (Safety) Regulations 2010
www.ea.govt.nz	Electricity Industry Participation Code (EIPC)
AS/NZS 4777.1:2024	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 5033:2021	Installation and safety requirements for photovoltaic (PV) arrays
Concrete NZ Technical Specification 01:2021	Surface Regularity Requirements for Concrete Floors
AS/NZS 3000:2018	Electrical Installations "Wiring Rules"

3.0 Definitions

3.1 Definitions and Acronyms

Terminology	Definition
AC	Alternating Current - An electric current that periodically reverses direction, typically used for power distribution in homes and industries.
ACS	Asset Capability Statement – Communicates plant characteristics from DG owners to Northpower and the system operator.
AOPO	Asset Owner Performance Obligations – Obligations of the asset owner under applicable codes and standards.
ANSI	American National Standards Institute – Defines standard protection function codes used in relay schemes.
ANM	Adaptive Network Management – A real-time control system that optimizes DG output based on network conditions.
AVR	Automatic Voltage Regulator – Device that maintains generator terminal voltage within limits.
CB	Circuit Breaker – A switch designed to protect an electrical circuit from damage caused by overload or short circuit.
CPCB	Connection Point Circuit Breaker – Primary isolation and protection interface between Northpower and the generation plant (owned by Northpower).
CPPR	Connection Point Protection Relay – Associated protection relay for CPCB
DC	Direct Current - An electric current that flows in one direction only, commonly used in batteries and electronic devices.
DG	Distributed Generation – Electricity generation plant connected to the distribution network.
DNP3	Distributed Network Protocol – Communication protocol used for SCADA and control systems.
EIPC	Electricity Industry Participation Code – Regulatory code governing electricity industry participation in NZ.
FRL	Fire Rating Level - A measure of how long a building element (such as a wall, door, or enclosure) can withstand fire exposure while maintaining structural integrity, insulation, and containment.
GPCB	Generating Plant Circuit Breaker – Circuit breaker on the generator side of the Point of Connection (owned by generator).
GPS	Global Positioning System – Used for time synchronization of SCADA and protection systems.
HV	High Voltage – Typically refers to voltages above 11kV in this context.
ICCP	Inter-Control Centre Communications Protocol – Protocol for data exchange between control centres.
IL	Importance Level – Building classification level per AS/NZS 1170 standards.

I/O	Input/Output – Digital and analogue signals for protection and control systems.
LST	Local Service Transformer – Transformer providing auxiliary supply for protection and control systems.
LV	Low Voltage – Typically refers to voltages below 1kV.
MCB	Miniature Circuit Breakers - A protective device that automatically switches off electrical circuits during overload or short-circuit conditions.
MW	Megawatt – Unit of real power.
MVAr	Megavolt-Ampere Reactive – Unit of reactive power.
NOC	Network Operations Centre – Northpower's control centre for monitoring and control.
NEE	Network Equipment Evaluation – Process for assessing suitability of equipment for network use.
POC	Point of Connection – Physical point where DG assets connect to Northpower assets; electricity may flow into or out of the network.
PQ	Power Quality – Measurement of voltage, frequency, and harmonics to ensure compliance.
RCD	Residual Current Device - A safety device that disconnects a circuit when it detects leakage current to prevent electric shock.
R&I/RID	Relay and Instrumentation Diagram – Drawing showing protection and control wiring and devices.
ROCOF	Rate of Change of Frequency – Protection function detecting rapid frequency changes, used for anti-islanding.
RTU	Remote Terminal Unit – Device for SCADA data acquisition and control.
SCADA	Supervisory Control and Data Acquisition – System for remote monitoring and control of network assets.
SID	SCADA Integration Diagram – Diagram showing SCADA communication and integration points.
SLD	Single Line Diagram – Simplified representation of electrical connections in a system.

3.2 ANSI Protection Function Codes

Terminology	Definition
25	Synchronizing Check – Ensures voltage, frequency, and phase match before breaker closure.
27	Undervoltage – Trips when voltage falls below set limits.
50/51	Instantaneous and Time Overcurrent – Protects against excessive current flow.
50N/67N	Earth Fault Protection – Detects ground faults using residual current or directional sensing.
59	Overvoltage – Trips when voltage exceeds set limits.
59N	Neutral Voltage Displacement – Detects loss of neutral or earth faults.
79	Auto-Reclose – Automatically recloses breaker after trip (not permitted on DG feeders).
81U/81O	Under-frequency / Over-frequency – Trips for frequency deviations beyond limits.
81R	ROCOF – Detects rapid frequency changes for anti-islanding.
87L	Line Differential Protection – Compares currents at both ends of a line to detect faults.
96	Vector Shift – Detects sudden phase angle changes for islanding detection.

4.0 Overview

4.1 Design Governance and Control

Northpower Network maintains responsibility for reviewing and approving all DG designs that connect to its electricity network up to the defined POC. External designers, consultants, and contractors must ensure their designs meet the minimum design, safety, and operational requirements outlined in this standard for approval. All external designers, consultants, and contractors must therefore comply with the minimum design, safety, and operational requirements specified in this standard.

4.2 Design Scope and Terms of Reference

4.2.1 Design

Northpower Network retains full ownership, authority, and technical oversight of the design for assets that belong to Northpower on its side of the POC. This includes all equipment and infrastructure required to integrate the DG into Northpower's network. External designers, consultants, and contractors must comply with the minimum design, safety, and operational requirements specified in this standard, as well as any additional design criteria specified by Northpower. Northpower does not own or assume responsibility for the design of any generator or generator asset owned equipment beyond the POC.

4.3 Terms of Reference

Northpower shall set out the requirements for connecting to the Northpower network. These requirements will be based on APL.S.200.02 Technical Requirements for Large Scale Distributed Generation Standard and an initial response shall be completed. The intent is to provide sufficient information for generation asset owner to undertake studies and prepare the conceptual design prior to a detailed design scope being developed.

4.4 Equipment and Installation Requirements

All equipment and materials used for DG connections shall be standardised and approved in accordance with the AED.S.200.01 Northpower Approved Materials and Suppliers Standard, which lists authorised manufacturers, models, and part numbers suitable for network use.

All installed equipment shall be clearly identified with durable nameplates and unique asset IDs compliant with the AED.S.200.05 Safety Signage and Identification Labelling Standard. This includes the application of safety signage and labels, as applicable to the equipment type and installation environment.

Equipment shall also incorporate PQ monitoring and recording facilities at the POC to measure voltage, current, frequency, and harmonics. Earthing requirements shall be implemented in accordance with Northpower's AED.S.209.01 Zone Substation and Distribution Earthing Design Standard, along with cable segregation and arc-flash protection measures to ensure operational safety and maintainability.

If equipment not listed in Northpower's AED.S.200.01 Approved Materials and Suppliers Standard is proposed for use, it must first undergo a Network Equipment Evaluation process by Northpower Network Engineering to confirm its suitability and compatibility before approval.

4.5 Easement

The generation asset owner shall provide easements and comply with APL.S.200.03 Northpower's Legal Protection Requirements for Electricity Reticulation Assets for entry to private land or other property for construction, repairs, maintenance, and operation of Northpower's electricity network. These requirements are separate from CST.S.100.01 Land Entry Standard, which covers Northpower's obligations to the property owner.

4.6 Compliance Enforcement

The generation asset owner must comply with Northpower's standards for the legal protection of electricity reticulation assets and for access to private land or other property for construction, maintenance, and operation of the network.

5.0 DG Electrical Connection Interface

Generation plants connecting to the Northpower network must interface through a Northpower switching station located at or near the generation plant. The switching station shall meet the following minimum requirements:

- Northpower-owned switchgear with circuit breakers or a switchboard equipped with approved CBs, capable of being isolated from the network during required maintenance.
- For DG installations at 33 kV and above, Northpower requires indoor switchgear housed in a controlled environment (e.g., air-conditioned building or enclosure). For 11 kV distribution-level DG installations, outdoor switchgear is acceptable provided it meets all relevant standards and safety requirements.
- Protection system installed and configured in accordance with the APL.S.206.01 Northpower Network Protection Design Guidelines and Network Protection Philosophy.
- Northpower Supervisory Control and Data Acquisition system with communication and control capabilities compliant with the approved DNP3 protocol.
- Northpower Power Quality monitoring and recording equipment for ongoing visibility of network performance.
- The site should have 24 hours, 7 days a week unimpeded access to competent Northpower staff in order to operate, maintain and inspect the connection assets.

Design considerations shall address ownership boundaries and demarcation points between Northpower and the DG owner. These ownership and demarcation points shall also be clearly defined and reflected in the initial conceptual design submissions, including the SLD, R&I, site layout.

5.1 Equipment Naming Compliance

All Northpower equipment naming, tagging, and asset identification used for DG installations shall comply with the relevant Northpower Equipment Data Standards, specifically NIMS.S.203.01 Substation Equipment Data Standard and NIMS.S.205.01 Distribution Equipment Data Standard. Compliance shall also include adherence to AED.S.200.05 Safety Signage and Identification Labelling Standard. This covers the assignment of asset IDs, functional equipment names, and any associated data attributes.

5.2 Northpower Point of Connection Circuit Breaker

All generation plant connecting to the Northpower network are required to interface through a Northpower owned Connection Point Circuit Breaker (CPCB). The CPCB serves as the primary isolation and protection interface between the Northpower network and the generation plant.

The revenue metering point shall be installed within the generation facility at a location agreed with Northpower. Northpower will not provide a revenue metering connection.

Figure 1 illustrates the arrangement between the CPCB (Northpower side) and the Generating Plant Circuit Breaker (GPCB) (generation side), with a dedicated connection link between them. No other electrical equipment shall be installed or connected along this link.

Figure 1:Point of Connection Circuit Breakers

5.2.1 New Sub transmission Feeder at Transpower Grid Exit Point (GXP)

Generation Asset Owners are required to engage directly with Transpower if their proposed generation plant connection is to be made at, or directly to, Transpower-owned assets located at a Grid Exit Point (GXP).

In such cases, Northpower will not provide technical advice or design guidance, as these connections fall under Transpower's jurisdiction and approval process.

5.2.2 New Sub-transmission Feeder at Northpower Owned Bus

Two connection options are available for linking to a Northpower-owned bus at the substation.

Figure 2 and Figure 3 illustrates the arrangement of the sub-transmission feeder, and its demarcation.

Figure 2 represents a configuration using a dedicated Northpower-owned feeder.

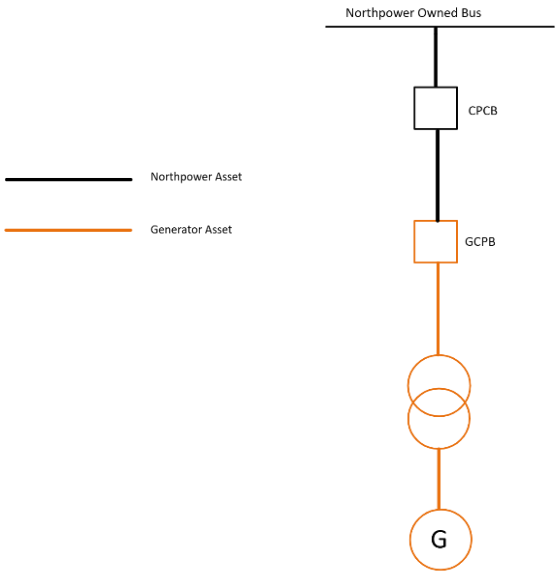

Figure 2: Dedicated sub-transmission feeder

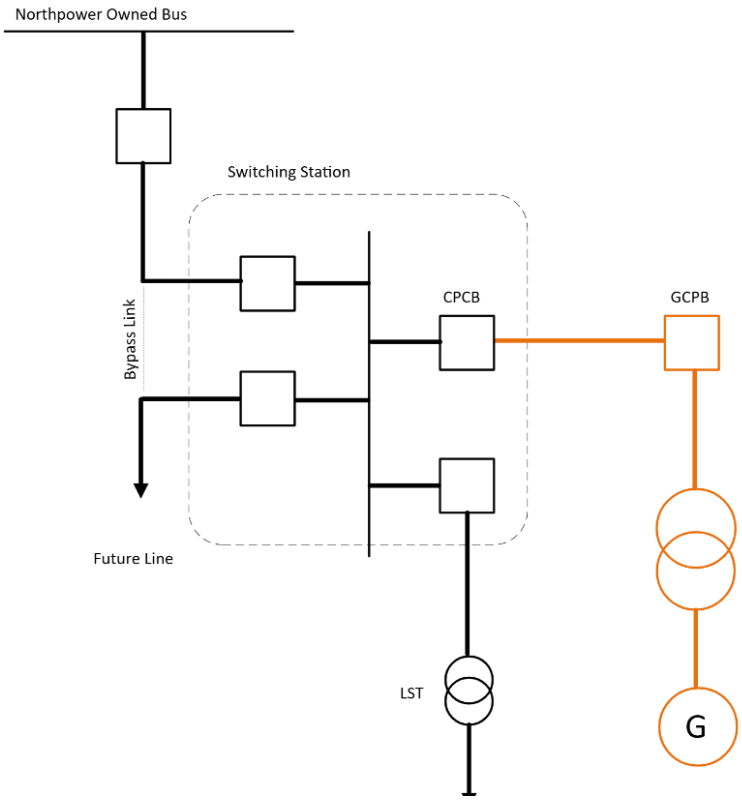

Figure 3: In-out configuration on sub-transmission network

5.2.3 Connection to existing sub-transmission circuits

Figure 4 and Figure 5 illustrate the in–out connection configurations applicable to the Northpower sub-transmission network, representing the two typical topologies used for DG integration.

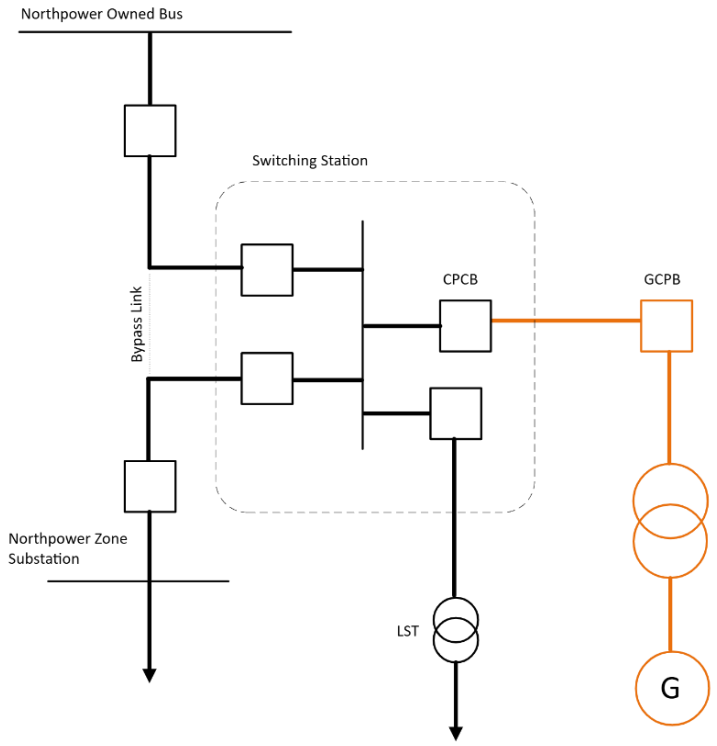

Figure 4: In-out from radial sub-transmission feeder

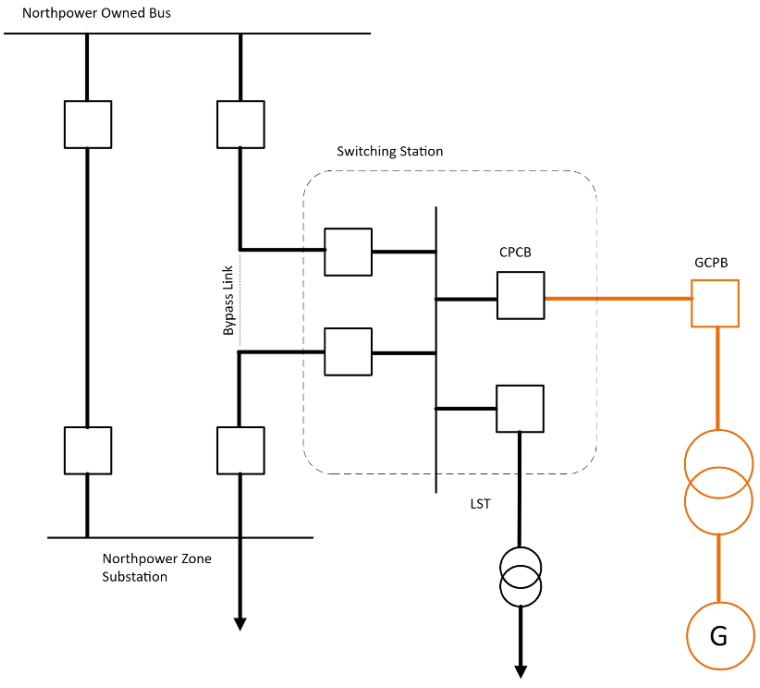

Figure 5: In-out from radial from meshed sub-transmission feeder

5.3 Preferred Distribution Connection Configuration

This section outlines the preferred connection configurations for DG connecting to the Northpower distribution network at 11 kV.

5.3.1 Connection to Existing Distribution Feeders

Connections to Northpower's existing distribution feeders shall be designed to ensure that supply security for existing customers is not compromised.

Figure 6 illustrates a typical configuration using a distribution switching station, which allows safe feeder section isolation and to include a visible break for DG isolation during maintenance works. If a three-way switchboard arrangement is not practicable, a tee-off configuration may be permitted upon review and approval by Northpower's Protection and Network Planning teams, provided that all security, protection, and communication requirements are met (Figure 6).

If the existing 11 kV network where the DG will be connected is currently configured as a radial system with unidirectional power flow, an in-out configuration is not required. However, if the existing network can be operated with bi-directional power flow through network switching, the DG connection shall be established using an in-out configuration to maintain the existing network flexibility and capability.

Where an in-out configuration cannot be achieved due to network limitations, a tee-off configuration may be permitted subject to review and approval by Northpower's Protection and Network Planning teams, ensuring all security, protection, and communication requirements are met. For DG installations connected via a tee-off radial circuit (as illustrated in Figure 7) a pole-top circuit breaker may be used for DG capacities up to 2.9 MVA. The pole top circuit breaker is to be installed in a Northpower controlled compound where the control box can be accessed by personnel at ground level. It shall include a pole top isolation switch to allow for safe isolation of the pole top circuit breaker and the network.

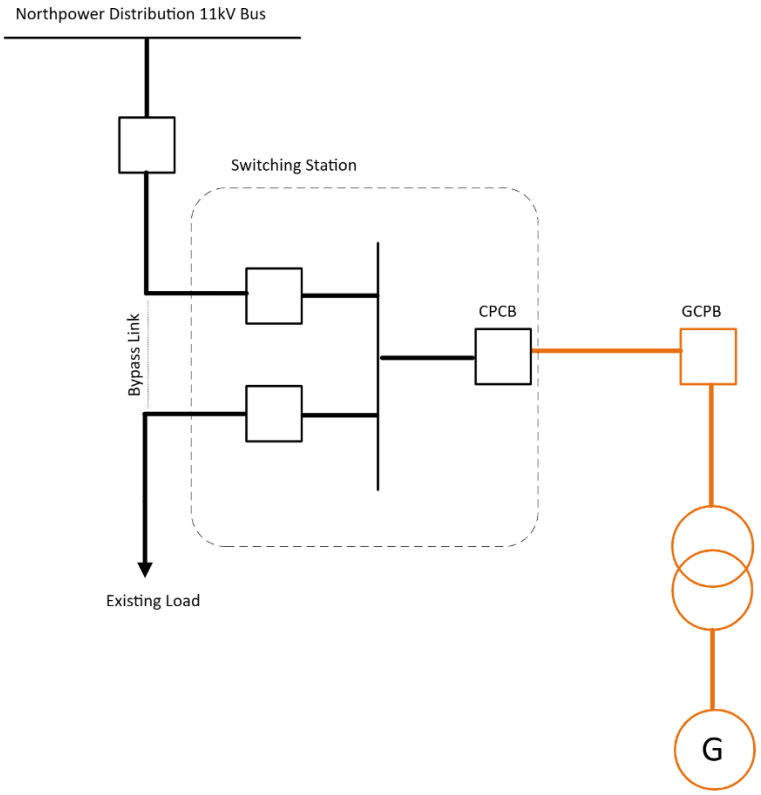

Figure 6: In-out from radial distribution feeder

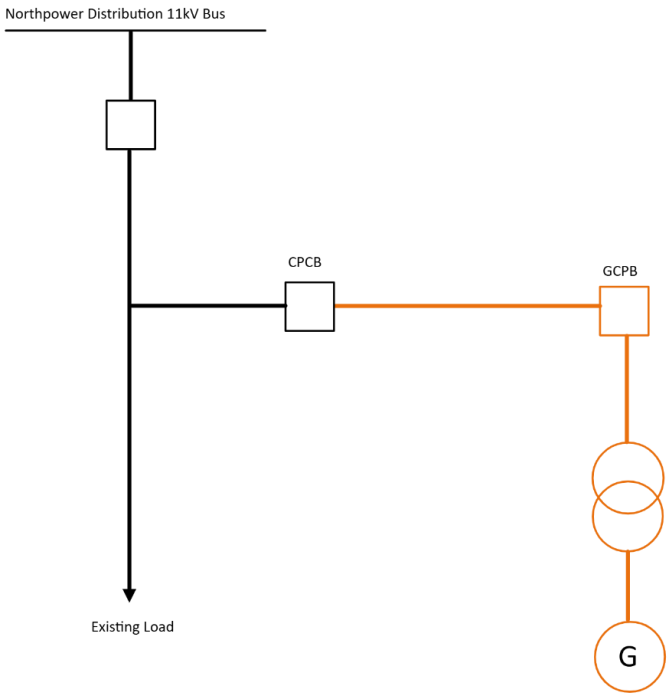

Figure 7: Distribution Tee-off from radial circuit

5.3.2 New Distribution Feeder to Northpower Zone Substation

A new distribution feeder originating from a Northpower zone substation may be connected radially, as illustrated in Figure 8.

If provision has been made in the substation for future expansion, any bay used for the DG connection must be reinstated by the generation asset owner.

This configuration provides a dedicated path for the DG plant connection, ensuring clear demarcation, reliable operation, and ease of isolation during network switching or maintenance activities.

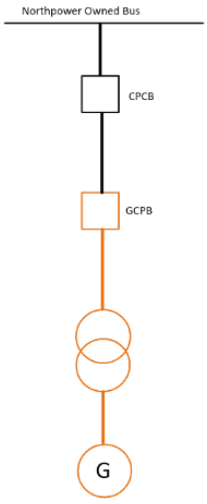

Figure 8: Dedicated feeder for Northpower Zone Substation

5.4 Provision for Bypass

For an in-and-out configuration, a provision for a bypassing thru a jumper arrangement shall be available as part of the design of the DG point of connection.

6.0 Protection Requirements

Protection systems are critical for maintaining safety, network stability, and reliable isolation of distributed generation during fault, abnormal, or islanding conditions. All DG connections shall comply with Northpower's Network Protection Design Guidelines AED.G.206.01 and Philosophy APL.S.206.01.

6.1 Protection Coordination and Grading

Both primary and backup protections must meet sensitivity and operating-speed requirements consistent with Northpower Protection Design Guidelines. Protection coordination studies shall demonstrate time and current grading with all upstream and downstream devices. All DG schemes shall incorporate anti-islanding, synchronization, and inter-tripping functions as applicable.

6.2 Scheme Integration

Protection relays must integrate with the control and SCADA systems for monitoring, alarm, and remote reset. Time-stamped events shall be synchronised via GPS. All protection configurations must be reviewed and approved by the Northpower Network before commissioning.

6.1 Connection Point Protection Relay (CPPR)

A dedicated Connection Point Protection Relay shall be installed as close as practicable to the Point of Connection. The CPPR shall:

- Monitor voltage, frequency, and current to detect faults, over-/under-voltage, and frequency deviations.
- Trip the CPCB and initiate isolation under abnormal conditions.
- Prevent export when the CPPR is offline or unavailable.
- Support remote status and command through SCADA integration.

CPPR settings shall ensure proper grading with Northpower zone substation protection and Transpower GXP relays where applicable.

6.2 Protection Philosophy and Operating Speed

Primary and backup protection must clear faults within the defined primary clearance time

For subtransmission-connected DG installations, primary protection shall provide instantaneous fault clearing for all types of faults. Backup protection clearing times shall be set with consideration of the applicable voltage and frequency ride-through requirements for inverter-based generators, and the critical clearing time for rotating generators.

For distribution-connected DG installations, inverter-based generators shall have protection clearing times coordinated with their voltage and frequency ride-through capability, while rotating generators shall be coordinated with their critical clearing time.

All protection settings shall coordinate with upstream Northpower protection devices, maintaining a minimum coordination time interval of 400 ms.

Backup Protection shall operate independently and provide redundancy if primary protection function fails.

6.3 Minimum Protection Requirements

Minimum protections for DG connections shall be implemented as per table below. All connections must include at least the Mandatory (M) functions; Optional (O) or Conditional (C) requirements depend on the connection type and network study.

The minimum protection requirements specified herein shall be applicable to all types of generating technologies, including inverter-based generators, rotating asynchronous generators (with or without rotor circuit inverters), and rotating synchronous generators.

Function	ANSI Code	11kV DG	33kV DG	Remarks
Overcurrent	51/67	M	M	Phase and directional OC as required by network topology
Earth Fault	50N/67N	M	M	Residual or sensitive EF for ground fault protection
Neutral Voltage Displacement	59N	M	M	Detect loss of neutral or earth faults
Under/Over-frequency	81U/81O	M	M	Disconnect for frequency deviation beyond Code limits
Rate of Change of Frequency (ROCOF)	81R	O	O	Used for anti-islanding where suitable
Over/Under-voltage	27/59	M	M	Protect equipment from sustained voltage excursions
Line Differential Protection	87L	C	M	Mandatory for critical feeders or looped networks
Inter-tripping	—	C	C	Required where remote breaker coordination is needed
Dead Bus Check	—	M	M	Prevent inadvertent energisation of dead busbars
Synchronising Check	25	M	M	Confirm phase, frequency, and voltage match before closure
Backup Relay (P2)	—	O	C	Redundant trip path for CPCB failure
Auto-Reclose	79	-	-	Not permitted on DG feeders

Table 1: Minimum Protection Requirement for Northpower side

Requirement	11kV DG	33kV DG	Remarks
Protection Report	M	M	Subject to initial review by Northpower Engineering
Generator plant circuit breaker (GPCB)	M	M	
Undervoltage (27) Protection	M	M	
Overvoltage (59) Protection	M	M	
Under-frequency (81U) Protection	M	M	
Over-frequency (81O) Protection	M	M	
Active Anti-islanding Protection	M	M	Optional for rotating machine generators
NVD (59N) Protection	M	M	
Synchronising Check (25) before closing GPCB	M	M	
Prevent closing GPCB onto dead bus/line	M	M	
OC (51) Protection	M	M	
EF (50N) Protection	M	M	
Local Protection within Generation Plant [R19]	M	M	
Protection Maintenance Plan	M	M	
Auto Reclose (79) on GPCB	-	-	Not permitted on DG feeders
Generator Pole Slip	M	M	Not required for inverter-based generators

Backup (CB Fail) for CPCB	M	M	
Inverter Integrated Protection	M	M	Not required for rotating machine generators
Rate of Change of Frequency (81R) Protection	O	O	
Vector Shift (96) Protection	O	O	
DC System	M	M	

Table 2:Minimum Protection Requirements for Generation Plant

6.4 Standard I/O Mapping for Protection Schemes

All digital and analogue input/output (I/O) assignments for protection relays and control interfaces shall follow the I/O mapping provided by Northpower.

7.0 SCADA Requirements

Northpower's Network Operations Centre (NOC) requires real-time operational visibility of each GPCB that interfaces the DG plant with the Northpower electricity distribution network.

Each GCPB shall provide the operational data points listed in Table 7, transmitted via the communication infrastructure specified under Section 10.0 – Communications and Cybersecurity Requirements.

Data Point	Unit of Measure
Circuit Breaker (CB) open, closed, tripped, and racked status	Binary
CB protection flag and alarm statuses	Binary
CB health status (heartbeat)	—
Line voltage (L1, L2, L3)	kV
Phase voltage (Ph1, Ph2, Ph3, N)	kV
Line current (L1, L2, L3)	Ampere
Real Power import (–) and export (+) with direction	MW (signed)
Reactive Power import (–) and export (+) with direction	MVAr (signed)
Curtailment indicator	Binary
Curtailment setpoint	MW

Table 3: SCADA Operational Data Points

All events within the DG facility or Northpower's network—such as circuit breaker operations, switching events, and protection activations—shall be time-stamped at the source device. These time-stamped events must then be transmitted to Northpower's SCADA system via the site RTU or equivalent communication gateway.

All DG owners must ensure that:

- Equipment clocks are GPS-synchronised to maintain consistent and accurate timestamping across the SCADA network.
- Communication links and configurations comply with the site-specific communications systems design standard.
- DNP3 is the approved communication protocol for all SCADA telemetry and control between the DG plant and Northpower's network.

All SCADA and protection data points shall be verified during benchmark and onsite testing in coordination with Northpower's Control Systems Team, ensuring correct point mapping, data scaling, and functional response before commissioning.

7.1 Protection and Control Panel Installation

For sub transmission-connected DG installations, protection relays and associated protection equipment shall be installed in a dedicated protection panel or enclosure, separate from other auxiliary devices such as RTUs, communications equipment, network switches, and control hardware.

For distribution-connected DG installations, auxiliary devices such as protection relays, RTUs, communications equipment, and control hardware may be installed within a single combined protection and control cabinet, provided spatial, thermal, and wiring-segregation requirements are met and all equipment complies with Northpower standards.

8.0 Runback Scheme Requirements

8.1 General

DG installations may be required to implement an export curtailment scheme to manage network loading, maintain voltage and stability limits, and ensure compliance with Northpower operational requirements. The curtailment scheme shall be designed to operate reliably under all normal and contingency network conditions.

8.2 Runback Scheme Equipment Architecture

The curtailment functionality may be implemented using either of the following approaches, based on project requirements and Northpower approval:

- A standalone relay or controller used solely for curtailment control, logic processing, and communication with the DG control system.
- Curtailment logic may be incorporated into the existing protection relay where capacity, processor load, and security allow. Integration must not compromise the performance, speed, or reliability of protection functions.

The selected architecture shall be reviewed and approved by Northpower Network Engineering during the design stage.

8.3 Runback Scheme Communication Requirements

Curtailment operation shall use RTU-to-RTU communication between Northpower and the DG, using the approved Northpower communication protocol (DNP3) over the designated site firewalled communication bearers.

The communication link shall support:

- Curtailment command initiation
- Acknowledgement and status feedback
- Setpoint transfer (MW and/or MVAr limits, where applicable)
- Health and heartbeat monitoring

Communication performance and failover behaviour must align with the site-specific communications system design standards.

8.4 Runback Scheme Operational Requirements

- The curtailment scheme shall operate independently of normal protection functions but shall not interfere with protection operation.
- The scheme must fail-safe, reverting to a safe predefined output state if communication or logic fails (reverting to a reduced export limit or ceasing generation as defined by Northpower).
- Curtailment actions must be logged and time-stamped for operational review and post-event analysis.

9.0 Switchgear Requirements

9.1 General

The selection and design of Ring Main Units (RMUs) and switchgear for DG connections shall be determined by the connection type, network fault level, and operational role of the equipment. For DG installations at 33 kV and above, Northpower's requirement is for indoor switchgear.

For 11 kV distribution-level DG installations, outdoor switchgear is acceptable, provided it meets all relevant standards and safety requirements.

9.2 Design Considerations

Each installation shall incorporate the necessary DC systems and SCADA integration to enable secure, real-time monitoring and control in accordance with site specific communications system design standard. Compatibility with existing switchgear types shall be verified to ensure spare-part uniformity and simplify future maintenance activities.

Operating interfaces shall be clearly arranged with mimic diagrams, padlocks, and visible isolation points to facilitate safe operation and maintenance

10.0 Communications Requirements

10.1 General

All DG installations shall comply with the Northpower provided site specific Communications System Design Standard to ensure a communications system that enables reliable monitoring, control, and coordination between the DG facility and NOC.

The communication system shall support SCADA integration, protection signalling (where applicable), curtailment control, and cybersecure data exchange between the DG and Northpower networks.

10.2 Protocols and Interfaces

The approved communication protocol for all DG connections is DNP3 over Ethernet, implemented via a firewalled interface between the DG's control system and Northpower's network.
Where ICCP as a service over DNP3 is required for remote control, Northpower will provide the ICCP connection and specify any additional communication requirements, including data exchange points, redundancy paths, and protocol security compliance.

10.3 Bearer and Topology Requirements

All communications design, topology, and associated requirements for this project shall be based on the site-specific Communications Systems Design Standard. This standard will be developed and provided as part of the conceptual design documentation. It will outline the detailed architecture, protocols, redundancy paths, and security measures necessary to ensure reliable and compliant communication between all relevant systems.

11.0 Earthing Systems

All earthing systems associated with DG connections shall be designed on a site-specific basis, incorporating measured soil resistivity data to accurately model ground performance. The design must ensure that step and touch voltages remain within acceptable limits as specified in AS/NZS 7000, Northpower safety standards, and the New Zealand Electrical Code of Practice for Earthing (ECP 35:1993). Where shared or interconnected earthing systems are proposed, they may only be implemented if validated through detailed modelling to confirm safety, ensuring no risk of transferred potential or circulating currents between the DG plant and the Northpower network. In cases where an earthing study is not available, the design may adopt a worst-case soil resistivity assumption. However, if this assumption is not accepted or the site conditions are uncertain, a detailed earthing study and soil resistivity measurement shall be conducted to validate safety compliance and confirm the adequacy of the design prior to installation.

12.0 Local Service Transformer

12.1 General

For sub-transmission DG installations (33 kV and above), a dedicated Local Service Transformer (LST) is required. For distribution DG installations (11 kV), the auxiliary supply may be derived from the nearest distribution transformer, provided isolation and protection requirements are met. If these conditions cannot be met, a dedicated LST or isolating transformer shall be installed.

12.2 Subtransmission DG Installations

For subtransmission-connected DG plants (33kV, 66kV, or above), the LST connection arrangement shall follow the configuration specified in the approved connection configuration drawings or R&I diagrams. The transformer shall be connected in a manner that ensures adequate isolation between the DG auxiliary supply and the Northpower network, maintaining electrical and operational independence.

12.3 Protection and Coordination

The high-side and low-side circuits of the LST shall be equipped with appropriate protection and coordination measures in accordance with Northpower protection standards. This includes overcurrent, earth fault, and fuse or circuit-breaker protection rated to coordinate with upstream and downstream devices.

12.4 Transformer Sizing

The LST rating and capacity shall be verified based on the calculated auxiliary load demand, including allowances for inrush current, diversity factors, and future load growth. The transformer shall be sized to continuously supply all connected auxiliary systems—such as relays, RTUs, chargers, and HVAC equipment—under worst-case operating conditions without exceeding 80 % of its rated capacity.

12.5 Distribution DG Installation LST

For distribution-connected DG plants (11kV), the power supply may be connected to the nearest distribution transformer, provided that all design and installations shall otherwise comply with the requirements of the Northpower Electricity Reticulation Design Standard particularly in relation to transformer protection, earthing and configuration practices.

If these conditions cannot be met, a separate dedicated LST shall be installed or use of isolating transformer for the DG auxiliary supply.

12.6 Use of Isolating Transformer

An isolating transformer shall be installed when the auxiliary or local service supply requires galvanic isolation or protection against circulating currents and voltage transients.

The primary purpose of the isolating transformer is to ensure electrical separation between the DG auxiliary systems and the Northpower network/load, particularly in cases where the local supply for the switchgear or RMU is derived from an existing distribution transformer. This separation prevents unwanted feedback or transferred potential that could compromise protection, control, or safety functions.

The isolating transformer shall be rated for continuous operation at the auxiliary load level and shall meet all Northpower electrical and safety standards for insulation, thermal performance, and fault withstand capability.

13.0 DC Supply Systems

13.1 General

All DG installations connected to the Northpower network shall be provided with a dedicated DC supply system designed in accordance with AED.G.206.01 Network Protection Design Guideline and APL.S.206.01 Network Protection Philosophy.

In cases where protection and control equipment is installed solely within the generator asset owner premises, the DC supply system for these components may be shared with the generator's existing DC system, provided this arrangement does not compromise protection coordination or operational boundaries.

13.2 Approved DC Voltage Levels

- For subtransmission-connected DG installations, the approved DC supply voltage for protection and control equipment is 110 VDC. SCADA and automation systems shall operate on 24 VDC, and a separate, dedicated 24 VDC supply shall be provided specifically for communications equipment such as firewalls, radios, and modems.
- For Distribution-connected DG installations (11kV), the approved DC system voltage is 24 VDC.

13.3 DC System Design Requirements

The DC system shall comprise:

A battery bank and charger system sized to meet the required minimum autonomy, as follows:

- Subtransmission DG installations: A minimum of 24 hours autonomy for both 110 VDC protection/control supply and 24 VDC SCADA/communications supply.
- Distribution DG installations: A minimum of 4 hours autonomy for the required 24 VDC auxiliary and control supply.
- Autonomy shall be calculated based on maximum continuous load conditions, including all connected protection, control, SCADA, communications, and auxiliary equipment.
- Voltage monitoring and low-voltage alarm functions integrated into SCADA or RTU systems for early fault detection.
- Protection and isolation on both the charger input and DC distribution circuits to safeguard against overcurrent and reverse polarity faults.

14.0 AC Supply Systems

14.1 General

Each DG installation and associated Northpower network facility shall include an AC supply system designed solely for auxiliary services such as lighting, heating, and ventilation. This AC supply provides general-purpose power within control buildings, kiosks, or equipment enclosures and shall be completely independent from any protection, control, or communication power sources.

14.2 Approved Use

The AC supply shall be strictly limited to the following applications:

- Lighting circuits, including normal and emergency illumination within control buildings, cubicles, or outdoor enclosures.
- Heating and ventilation equipment, such as air conditioning units, panel heaters, or exhaust fans; and
- Approved general-purpose outlets for maintenance use, rated and protected in accordance with Northpower electrical safety requirements.

No protection, control, automation, or communication equipment shall be powered from the AC supply. The AC circuit must not energise any relays, RTUs, trip coils, or intertripping circuits, nor be used for battery chargers, SCADA modems, or other control devices unless explicitly approved by Northpower Network Engineering.

Design and Installation Requirements

- The AC supply shall be derived from the LST and protected by suitable miniature circuit breakers (MCBs) or residual current devices (RCDs).
- Circuits shall be clearly segregated from DC control wiring and labelled to prevent inadvertent cross-connection.
- All outlets shall be installed with appropriate IP ratings and isolation switches, particularly in outdoor or high-humidity environments.
- The AC system shall be included in the site earthing design, ensuring correct bonding and safety compliance.

15.0 Building Requirements

15.1 General

This section specifies the architectural, civil, structural, security, power, lighting, communications, labelling, and documentation requirements for indoor facilities constructed to accommodate DG connections to the Northpower network. These requirements apply to buildings and enclosed structures designed for housing equipment and systems associated with DG installations.

Local planning and consenting requirements (Resource Management Act and local council consents e.g., Whangārei and Kaipara District Councils) shall be met prior to construction.

15.2 Building Classification and Design Life

DG buildings/enclosures shall be designed to meet the minimum seismic performance requirements applicable to the structure, based on the assessed seismic hazard and the expected operational role of the facility. Transportable buildings may not meet higher-level seismic requirements and shall be evaluated accordingly.

Building components shall be selected based on:

- Structural durability
- Environmental exposure (including coastal and corrosive conditions)
- Life-cycle cost considerations
- Maintainability and replacement feasibility

Non-structural elements (e.g., doors, finishes, external cladding) may be replaceable within the design life, provided this is addressed within life-cycle assessments.

15.3 Structural and Environmental Performance

Buildings shall:

- Meet minimum IP55 enclosure performance for weather protection and dust ingress.
- Provide minimum thermal insulation equivalent to R3.0 for walls, floors, and ceilings where enclosed electrical equipment is installed.
- Be designed to withstand internal arc fault overpressure and safely vent arcing by-products away from personnel access areas.
- For all sites prone to flooding, the above ground- building floor levels shall be a minimum of 500mm above the 1 in 100-year (1% Annual Exceedance Probability) flood level.
- Substation building areas shall be located above the ground water table to minimise entry of ground water. Where site constraints require below-ground structures (e.g., cable basements), appropriate engineered drainage and waterproofing systems shall be implemented
- An appropriately designed groundwater drainage system, certified by a practising Civil or hydraulic engineer, shall be submitted by the designer to satisfy design requirements.
- Any discharge to stormwater shall be in accordance with relevant council standards and in accordance with Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines).

Noise and vibration generated by transformers, inverters, or auxiliary plant shall be assessed and mitigated to ensure compliance with applicable environmental noise limits and neighbouring land-use requirements.

15.4 Asset Life, Maintainability, and Future Provision

Building designs shall facilitate:

- Safe installation, operation, inspection, and maintenance of all electrical and auxiliary equipment.
- Efficient replacement of major equipment (e.g. switchgear, relay panels, batteries) without structural modification.
- Future expansion, reconfiguration, or upgrade of DG interface equipment were reasonably foreseeable.

Where future DG expansion is identified, buildings shall allow:

- Clear structural load paths for future equipment
- Provision for additional penetrations, ventilation, or cable entry
- Space allocation for future protection, SCADA, or communications equipment

Life-cycle costing shall be applied where design trade-offs impact maintenance access, outage requirements, or long-term asset performance

15.5 Structural Design

- Loads: Design for permanent/imposed loads; include equipment handling and concentrated loads.
- Wind Loads: Design structures in accordance with the selected Importance Level (IL), incorporating local wind pressures, including increased pressures at roof edges and corners.
- Seismic Loads: Design to meet the serviceability and ultimate seismic performance requirements applicable to the selected Importance Level (IL).
- Redundancy: Prevent progressive collapse following credible fire/overpressure events.
- Foundations: Coordinate with geotechnical conditions; limit differential settlement affecting equipment, conduits, and cable entries.
- Floors shall comply with recognized standards for industrial applications, such as Concrete NZ Technical Specification 01:2021, to ensure appropriate flatness and levelness for equipment handling.
- Walls (below/above grade): Design for crack control, hydrostatic pressure, movement at duct/conduit interfaces; allow fixings for cable trays and equipment.
- Roofs: Minimum slope ≥5°; avoid penetrations through sheeting where practicable; use concealed fasteners or Northpower-approved systems. Drainage via oversized gutters/downpipes; avoid internal box gutters unless approved. Provide safe roof access provisions (anchors, brackets) commensurate with maintenance risk.

15.6 Fire, Overpressure, Ventilation and Thermal Performance

- Fire Resistance: Provide FRLs for ceilings/roofs/floors/walls/doors where required; install thermal/smoke detection and extinguishers.
- Arc-Fault/Overpressure: Where indoor switchgear is installed, provide venting or containment per manufacturer and Northpower guidance; byproducts shall be directed away from personnel access.
- Ventilation/Temperature: Provide systems to maintain rooms at a 21 °C temperature setpoint, with an allowable range of ±5 °C, unless equipment specifies otherwise. Maintain a humidity range of 5% to 90%, ensuring a non-corrosive environment and adequate dust control.
- Thermal Modelling: For enclosed rooms, demonstrate thermal performance (fabric, insulation, ventilation) and life-cycle efficiency where applicable.

15.7 Internal Layouts and Accommodation

- Equipment Layout: Allow clear working/egress spaces around HV equipment; avoid proximity to exposed conductors; keep defined escape paths unobstructed.
- Battery Accommodation: Use cabinet-type enclosures in control/protection rooms with ventilation and separation to allow maintenance without affecting parallel systems.
- Cable Marshalling Areas: Not to be confined spaces; provide adequate height, ventilation, lighting, and cable trench radii; avoid sharp edges; clearly mark emergency egress.
- Emergency Facilities: Provide eyewash/safety shower where risk assessment determines; prefer external location near switch room door; manage splash zones and drainage.
- Storage facilities (where specified) for spare equipment
- An ergonomically designed operator's desk, plan table, chair, filling cabinet, notice board and UHF radios for communication.

15.8 Access, Egress and Equipment Handling

Rooms containing high-voltage or major electrical equipment shall have two exits located diagonally opposite, unless a risk assessment and applicable Code provisions allow otherwise.

Prepare Equipment Handling Plans covering installation, maintenance, replacement, and decommissioning; provide pulling points, manoeuvring space, and lifting facilities (gantry/monorails where needed).

Corridors/doors shall meet Code and handling requirements; identify unencumbered heights above/below equipment in design.

15.9 Security

15.9.1 Personnel and Equipment Access

DG buildings shall provide:

- Two exits from rooms containing high-voltage or major electrical equipment, consistent with Section 15.8 and applicable Code requirements.
- Safe access routes for routine operation and emergency egress
- Clear separation of personnel access and equipment handling paths

Doors shall open in the direction of egress and be sized to accommodate the largest equipment items.

15.9.2 Security Requirements

Buildings housing Northpower-owned DG interface equipment shall:

- Provide protection against unauthorised access
- Include intruder-resistant walls, doors, and ventilation openings
- Use locks, access systems, and security arrangements consistent with Northpower security standards

Lightweight cladding or architectural elements shall not compromise the integrity of the security envelope.

15.9.3 Perimeter/Building Security

Fence live yards and secure buildings against unauthorised entry; avoid external recesses adjacent to public areas.

15.9.4 Doors/Louvres

External doors metal-clad/solid core security door; fire-rated where required; outward-opening; sealed hardware; corrosion-resistant frames. Fit intruder-resistant security grilles for louvres at accessible locations.

15.9.5 Windows

No windows shall be installed in substation control room buildings. This requirement ensures security, environmental control, and protection of equipment.

15.9.6 Keys and Locks

Use Northpower lock system; keys issued only under Northpower authority.

15.9.7 Monitoring/Alarms

Install thermal/smoke alarms integrated with SCADA and local fire service as applicable; intruder alarms optional per Northpower direction.

15.10 Power and Lighting (Building Services)

Provide AC lighting, general-purpose outlets (GPOs), and building services wiring in accordance with AS/NZS 3000 (Electrical Installations – Wiring Rules) and relevant Northpower design standards (e.g., AED.S.200.04 Electricity Reticulation Design Standard).

- Back-Up Lighting: Provide self-contained back-up lighting to support safe egress and essential visibility during loss of supply. This lighting is not classified as emergency lighting and therefore does not require full compliance with building emergency lighting code requirements. A minimum run-time of 15 minutes shall be provided.
- Switch/Light Locations: Place switches inside rooms near doors; locate luminaires for maintenance without equipment outages.

15.11 Data and Communications (Building Provision)

Provide space, cable trays/ducts, and conduits to support SCADA, protection signalling, and communications per Section 10 – Communications Requirements and site communications design.

Maintain fibre bend radii and conduit labelling; avoid common failure points on redundant routes; segregate communications from power cabling where practicable.

15.12 Plant and Equipment Labelling

All plant/equipment within control/switch rooms and outdoor enclosures shall be fitted with durable identification nameplates and labelled per AED.S.200.05 Safety Signage and Identification Labelling Standard. Equipment naming and asset identification shall comply with NIM.S.203.01; apply consistently across drawings, SCADA point maps, and site labels.

15.13 Building Signage

Provide statutory signage: Emergency information diagrams, safety signage and hazard boards.

Install emergency information and drainage diagrams at designated locations (control room phones, entrance doors, main exits) and keep them current through commissioning and modifications.

15.14 Building Design Documentation and Certification

Design Deliverables: Provide Room Data Sheets, architectural finishes schedules, structural calculations, thermal/ventilation assessments (where applicable), Equipment Handling Plans, civil/site drainage, fencing/gates, and yard grading drawings (see Section 17 – Documentation and Design Deliverables).

Maintenance Procedures: Submit Preliminary Maintenance Procedures and Operation Schedules at design stage; final manuals within 4 weeks of Practical Completion.

15.15 Access, Security and Safety (Ownership/Demarcation)

15.15.1 Access

Northpower shall have 24/7 access to all Northpower-owned assets at the DG POC without requiring special permits or escorts. Where Northpower equipment is housed within DG-owner premises, immediate unrestricted access shall be always provided.

15.15.2 Pre-livening

All security measures (fences, gates, locks, access systems, identification signage) for Northpower assets shall be installed, functional, and verified prior to livening.

15.15.3 Demarcation

Ownership boundaries and operational responsibilities shall be defined on SLDs, R&I, SID, site layout drawings, and connection agreements.

15.15.4 Asset Life and Maintainability

Designs shall minimize whole-of-life costs through durable materials, replaceable non-structural components, standardized layouts, and accessible service routes.

Where component replacement during design life is intended (e.g., external sheeting/gutters/doors/finishes), include the maintenance/refurbishment regime and outage implications in life-cycle planning.

16.0 Line Design Requirements

16.1 General

All line and cable works associated with DG connections shall be designed and constructed in accordance with Northpower's Electricity Reticulation Underground Design Standard and Overhead Line Design Standard.

The design shall consider connection configuration, fault level, system voltage, and site conditions. For subtransmission connections (typically 33kV and above), dedicated feeders or in-and-out connections shall be implemented as per approved connection configurations.

For distribution-connected DG (11kV), tee-off or dedicated radial feeders may be used subject to network studies and Northpower Network approval.

16.2 Conductor and Cable Selection

- Conductor and cable sizing shall be based on continuous load current, fault-level withstand, and thermal performance under Northland environmental conditions.
- Conductors shall be selected to maintain voltage regulation and minimise network losses, with the preferred types and sizes as specified in the Northpower Electricity Reticulation Standards.
- All underground cables and overhead lines shall use Northpower-approved materials and accessories.

17.0 Documentation and Design Deliverables

17.1 General

All documentation, drawings, and design reports associated with DG projects shall be prepared in accordance with Northpower's Design Standards.

Deliverables shall include the following minimum requirements unless otherwise specified during the design review process:

- Single Line Diagram (SLD)
- Relay and Instrumentation Diagram (R&I)
- SCADA Integration Diagram (SID)
- Cable schedules, termination diagrams, and equipment labelling details
- General Arrangement Drawings (GA) for substation or plant layout
- Earthing Layout
- Lighting and Power Layout
- Protection and Control Schematics
- Protection Packages
    - Protection settings and configurations
    - Protection relay Logic Diagrams
    - Curtailment Schemes Logic Diagrams
    - Discrimination curve and statements
    - Relay Testing overview
    - Relay labels
    - SCADA Mapping
- Communications Schematics
- Panel Design
- Bill of Materials (BOM)
- Equipment Specifications and Data Sheets
- Civil/Structural Drawings for foundations and trenches
- Architectural Finishes Schedules
- Structural Calculations
- Thermal/Ventilation Assessments (where applicable)
- Equipment Handling Plans
- Cable Routing Plans
- Fencing and Gates Design and Layout
- Site Drainage Plans
- Yard Grading
- Testing and Commissioning plan
- As built Documentation
- Drawing transmittals

Additional deliverables may be requested as part of the design scope submission depending on the project complexity, network configuration, and protection philosophy.

All design, construction, and as-built drawings submitted for DG installations shall comply with the Northpower Substation Drawing Numbering System, including drawing formats, numbering conventions, revision control, and title block requirements.

Document Review History

Version Number	Date	Revision Notes (reason for change)
1.0	20/02/2026	New Document Release

Controlled Document