Northpower
Electricity Network

Electricity Reticulation Design Standard

Document summary

This standard details Northpower's requirements for the design of electricity distribution infrastructure to be connected to Northpower's network.

Document approval

Version	2
Document Owner	Shaun BROWN Distribution Engineering Manager
Document Approver	Shaun BROWN Distribution Engineering Manager
Date Published	17/03/2024
Date for Next Review	16/03/2027

Controlled Document

Table of contents

Controlled Document

1.0 Introduction

1.1 Purpose

This standard provides Northpower's requirements for the design of electricity distribution infrastructure to be connected to Northpower's distribution network.

1.2 Scope

The scope of this Standard relates to electricity distribution reticulation beyond the zone substation and up to the customer's point of connection and includes:

- Transformer selection and utilisation
- Voltage Drop requirements
- Fusing requirements
- Point of connection requirements

Exclusions:

This standard does not include the following:

- Detailed Overhead Design
- Detailed Underground Design
- Detailed Earthing Design

1.3 Application

This Standard applies to the utilisation by designers of electricity distribution reticulation that may be connected to Northpower's distribution network.

This standard is an overarching design standard that should be read in conjunction with the Overhead Line Design Standard, Underground Design Standard and Zone Substation and Distribution Earthing Design Standard to provide detail for design.

For planning guidance, *refer to Northpower's Network Planning Standard.*

Any proposed deviation from these design standards will require approval from Northpower Network.

2.0 References

Internal Reference	Details
Overhead Line Design Standard	Northpower networks requirements for overhead line design on Northpower's Distribution and Sub Transmission Network.
Electricity Reticulation Underground Design Standard	Northpower networks requirements for the design and configuration of underground distribution network and associated ground mounted equipment for voltages up to and including 11kV.
Northpower Approved Materials and Suppliers Standard	Northpower network's approved materials for use by contractors constructing electricity distribution reticulation.
Zone Substation and Distribution Earthing Design Standard	This standard is to ensure that design of power systems earthing infrastructure is completed in a safe and consistent manner for Northpower staff and members of the public.
Security Signage Labelling Guidelines	This document sets out the key security, signage and labelling requirements for Northpower"s electrical sites.
Network Planning Standard	*Under Action. If not published – see Network Asset Planning team for guidance.*
Power Quality Guidelines	Northpower networks requirements for both Power Quality Guidelines and Motor Starting
Distribution As Built Records Standard	Northpower requires new construction, corrective and reactive maintenance activities that impact the Northpower Network to be provided to an approved As-Built standard. This document details the Network's requirements for all As-Built documentation, including As-Built plans, data capture forms, test records and photographs.
New LV Service Connections Standard	Northpower networks core processes and technical requirements for low voltage service connections to Northpower's network.
Customer Initiated Works Standard	Northpower networks standard for managing Customer Initiated Works, where a Customer connection requires works to amend or upgrade the electricity distribution network to enable their connection to the distribution network
Subdivision Resource Consent Standard	Northpower networks requirements and procedures for subdivision resource consent and critical electricity lines over Northpower's supply area.
Network Lock & Key Standard	Northpower's network electricity assets are to be secured against access by unauthorised people by implementing a hierarchical lock and key system.

External Reference	Details
AS/NZS 3000	Electrical Installations (Wiring Rules) Section 3.6 Voltage Drop
Electricity Engineers Association	Safety in Design Guide
IEC 60296	Specification for Unused Mineral Insulating Oils for Transformers and Switchgear
IEC 60422	IEC Supervision and Maintenance Guide for Mineral Insulating Oils in Electrical Equipment
Kaipara District Council	Engineering Standards
NZECP 34	NZ Electrical Code of Practice for Electrical Safe Distances
NZ Government	Electricity (Safety) Regulations 2010
NZ Government	Electricity Act 1992 Part 1 Sect 2 Interpretation
NZ Government	Health and Safety at Work Act
NZ Utilities Advisory Group	National Code of Practice for Utility Operators' Access to Transport Corridors
Whangarei District Council	Environmental Engineering Standards

3.0 Definitions

Terminology	Definition
A	Amps (Current)
ANSI	American National Standards Institute
AS/NZS	Australian and New Zealand Standard
DIN	Deutche Industrie Normenausschuss (German electrical equipment standard)
Distribution	Reticulation utilised for distributing electricity to customers
Fuse	Over current protection device (intended to protect the network)
HRC	High Rupturing Capacity (fuse type)
HV	High Voltage (distribution is 11,000 Volts)
IEC	International Electrotechnical Commission (International Standards)
kVA	Kilo Volt Amps (Power rating)
LV	Low Voltage (distribution is 480/415/240 Volts)
Point of Connection	The point where the service main connects to the network Defined in the Electricity Governance Rules 2003
Point of Supply	The point at which the exclusive fittings enter the property supplied Defined in the Electricity Act 1992
RMU	Ring Main Unit or ground mounted HV switch
Service	Supply to a property
TCC	Time Current Curve (fuse characteristic)

4.0 General

4.1 Distribution Network

The electricity distribution network mainly consists of 11,000 Volt three phase high voltage feeders and 400 Volt three phase low voltage feeders. There are also some 11,000 Volt two-phase spur lines and 480 Volt dual phase feeders. Some remote areas also have 11,000 Volt express lines with regulators.

The low voltage supply to customers is one, two or three phase 230/400 Volts.

4.2 Northpower Requirements

The following requirements are to be followed for all distribution reticulation designs. Only Northpower approved materials should be installed on Northpower's distribution network. This is required to facilitate maintenance and spares holdings. In addition designs needs to comply with the Electricity (Safety) Regulations and good engineering practice.

4.3 Council and Other Organisations Requirements

For council and other organisations requirements, such as District Councils, Regional Councils and Heritage New Zealand refer to *Network Planning Standard*.

4.4 Security and Signage

Electricity reticulation, equipment and buildings shall be secured against unauthorised access for safety and network security.

Electricity reticulation, equipment and buildings shall also be provided with safety signage and identification labelling for warning of hazards, identifying ownership and providing emergency contact details.

Reticulation and equipment are also to be provided with asset identification codes/numbers, fusing details and circuit or customer connection details where required.

Refer to the following:

- Security, Signage/Labelling Guidelines
- Electricity Network Lock Standard

4.5 Quality of supply

The quality of electricity supplied, in relation to voltage limits, harmonics and flicker, is required to be maintained in compliance with the Electricity (Safety) Regulations Section 28 Voltage supply to installations and Section 31 Requirements relating to quality of supply. Customers connected to Northpower's network must not cause interference that adversely affects the supply to other customers. Northpower reserves the right to disconnect customers that cause interference on the distribution network.

Refer to *Power Quality Guidelines*

5.0 Transformers

5.1 General

Only Northpower's approved 11,000 Volt transformers or distribution substations shall be utilised on the HV distribution network with the exception of refurbished transformers. Refer to Section 5.3 for a list of standard transformers.

Where additional supply is required from the Northpower network, the low voltage network shall be extended unless any of the following scenarios are met:

- Required voltage drop limits are unable to be maintained with standard conductors
- Legal or access constraints prevent installation of additional low voltage reticulation
- Industrial/commercial load or pumps requiring a dedicated transformer
- The cost of extending the reticulation is significantly more than installation of a transformer (approval from Northpower Network Distribution Engineer required)

Details on transformer installation design are included in the following:

> Underground Design Standard
> Overhead Line Design Standard

5.2 Transformer Configuration and Service Phasing

Table 1 below outlines standard transformer capacity and configurations with their corresponding phasing requirements.

Table 2 outlines loading details for supply options.

Table 1: Transformer Capacity and Configurations with Corresponding Phase Allocations

Transformer Capacity and Configuration	Standard Residential Phasing	Large Residential or High VD	Extra Light	Commercial & Industrial Phasing
15-50 kVA 1 Phase Paralled (Single phase output 240V)	1	1	1	1

Controlled Document

15-30 kVA 1 Phase Series (Dual phase output 480/240V)	2	2	1	2
15 kVA 3 Phase Standard (415/240V)	3	3	1	3
30 kVA 3 Phase Standard (415/240V)	2	2 or 3	1	3
50 kVA 1 phase Series (Dual phase output 480/240V)	1	2	1	2
50 kVA and Over 3 Phase Standard (415/240V)	1	2 or 3	1	3

Table 2: Supply Options and Details

Notes for Supply Options	Loading Details and Restrictions (Undiversified)
Standard residential dwelling	Average or normal load (maximum demand of 15 kVA)
Large residential dwelling	Above average or extra load e.g. spa pool or underfloor heating (20 kVA)
Extra-large dwelling	Depends on customer's specific requirements (30 kVA may be appropriate)
High Voltage Drop (VD)	Additional phase required to reduce voltage drop for long LV run.
Extra Light	Light load e.g. shed, small pump, cabinet, temporary or caravan supply (5 kVA) Not intended as permanent dwelling i.e. no stove or hot water. Note that any load increase will require a supply upgrade
Commercial and Industrial	Depends on customer's specific requirements. (45 kVA may be appropriate)

Three phase standard transformers should generally be utilised on three-phase HV reticulation.

Single-phase series transformers with dual phase output should be utilised on two-phase HV reticulation.

Single-phase series 15 to 30 kVA transformers may also be utilised on three-phase HV reticulation where there is no requirement for a three-phase supply. When a one-phase transformer is installed on a three-phase line, the phases connected must be balanced with other one-phase transformers connected on the same HV feeder.

Single-phase paralled transformers with a one-phase output can be utilised when the customer connected requires a one-phase supply. Generally utilised to supply one customer, however, can supply multiple customers if they all have one-phase supplies.

Transformers shall not be connected to 11 kV express lines as these may be upgraded to sub-transmission lines in the future. Currently Northpower has two express lines in operation:

- Dargaville Zone Substation to Ahikiwi Regulator
- Whakapara (from Russell Rd intersection) to Helena Bay Regulator

5.3 Transformer Capacity and Loading

The transformer capacity and LV reticulation voltage drop are based on After Diversity Maximum Demand (ADMD) calculations. The calculations are based on a maximum undiversified demand of 15 kVA for an average or standard residential dwelling which reduces to a diversified demand of 3 kVA in urban areas with transformers 100 kVA and over. Refer to section 6.4 Low Voltage Distribution Network Design Parameters, for the equivalent number of standard residential dwellings for various supply options.

Commercial and industrial developments should utilise the undiversified demands.

Table 3, below, outlines the transformers installed on the Northpower network, both standard and previously utilised, with their corresponding maximum number for residential dwellings connected.

Table 3: Northpower Standard Transformers and Maximum number of Residential Dwellings

Transformer Capacity kVA	Transformer configuration and types available	Maximum number of standard residential dwellings or equivalents that may be connected
1	Pole (1 phase)	Local supply to equipment
10	Pole (1 & 3 phase)	1
15	Pole (1 phase)	1
15	Pole (3 phase) & Ground (Micropad 1 & 3 phase)	1
20	Pole (1 & 3 phase)	2
25	Pole (1 & 3 phase)	3
30	Pole (1 & 3 phase) & Ground (Micropad 1 & 3 phase)	4
50	Pole (1 & 3 phase) & Ground (Micropad 1 & 3 phase)	11
75	Pole only (3 phase)	21
100	Pole (3 phase) & Ground (Minisub 3 phase)	31
150	Pole (3 phase) (See Note 2)	51

Transformer Capacity kVA	Transformer configuration and types available	Maximum number of standard residential dwellings or equivalents that may be connected
150	Ground only (3 phase)	51
200	Ground only (Minisub 3 phase)	71
250	Ground only (3 phase)	91
300	Ground only (Minisub 3 phase)	111
400	Ground only (3 phase)	Commercial and Industrial Use
500	Ground only (Minisub 3 phase)	Commercial and Industrial Use
750	Ground only (Minisub 3 phase)	Commercial and Industrial Use
800	Ground only (3 phase)	Commercial and Industrial Use
1000	Ground only (Minisub 3 phase)	Commercial and Industrial Use
1250	Ground only (Minisub 3 phase)	Commercial and Industrial Use

Note that bold and grey highlighted transformers are the current standard transformers. Transformers with white background are no longer standard however are still installed on the network and may be available as refurbished units.

Note 2: 150kVA pole mounted transformers are only to be used in special cases. *Refer to Overhead Line Design Standard* for further information.

5.4 Ferroresonance

Ground mounted transformers supplied by a HV cable with single phase switching may be susceptible to ferroresonance.

Refer to Electricity Reticulation Underground Design Standard.

5.5 Transformer Tapping

New and refurbished transformers installed on the network shall have off load external tap adjustment.

The transformer HV primary needs to be able to be tapped at 11275, 11,000, 10,725, 10,450 or 10,175 Volts (i.e. from +2.5% buck to -7.5% boost in 2.5% steps) to maintain the required voltage along the feeder.

11kV feeder voltage profiles have been used to determine the appropriate transformer tap setting depending on transformer location on the feeder.

The recommend transformer tap setting can be found in the GIS under the Distribution Substation attribute 'Profiled Voltage' shown in Figure 1.

The recommend transformer tap setting for new transformer installations shall be specified on construction plans. The transformers no-load voltage field check should be used to confirm that the secondary voltage measured with the transformer set on the recommended tap is within acceptable limits, taking into consideration feeder loading at the time (this can be checked with control).

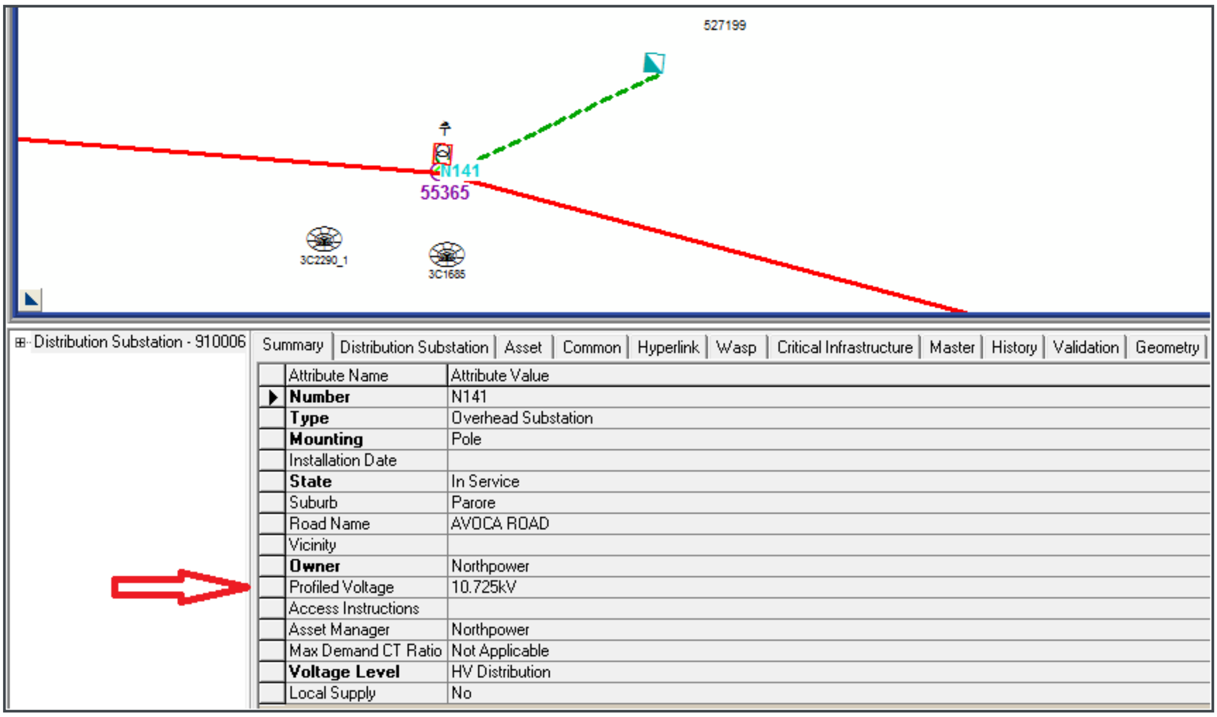


Figure 1: GIS Snapshot of Profiled Voltage for Tap Setting

5.6 Transformer Monitoring Systems

Northpower network currently has a remote transformer and feeder monitoring system under trial.

For more information, refer to Northpower Network Distribution Engineer.

6.0 Voltage Drop

6.1 Methodology

- Based on the expected load, the proposed design must comply with the voltage drop specified. Voltage drop must meet the customer's and regulatory requirements. The design includes:
- Reticulation route and length
- Conductor type and size
- Number of phases
- Transformer location and capacity
- The expected load characteristics may include the following:
- Diversity
- Distribution
- Planned or stages developments
- Demand side management

Controlled Document

- Time of use tariffs
- Load balancing across phases

Based on the above, all new network design needs to ensure that:

- Distribution transformer to be installed central to load.
- Volt drop shall be no more than 5% to account for design tolerance.
- LV cable runs no longer than:
    - 185mm 4c no more than 250m in urban environment and 350m in rural environment.
- 120mm 4c only used for T-off main line / cable to one pillar only. (No further cable extension will be allowed)
- 100A per phase shall be allowed at a LV open point link pillar.
- LV back feeds installed where possible.

LV Cable Length guide:

Maximum cable length for 3 X 63A and 3 X 100A single phase supply for dedicated single cable run. The design will allow no more than a 5% VD at pillar.

Maximum cable lengths for 63A at pillar:
120mm 4c – 250m
185mm 4c - 350m
300mm 4c – 500m
Maximum cable length 100A at pillar:
120mm 4c – 200m
185mm 4c - 250m
300mm 4c - 340m

Controlled Document

6.2 Interpretation of Regulations and Standards

Electricity (Safety) Regulations Section 28 Voltage supply to installations

- Installations operating between 200 volts AC and 250 volts AC must be a standard low voltage 230 volts AC and except for momentary fluctuation must be kept within 6%, measured at the point of supply.
- Northpower standard is for volt drop to be to be no more than 5% for all new connections.

AS/NZS 3000 Electrical Installations Section 3.6 Voltage Drop

- The voltage drop between the point of supply and any point in the installation shall not exceed 5% unless the installation is specifically designed to operate at reduced voltage.

The point of supply is the point on the boundary where the exclusive (low voltage) fittings enter the property.

Refer to the Electricity Act 1992 Part 1 Section 2 Subsection 3.

6.3 High Voltage Distribution Network Design Parameters

The high voltage distribution network generally has a nominal voltage of 11,000 Volts and extends from the zone substation to 11,000V/415V transformer.

The following zone substations have a nominal voltage of 10,800V, in conjunction with distribution transformers being tapped at 10,725V will allow for stronger back feeds.

- Mangawhai
- Parua Bay
- Ngunguru

Where Voltage Regulators are installed, these are set to a designed nominal voltage.

Northpower's LV voltage variation is based on a maximum voltage drop in the HV distribution network of 6%.

6.4 Low Voltage Distribution Network Design Parameters

The low voltage distribution network has a nominal voltage of 230 Volts extends from the transformer LV output to the customers point of supply.

Design shall allow for the positive and negative 5% voltage variation between 241.5 Volts (maximum) and 218.5 Volts (minimum).

Subdivision reticulation design should allow no more than 5% volt drop between the transformer terminals and each installation’s point of supply.

Methods of calculating voltage drop can be either:

- Mathematical calculation (computer modelling)
- Charts and data

Northpower can provide details of existing reticulation, transformers, equipment, customer numbers and loadings that are required for network design calculations.

Table 4 outlines the standard loadings that shall be used in voltage drop calculations.

Table 4: Supply Options with Corresponding Loading and Diversification

Supply Options	Supply Phasing & Fusing	Total Loading kVA	Undiversified Loading 100% kVA / phase Last on feeder	Diversified Loading 33% kVA / phase 2 to 15 on feeder	Diversified Loading 20% kVA / phase >15 on feeder	Equivalent Standard Residential for Transformer Capacity
Extra Light	1 phase 20 A	5	5	1.7	1	0.3
Residential Small Unit	1 phase 30/32 A	10	10	3.3	2	0.7
Residential Standard	1 phase 60/63 A	15	15	5	3	1
Residential Standard	2 phase 30/32 A	15	7.5	2.5	1.5	1
Residential Standard	3 phase 20 A	15	5	1.7	1	1
Residential Large	2 phase 60/63 A	20	10	3.3	2	1.3
Residential Large	3 phase 60/63 A	20	6.7	2.2	1.3	1.3
Residential Extra Large	3 phase 60/63 A	30	10	3.3	2	2
Light Commercial	3 phase 60/63 A	30	10	-	-	-
Commercial	3 phase 60/63 A	45	15	-	-	-
Light Industrial	3 phase 60/63 A	45	15	-	-	-
Light Industrial (higher loading alternative)	3 phase 80 A	60	20	-	-	-

Note: Volt Drop Calculation shall dictate service fuse size.

For details on supply or service fusing refer to Section 7.5 Transformer and Service Fusing. **Note** that barrel type fuses used in pole mounted and underground pillar fuse holders are rated 30A and 63A white tag and blade type fuses used in ground mounted fuse holders are rated 30A and 63A.

Commercial and industrial should utilise undiversified loadings for voltage drop and transformer capacity calculations.

Commercial developments may need to be designed to customer's specific load and capacity requirements if these exceed 3 phase 60/63A.

Controlled Document

Medium, heavy and rural industrial developments should be designed to the customer's specific load and capacity requirements.

Voltage drop should be calculated with the last allocated connection on the feeder as an undiversified load and all other allocated connections as diversified loads.

If there is at least one connection on each available phase then the load can be assumed to be balanced for the purpose of the voltage drop calculation. Any section of reticulation that does not have connections allocated on all of the phases available can be assumed to be unbalanced.

Voltage rise will also require to be calculated if there is distributed generation to be connected to the feeder to ensure voltage limits are not exceeded.

7.0 Fusing

7.1 Introduction

Fuses are used in LV and HV circuits for the protection of reticulation and equipment from overload and fault currents. Fuses are also used for isolation or switching load and are a cost effective alternative to circuit breakers.

7.2 Types of Fuses and Fuse Links

Fuse Wire or Element are used in semi-enclosed LV fuse carriers or HV dropout or expulsion fuse links.

High Rupturing Capacity (HRC) Cartridge Type Fuses. HRC refers to the fuse's ability to interrupt high ampere currents and contain the energy dissipated at the time of fuse failure. This prevents arcing and possible flashover, which could result in fire or feeder protection operation.

DIN fuses are HRC cartridge type fuses having knife or blade type mounting tags allowing for quick removal or replacement by means of a puller handle. These fuses can also be fitted into a three phase cartridge.

Solid Fuse Links are fuse links fitted with a solid element comprising of a copper tube having a continuous current rating. They are used in place of fuse links at isolation points where a visible break is required.

Fuse types for current approved equipment:

- HV pole mounted (drop out) expulsion fuses are ANSI type K.
- HV ground mounted HRC fuses are ABB CEF or equivalent
- All LV fuses are to be HRC type.
- HRC fuses are to be compliant with BS 88 (tag type and barrel/ferrule type) or IEC 60269 (DIN knife blade)
- Fuse types for older previously approved equipment:

- Oil switch ring-main units - HRC ceramic/porcelain fuses compliant with BS 2692 / IEC 60282 ANSI type K
- Wilde type ring-main units – HRC air type DIN fuses compliant with IEC 60282 / DIN 43625 ANSI type K

Note that fuses will typically carry a current of 150% of the rated current for several minutes before operating. This is intended to accommodate short-time overload, inrush and motor starting currents. This is important when selecting fuse ratings for overload protection rather than fault protection. Fuses shall also be rated to safely interrupt the calculated fault current. A fault current is usually much greater than the rated current and operation of the fuse is typically very fast. *Refer to fuse manufacture's total clearing time time-current curves.*

7.3 High Voltage applications

7.3.1 Overhead Lines

Spur lines, over 1000 m long or with three or more transformers, should have dropout fuse holder with solid links provided at the tap off point.

Fused links should only be used at spur line tap off where a single transformer is fed with a short spur line (three spans or less) and the tap off structure is visible from the transformer. These fuses provide protection for the transformer.

7.3.2 Cables

Where HRC fuses are used to provide overload protection for cables, the HRC fuse rating must not exceed the maximum continuous current rating of the cable (after applying relevant cable de-rating factors). This will ensure that the fuse will always operate before the current in the cable exceeds approximately 1.5 times the maximum current rating of the cable. Consideration needs to be given to cable de-rating factors (due to burial or enclosure) and co-ordination/discrimination with upstream and downstream protection.

7.3.3 Transformers and Ring Main Units

All distribution transformers must be protected by HV fuses, which have ratings appropriate for the transformer size. These fuses are rated primarily for protection from fault currents, not overload current and are generally, twice transformer rated full load current. Distribution transformers fuse protection are installed either on poles for pole mount transformers and ground mount transformers in an overhead network or Ring Main Units fuse switches for underground networks. In some cases, high rated distribution transformers are protected by circuit breakers where fuses can't be used.

Refer to *Underground Reticulation Design Standard* for further information.

7.3.4 Shunt Capacitors

All fixed 6.35/11kV shunt capacitor banks must be fitted with dropout fuse links for protection and isolation purposes. Fuse ratings should be between 125% and 165% of the nominal current rating of the capacitor bank, taking into consideration the fusing factor (approximately 1.5) of the fuse. A fuse rating one size up from the capacitor bank nominal current rating will normally be appropriate. Where excessive harmonic currents are present or voltages are unregulated, a fuse with a higher rating may be necessary to prevent nuisance operation. Where these fuse links are the primary means of isolation they must be able to safely break rated capacitive current and effectively contain arcing.

7.3.5 Voltage Regulators

Generally, voltage regulators are a bespoke network design. For further information, consult with Northpower Network Engineering Deliver Team.

7.4 Low Voltage Applications

7.4.1 Transformer fuses

Distribution transformer LV fusing for Northpower's transformers must be Northpower owned and located with the transformer.

The fusing should be located as follows:

- Ground mounted - on the transformer LV panel
- Pole mounted – on the pole by the transformer
- Room mounted - within the transformer room

For single services or customers supplied from dedicated transformers only one set of LV fuses will be required which should be rated to suit the installations requirements. If the customer requires additional fusing this should be installed in the customer's switchboard beyond Northpower's transformer fusing.

Refer to section *7.5 Transformer and Service Fusing* of this document, for recommended LV fuse ratings for different transformer sizes. These fuse ratings are based on the generally accepted practice of allowing transformer load to exceed transformer full load rating for short time periods. Care needs to be taken if it is known that the transformer load could exceed 100% of its rating for extended periods, e.g. load with unusually high load factor.

7.4.2 Cables

Three phase fused load disconnects with DIN fuses are to be used for the protection of all 3 phase LV underground cable feeder circuits originating in new pad mounted transformers.

Where HRC fuses are used to provide overload protection for cables, the HRC fuse rating must not exceed the maximum continuous current rating of the cable (after applying relevant cable de-rating factors). This will ensure that the fuse will always operate before the current in the cable exceeds approximately 1.5 times the maximum current rating of the cable.

7.4.3 Service Fuses

The service main fuse ratings, shown in Table 5, Table 6 and Table 7 below, are the maximum fuse ratings permissible for the associated transformer size in order to ensure discrimination with the transformer LV fuse. Fuse Ratings should suit the installations requirements. Refer to Electricity (Safety) Regulations Section 32 Protection against fault currents.

Residential, light commercial and light industrial customers fusing is generally at 60/63 A to protect Northpower's network from faults on the service main. Lower rated fuses will be required in the following cases:

- Connections to transformers rated 30 kVA and under
- Extra light supplies including some street lights.
- Network supply restrictions.
- Customer requirements.

Supplies over 60/63 A should be three phase or match transformer secondary phasing.

Service main fuses for new installations are only required to provide for protection against fault currents.
For specialised applications the appropriate type and rated HRC fuse must be selected e.g. motor starting (refer to the manufacturer's specifications).

7.5 Transformer and Service Fusing

Table 5: Three Phase Distribution Transformers Fusing

Transformer kVA	HV Amps	HV Dropout Fuse Pole Mounted	HV HRC Fuse Ground Mounted	LV Amps	Transformer LV Fuse	LV Service Fuse (max)
10	0.5	2	6	14	30/32	30/32
15	0.8	2	6	22	40	40
20	1.1	2	6	29	50	40
25	1.3	3	6	36	60/63	50
30	1.6	3	6	43	60/63	50
50	2.6	6	6	72	80	60/63
75	3.9	10	16	108	125	100
100	5.3	10	16	145	160	125
150	7.9	15	16	217	250	200
200	10.5	20	25	289	315	200
250	13.1	25	25	361	355	250
300	15.8	30	40	434	400	315
400	21	40	40	578	630	400
500	26.3	50	50	723	800	630
750	39.4	80	80	1084	1000	800
800	42	80	80	1156	1000	800

Transformer kVA	HV Amps	HV Dropout Fuse Pole Mounted	HV HRC Fuse Ground Mounted	LV Amps	Transformer LV Fuse	LV Service Fuse (max)
1000	52.5	100	80	1445	1400	1000
1250	65.6	100	100	1812	1800	1250

Table 6: Two Phase Series Transformers (Dual Phase Output) Fusing

Transformer kVA	HV Amps	HV Fuse Pole Mounted	HV Fuse Ground Mounted	LV Amps	Transformer LV Fuse	LV Service Fuse (max)
10	0.9	2	6	22	40	40
15	1.4	3	6	33	50	50
20	1.8	3	6	43	60/63	50
25	2.3	6	6	54	60/63	50
30	2.7	6	6	65	80	60/63
50	4.5	10	16	109	125	100

Table 7: One Phase Parallel Transformers (One Phase Output) Fusing

Transformer kVA	HV Amps	HV Fuse Pole Mounted	HV Fuse Ground Mounted	LV Amps	Transformer LV Fuse	LV Service Fuse (max)
1	0.1	1	-	4.3	5	-
10	0.9	2	6	43	60/63	60/63
15	1.4	3	6	65	80	60/63
20	1.8	3	6	87	100	80
25	2.3	6	6	109	125	100
30	2.7	6	6	130	160	125
50	4.5	10	16	217	250	200

Table 8: Three Phase Distribution Transformer Maximum Main Cable fusing

Cable Size	Industrial LV Fuse	Distribution LV Fuse
70	120	200
95	160	250
120	200	315
185	250	400
240	315	400

300	355	500
630	500	N/A

Note Maximum fuse size is also dependent upon transformer size

Note that bold and gray highlighted transformers are the current standard transformers. Transformers with white background are no longer standard however are still installed in the network and may be available as refurbished units.

1 kVA transformers are used for the local supply to HV switching equipment and have the HV fusing internally fitted in the 11 kV bushing.

7.6 Point of Connection

The point of connection is where the service main, supplying the customer, is connected to the network. The point of connection can be located in a pillar, cabinet, transformer LV panel or on a pole.

For a new subdivision the point of connection will require to comply with the district council subdivision requirements.

The point of connection should preferably be located within the road corridor by the boundary of the new lot, i.e., by the point of supply.

However, the point of connection can alternatively be located:

- Within the lot e.g., if there is existing reticulation within the lot
- Up to 10 m (unobstructed) from the boundary e.g., from pole or if it is not practical to locate by the boundary
- More than 10 m from the boundary with a supply (service main) run along a road or easement to or within the Lot (Note must also comply with the following paragraph)

Where the point of connection is not located on the boundary, (i.e., up to 10 m from the boundary) and the supply is intended for an underground service, there should be an unobstructed cable route from the point of connection to the boundary. If there is an obstruction, e.g., a driveway, ditch or wall, a duct should be provided under the obstruction.

Refer to the following for details of subdivision requirements:

- ENS 05.01.005 Subdivision Resource Consent Requirements
- Whangarei District Council Environmental Engineering Standards Section 8
- Kaipara District Council Engineering Standards Section 10

For a new connection or supply not associated with a subdivision, the point of connection may be located at a convenient new or existing pillar, pole, cabinet or transformer that is easily accessible and can be easily identified as the connection point.

In an urban area the point of connection should not be more than 25m along the road or 50m along an easement and road from the boundary of the property or the infrastructure equipment to be connected. Pillar connections should be on the same side of the road as the property.

In all cases it must be practical to provide a supply, suitable for a dwelling, from the point of connection to the proposed building site.

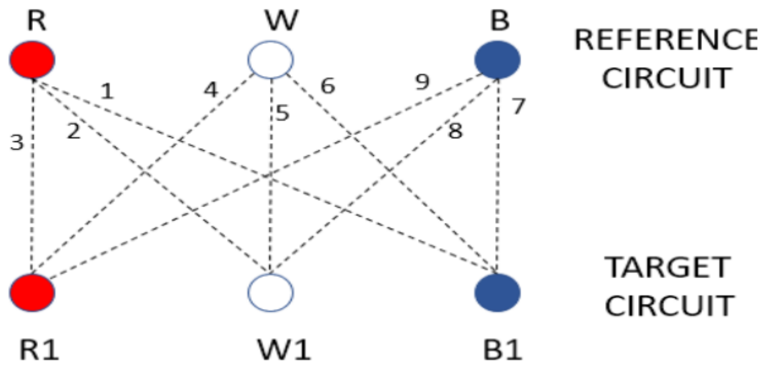
8.0 Phasing Tests

8.1 Live Phasing

Live phasing between two circuits in a network may be carried out using one of the phase comparators described in 393S192 Section 4.1 Phase Comparators. Always follow the equipment manufacturers instructions when carrying out phasing. If the phasing equipment indicates that circuits are out of phase, the associated electric lines and equipment shall not be placed in service. Further investigation and appropriate actions shall be undertaken to correct the connections and further phasing tests must be undertaken to verify that the circuits are in phase. Electric lines and equipment shall only be placed in service upon verifying correct polarity.

8.2 HV Phasing Procedure

Step 1: Check the instruments functionality by measuring between two phases of the reference circuit. The deflection or indication of the phasing device will depend on the type of device used. The device should indicate “out of phase”. If a voltage detector type phasing device is being used, the reading should be between 90% to 100% of the nominated voltage.



Step 2: Carry out phasing tests as described below. The following results are expected if phasing is correct.

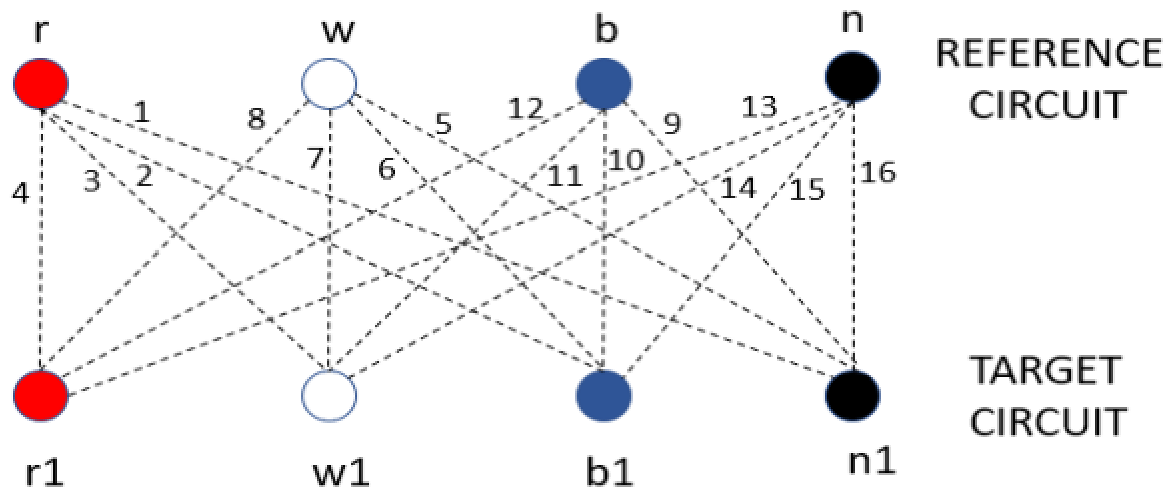
Test	Phases	Expected result
1	R-B1	Out of phase
2	R-W1	Out of phase
3	R-R1	In Phase
4	W-R1	Out of phase
5	W-W1	In Phase
6	W-B1	Out of phase
7	B-B1	In Phase
8	B-W1	Out of phase
9	B-R1	Out of phase

Step 3: Check the phase comparators functionality again.

If phasing is correct, the circuits may be placed in parallel.

8.3 LV Phasing Procedure

Step 1: Check the instruments functionality by measuring between two phases of the reference circuit. The instrument should indicate around 400 V.



Step 2: Carry out the phasing tests shown in the table below. The following results are expected if phasing is correct.

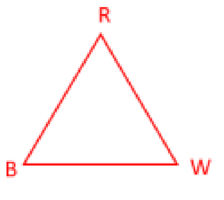
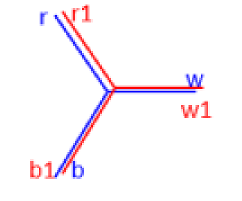
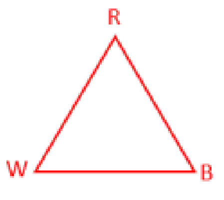
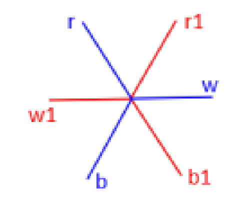
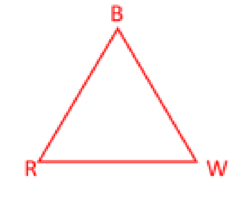
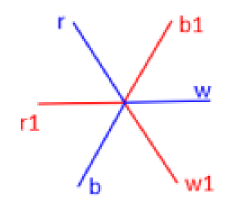
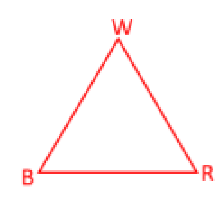
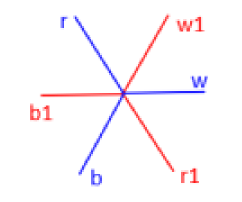
Test	Phases	Expected result
1	r-n1	216 V - 244 V
2	r-b1	376 V – 424 V
3	r-w1	376 V – 424 V
4	r-r1	<10 V
5	w-n1	216 V - 244 V
6	w-b1	376 V – 424 V
7	w-w1	<10 V
8	w-r1	376 V – 424 V
9	b-n1	216 V - 244 V
10	b-b1	<10 V
11	b-w1	376 V – 424 V
12	b-r1	376 V – 424 V
13	n-r1	216 V - 244 V
14	n-w1	216 V - 244 V
15	n-b1	216 V - 244 V
16	n-n1	<10 V

Step 3: Check the instruments functionality again.

If phasing is correct, the circuits may be placed in parallel. If phasing is incorrect, the circuits shall not be placed in parallel.

8.4 LV Parallel Problems

Whenever any measurement is done, the user must know what to expect before applying the measuring instrument to the circuit. Phasing is no different, and when phasing between two low voltage circuits, one would expect the circuits to be in phase. Typical phasing results when circuits are in phase range from 0 V to around 10 V. This voltage difference is due to the volt drop over the length of the circuit or minor phase shifts. When circuits are out of phase the difference in voltage (between points that are expected to be in phase) is approximately 400 V. Phasing between two LV circuits can sometimes give unexpected results. One situation where this can happen is where the HV supply phases to a distribution transformer have been crossed. The measured results will depend on which phases have been crossed. The table below shows the vector diagrams of the target and reference transformers, expected results when phasing between the two LV circuits, and which HV phases of the target transformer to swap to allow the LV circuits to phase in.

Target transformer HV vector diagram	Reference Transformer (blue) and Target Transformer (red) LV Vector diagrams	Reference Transformer			Target transformer	
		r	w	b		In phase.
		0-10 V	376-424 V	376-424 V	r1	
		376-424 V	0-10 V	376-424 V	w1	
		376-424 V	376-424 V	0-10 V	b1	
		r	w	b		Out of phase. Swap HV phase W and B
		216-244 V	216-244 V	432-488 V	r1	
		216-244 V	432-488 V	216-244 V	w1	
		432-488 V	216-244 V	216-244 V	b1	
		r	w	b		Out of phase. Swap HV phase R and B
		216-244 V	432-488 V	216-244 V	r1	
		432-488 V	216-244 V	216-244 V	w1	
		216-244 V	216-244 V	432-488 V	b1	
		r	w	b		Out of phase. Swap HV phase R and W
		432-488 V	216-244 V	216-244 V	r1	
		216-244 V	216-244 V	432-488 V	w1	
		216-244 V	432-488 V	216-244 V	b1	

9.0 Documentation

A compliant Northpower Network Distribution design shall include all of the applicable following sections:

9.1 Volt Drop Calculations

Voltage drop calculations shall be provided for all low voltage distribution reticulation designs and must not exceed 5% including:

- New feeders established from a transformer
- Extensions or spurs from existing LV distributors
- The voltage drop calculations shall include all installations designed to be connected including:
  - New connections proposed
  - All existing connections to the feeder
  - All connections previously allocated but not yet connected

9.2 Pole Calculations

A pole calculation is required for any of the following scenarios:

- Pole is being replaced or upgraded.
- A conductor or conductors being added or upgraded attached to the pole. This includes Fibre and Streetlight Conductors.

Pole calculations can either be manual calculations or computer modelled but shall be submitted in an agreed PDF format.

Pole calculations must follow Northpower Network *Overhead Line Design Standard*

9.3 Design Plans

The design plans shall meet Northpower Network *Distribution As Built Records Standard.*

10.0 Document Review History

Version Number	Date	Revision Notes (reason for change)
1.0	24/09/2021	New Document Release. Replacing documents: • ENS 03.04.025 Transformer Selection • ENS 03.01.015 Fusing Policies • ENS 03.01.080 Voltage Drop Determination • ENS 03.01.035 Subdivision Design Guide
2.0	12/03/2024	New Document Release • 6.0 LV Max Volt drop reduced to 5% • 6.4 LV Max Cable Length Guide • 8.2 HV Phasing procedure • 8.3 LV Phasing Procedure • 8.4 LV Paralleling problems Replaces document: AED.S.01.04 Electricity Reticulation Design Standard (now archived) due to document changing ID code to new taxonomy