

## Network Standard

### NETWORK

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NW000-S0024

**NS109 DESIGN STANDARDS FOR OVERHEAD SUPPLY DEVELOPMENTS AND DISTRIBUTION CENTRES**



**ISSUE**

For issue to all Ausgrid and Accredited Service Providers' staff involved with the design and installation of overhead supply reticulation systems and associated distribution centres and is for reference by field, technical and engineering staff.

Ausgrid maintains a copy of this and other Network Standards together with updates and amendments on [www.ausgrid.com.au](http://www.ausgrid.com.au).

Where this standard is issued as a controlled document replacing an earlier edition, remove and destroy the superseded document

**DISCLAIMER**

As Ausgrid's standards are subject to ongoing review, the information contained in this document may be amended by Ausgrid at any time. It is possible that conflict may exist between standard documents. In this event, the most recent standard shall prevail.

This document has been developed using information available from field and other sources and is suitable for most situations encountered in Ausgrid. Particular conditions, projects or localities may require special or different practices. It is the responsibility of the local manager, supervisor, assured quality contractor and the individuals involved to make sure that a safe system of work is employed and that statutory requirements are met.

Ausgrid disclaims any and all liability to any person or persons for any procedure, process or any other thing done or not done, as a result of this Standard.

All design work, and the associated supply of materials and equipment, must be undertaken in accordance with and consideration of relevant legislative and regulatory requirements, latest revision of Ausgrid's Network Standards and specifications and Australian Standards. Designs submitted shall be declared as fit for purpose. Where the designer wishes to include a variation to a network standard or an alternative material or equipment to that currently approved the designer must obtain authorisation from the Network Standard owner before incorporating a variation to a Network Standard in a design.

External designers including those authorised as Accredited Service Providers will seek approval through the approved process as outlined in NS181 Approval of Materials and Equipment and Network Standard Variations. Seeking approval will ensure Network Standards are appropriately updated and that a consistent interpretation of the legislative framework is employed.

**Notes:** 1. Compliance with this Network Standard does not automatically satisfy the requirements of a Designer Safety Report. The designer must comply with the provisions of the Workplace Health and Safety Regulation 2011 (NSW - Part 6.2 Duties of designer of structure and person who commissions construction work) which requires the designer to provide a written safety report to the person who commissioned the design. This report must be provided to Ausgrid in all instances, including where the design was commissioned by or on behalf of a person who proposes to connect premises to Ausgrid's network, and will form part of the Designer Safety Report which must also be presented to Ausgrid. Further information is provided in Network Standard (NS) 212 Integrated Support Requirements for Ausgrid Network Assets.

2. Where the procedural requirements of this document conflict with contestable project procedures, the contestable project procedures shall take precedent for the whole project or part thereof which is classified as contestable. Any external contact with Ausgrid for contestable works projects is to be made via the Ausgrid officer responsible for facilitating the contestable project. The Contestable Ausgrid officer will liaise with Ausgrid internal departments and specialists as necessary to fulfil the requirements of this standard. All other technical aspects of this document which are not procedural in nature shall apply to contestable works projects.

**INTERPRETATION**

In the event that any user of this Standard considers that any of its provisions is uncertain, ambiguous or otherwise in need of interpretation, the user should request Ausgrid to clarify the provision. Ausgrid's interpretation shall then apply as though it was included in the Standard, and is final and binding. No correspondence will be entered into with any person disputing the meaning of the provision published in the Standard or the accuracy of Ausgrid's interpretation.

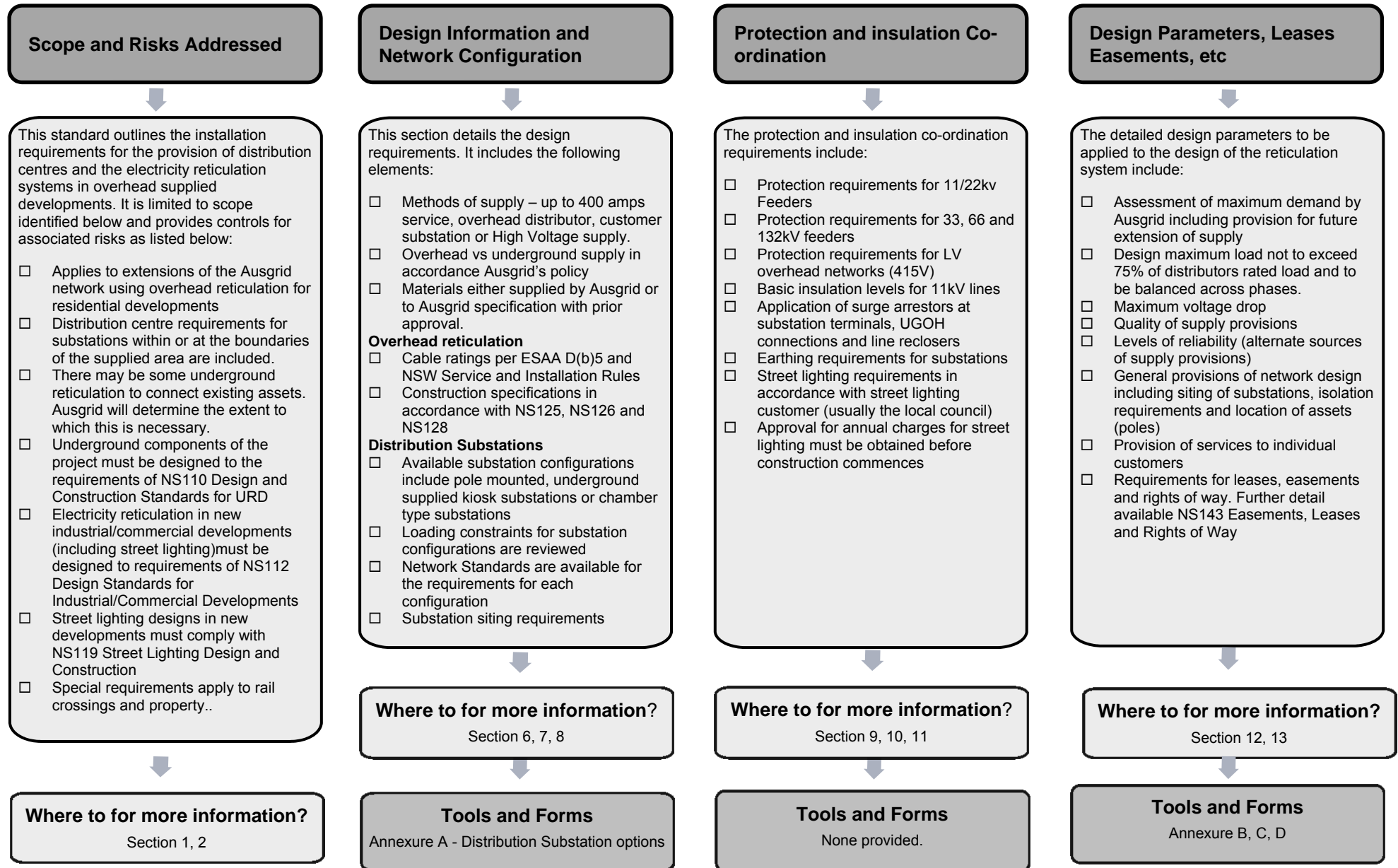
**KEYPOINTS**

This standard has a summary of content labelled "KEYPOINTS FOR THIS STANDARD". The inclusion or omission of items in this summary does not signify any specific importance or criticality to the items described. It is meant to simply provide the reader with a quick assessment of some of the major issues addressed by the standard. To fully appreciate the content and the requirements of the standard it must be read in its entirety.

**AMENDMENTS TO THIS STANDARD**

Where there are changes to this standard from the previously approved version, any previous shading is removed and the newly affected paragraphs are shaded with a grey background. Where the document changes exceed 25% of the document content, any grey background in the document is to be removed and the following words should be shown below the title block on the right hand side of the page in bold and italic, for example, Supersedes – document details (for example, "Supersedes Document Type (Category) Document No. Amendment No.")

# KEY POINTS OF THIS STANDARD



# Network Standard NS109 Design Standards for Overhead Supply Developments and Distribution Centres

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## 1.0 PURPOSE

This Network Standard outlines the installation requirements for the provision of distribution centres and the electricity reticulation systems in overhead supplied developments.

Installations must comply with the requirements of this Network Standard and all design and construction standards and specifications referenced in this document or issued by Ausgrid.

## 2.0 SCOPE

Detailed design of electricity reticulation systems depends on assessed maximum demands, building and street layouts, street lighting requirements and other local factors. The design information and parameters specified in this Network Standard provide for minimum acceptable standards. Any deviations from this specification must be submitted to Ausgrid for approval before they are implemented.

Where new developments take place in overhead reticulated areas, Ausgrid will determine the extent of undergrounding of existing overhead mains that may be necessary. For new subdivisions, dedicated roadway sites for future substations and cable easements for future use may also be required by Ausgrid. For underground reticulation supply requirements refer to NS110 Design and Construction Standard for URDs.

Distribution Centres and the electricity reticulation systems (including any street lighting) in new industrial/commercial developments must be installed in accordance with the requirements of NS112 Design Standards for Industrial and Commercial Developments.

Street lighting design may form part of the low voltage system design in new developments and must conform to the requirements of both the street lighting customer and Ausgrid. Approval of the street lighting customer for the applicable street lighting charges must be obtained first before construction work commences. Refer also to NS119 Street Lighting Design and Construction.

All future rail crossings (overhead or underground) should allow for all poles or the ends of ductlines to be located off rail property wherever possible.

Poles should be located in the road either side of a rail crossing, provided Rail's technical requirements on maximum span lengths etc permit this.

Ducts should be run the full width of the rail corridor, finishing just outside the rail property boundary. Note that this does not necessarily require a bore across the entire width of rail land, only that the ductline protecting any cables should continue the entire width of the crossing, so that the need to enter rail land for works is minimised.

Where new works on existing crossings permit, advantage should be taken of the opportunity to extend ductlines or relocate poles where this is appropriate. Any such projects should be referred to Asset and Network Planning for a decision on what work should be included in these cases.

## 3.0 REFERENCES

### 3.1 General

All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards. Current Network Standards are available on Ausgrid's Internet site at [www.ausgrid.com.au](http://www.ausgrid.com.au).

### 3.2 Ausgrid documents

- Bushfire Risk Management Plan
- Company Form (Governance) - Network Technical Document Endorsement and Approval
- Company Policy ( Network) - Bushfire Risk Mitigation – Implementation of Automatic Reclosing for High Voltage Feeders
- Company Procedure (Governance) - Network Document Endorsement and Approval
- Company Procedure (Network) – Network Standards Compliance
- Company Procedure (Network) - Production / Review of Engineering Technical Documents within BMS
- Company Procedure (System Control) – Bush Fire Risk Mitigation
- Connection Policy – Connection Charges
- Electrical Safety Rules
- Electricity Network Safety Management System Manual
- ES1 Premises Connection Requirements
- ES4 Service Provider Authorisation
- NEG-OH21 Vegetation Safety Clearances
- NEP SD02 Arcing Fault Detection Protection of LV Switchboards
- NS100 Field Recording of Network Assets
- NS104 Specification for Electrical Network Project Design Plans
- NS110 Design and Construction Standard for URDs
- NS112 Design Standards for Industrial and Commercial Developments
- NS113 Site Selection and Construction Design Requirements for Chamber Substations
- NS114 Electrical Design and Construction Standards for Chamber Type Substations
- NS116 Design Standards for Distribution Equipment Earthing
- NS117 Design and Construction Standards for Kiosk Type Substations
- NS119 Street Lighting Design and Construction
- NS122 Pole Mounted Substation Construction
- NS125 Construction of Low Voltage Overhead Mains
- NS126 Construction of High Voltage Overhead Mains
- NS127 Specification for Low Voltage Cable Joints and Terminations
- NS128 Specification for Pole Installation and Removal
- NS129 11kV Joints and Terminations – Paper Insulated Lead Covered Cables
- NS130 Specification for Laying Underground Cables up to and Including 11kV
- NS141 Site Selection and Site Preparation Standards for Kiosk Type Substations
- NS143 Easements, Leases and Rights of Way
- NS158 Labelling of Mains and Apparatus
- NS161 Specification for Testing of Underground Cables
- NS167 Positioning of Poles and Lighting Columns
- NS181 Approval of Materials and Equipment and Network Standard Variations
- NS212 Integrated Support Requirements for Ausgrid Network Assets
- NS261 Requirement for Design Compliance Framework for Network Standards
- Policy for ASP/1 Premises Connections
- Public Electrical Safety Awareness Plan
- Tree Safety Management Plan
- TS4200 Fuse Standards

### 3.3 Other standards and documents

- AS1307.2 Metal-oxide surge arresters without gaps for a.c. systems
- ENA Doc 001-2008 National Electricity Network Safety Code

- ENA Doc 025-2010 EG-0 Power System Earthing Guide
- ESAA D(b)5 Current Rating of Bare Overhead Line Conductors
- ISSC3, Guideline for Managing Vegetation Near Power Lines
- National Electricity Rules
- Service and Installation Rules of NSW

### 3.4 Acts and regulations

- Community Land Development Act 1989
- Conveyancing Act, 1919
- Electricity Supply (General) Regulation 2014 (NSW)
- Electricity Supply (Safety and Network Management) Regulation 2014
- Real Property Act 1900
- Work Health and Safety Act 2011 and Regulation 2011

## 4.0 DEFINITIONS

<b>Accredited Service Provider (ASP)</b>	An individual or entity accredited by the NSW Department of Industry, Division of Resources and Energy, in accordance with the Electricity Supply (Safety and Network Management) Regulation 2014 (NSW).
<b>Business Management System (BMS) Customer</b>	An Ausgrid internal policy and procedure framework that contains the approved version of documents.
<b>Document control</b>	A customer is an individual or an entity who is an end-user of electricity.
<b>Easements</b>	Ausgrid employees who work with printed copies of document must check the BMS regularly to monitor version control. Documents are considered "UNCONTROLLED IF PRINTED", as indicated in the footer.
<b>Leases</b>	An easement is a right of a definite limited character secured by one party to use a portion of land which is owned by another party. Common examples are rights of way, drainage easements and easements for services. Easements are created in accordance with the Conveyancing Act and the Real Property Act. Easements may be created for a definite period of time or in perpetuity.
<b>Licences</b>	A lease is a contract by which one party, the lessor, usually in consideration of rent, conveys exclusive possession of land or premises to another party, the lessee, for a specified time. The rights and obligations of both parties are usually set out in a lease document.
<b>Lot Boundary</b>	A licence in relation to land or premises may convey similar rights to a lease, the consideration generally being described as a fee. The existence of a licence is not recorded on a certificate of title.
<b>Low Voltage Distributor</b>	The dividing boundary line between adjoining lots.
<b>LV Link</b>	An electricity line rated at not more than 1000V AC which originates at the low voltage end of a distribution substation and serves to convey electrical energy to end users via their service mains. Low voltage distributors are constructed in public roadways or through easements on private land.
<b>Network Standard</b>	A 3 phase set of individual overhead links which serve as a switching point using removable links.
	A document, including Network Planning Standards, that describes the Company's minimum requirements for planning, design, construction, maintenance, technical specification, environmental, property and metering activities on the distribution and transmission network. These



	documents are stored in the Network Category of the BMS repository.
<b>Overhead Service mains</b>	The dedicated overhead mains extending from the overhead low voltage distribution network to customers point of attachment.
<b>Pole</b>	Overhead mains conductor support, substantial composed of either wood, concrete or metal.
<b>Review date</b>	The review date displayed in the header of the document is the future date for review of a document. The default period is three years from the date of approval however a review may be mandated at any time where a need is identified. Potential needs for a review include changes in legislation, organisational changes, restructures, occurrence of an incident or changes in technology or work practice and/or identification of efficiency improvements.
<b>Service Enclosure</b>	An enclosure providing a point of connection of service mains to the low voltage network. A service enclosure can be either a pillar or a pillar-standard.
<b>Street Alignment (or Building Line)</b>	The boundary line between the dedicated roadway and the adjoining subdivision lots. This is also known as the building line.
<b>Street Lighting Customer</b>	The Body controlling the standard of lighting and responsible for the applicable Street Lighting charges. For dedicated roadways, the Street Lighting customer is the local Council, and for Community Land Title developments under the Community Land Development Act, 1989 it is the Community Association responsible for that particular development.

## 5.0 ASBESTOS

All materials and equipment used for construction of Ausgrid's assets are to be free from Asbestos and or Asbestos related products. Suppliers are expected to comply with the Work Health and Safety Act 2011 (NSW) together with the Work Health and Safety Regulation 2011 (NSW) and confirm in writing that all products supplied to Ausgrid contain no Asbestos related materials.

## 6.0 DIVISION OF RESPONSIBILITIES

During the course of supply negotiations the Accredited Service Provider shall provide all information to allow Ausgrid to determine the most appropriate method of supply. Ausgrid will prepare and provide design information sufficient to enable design and construction drawings to be completed.

The Accredited Service Provider is responsible for the design, supply of some materials and construction of the electricity reticulation system (including substations) to supply the new development as detailed in Ausgrid's Policy for ASP/1 Premises Connections. The Accredited Service Provider can use either Ausgrid staff or Accredited Contractors to complete the electrical design and construction for which he/she is responsible, as detailed in ES4 Service Provider Authorisation. The Accredited Service Provider is also responsible for providing local authorities and the RMS (as appropriate) with copies of the proposed construction plans at least 40 days before work is to commence, and must comply with any special requirements of these authorities. Refer also to NS104 Specification for Electrical Network Project Design Plans. In addition, where other authorities such as the State Rail Authority or Waterways Authority have jurisdiction over land or water impacted by the development, special additional conditions may apply. As these may vary from time to time, current applicable conditions must be checked at the time of the development.

The customer (end user) is responsible for supplying and installing the portion of service mains from the street alignment to the customer's terminals in accordance with the Service and Installation Rules of NSW.

## 7.0 DESIGN INFORMATION

### 7.1 Methods of supply

There are four approved methods of supply. The appropriate choice to be utilised is dependent on the assessed and foreseeable maximum demand of the development.

The decision as to the most appropriate method of supply will be made by Ausgrid as part of the supply negotiation phase. This initial step in the process of establishing an electricity supply involves exchange of details pertaining to the development between the developer and Ausgrid. The options for electricity supply are:

- Service from the existing low voltage reticulation system - nominally 400/230V. This may provide for the connection of services (overhead or underground) rated at 100, 200, 300 or 400 amps.
- This method of supply is limited by the available capacity of the existing reticulation system and the associated distribution substations.
- Reference should be made to the Service and Installation Rules of NSW (Clause1.4).
- Direct Distributor - nominally 400/230V.
- Overhead mains taken from a distribution substation remote from the customer's premises which can usually supply up to 400 amps. This method of supply is restricted by voltage drop and the capacity of the distribution substation. As well as interference considerations.
- Customer Substation - nominally 11000V/400/230V.
- Ausgrid may determine that the existing network is unable to meet the Accredited Service Providers supply requirements. Therefore, in accordance with the Service and Installation Rules of NSW, the Accredited Service Provider may be required to provide a suitable space and approved easement or lease to accommodate Ausgrid transformer(s), pole, switchgear and other associated equipment. Generally supply by this method will be restricted to the capacity of a 400kVA substation rated appropriately for the load cycle imposed by the customer, however larger installation may be possible.
- Where supply is taken direct from a customer substation, the customer's main switchboard shall, wherever practicable, be located immediately adjacent to the substation. If the customer's main switchboard cannot be located immediately adjacent to the substation, the proposed location must be approved by the local Ausgrid Customer Supply Planning Section before the design proceeds.

A list of all distribution substation types and their approximate ratings is as detailed in Annexure A. Refer also to Note 3 of Annexure A.

- High Voltage Supply - nominally 11kV, 22kV, 33kV and 66kV.
- Consideration will be given to application for high voltage supply where, in the opinion of Ausgrid, it satisfies technical or economic considerations and the customer is able to safely operate and maintain the high voltage network. This option is not available in some areas and is restricted to premises with single customers. Where this option is considered a possibility and the supply voltage is higher than 11kV, Ausgrid will provide the design information to the developer as required on a project specific basis.

### 7.2 Underground/overhead policy

#### 7.2.1 General guidelines

Refer to Ausgrid's Policy for ASP/1 Premises Connections for details of Ausgrid's overhead and underground mains policy.

The general guidelines for the form of construction for each development shall be determined by Ausgrid and shall be in accordance with the prevailing policy of the time. The final interpretation

and decision as to the type of construction to be used shall be Ausgrid's. Notification of the type of construction shall be issued in the design information.

### **7.2.2 Materials to be used for construction**

Materials to be used for all overhead construction works are to be equivalent or superior in terms of total life time performance as those issued and used by Ausgrid. Where materials are intended to be supplied that are not sourced directly from Ausgrid or do not meet Ausgrid's specifications, these shall be indicated for assessment during the design checking phase, i.e.; the design shall be assessed for compliance with this standard on the basis that materials and equipment to be used are of equivalence to that which would be used and supplied by Ausgrid.

Where materials are sourced from other than Ausgrid evidence of compliance with Ausgrid's specifications or manufacturer certificate of equivalence to that supplied to Ausgrid shall be required.

Designers intending to use alternate materials are advised to discuss this situation with Ausgrid's Engineering Group before making such decisions for evaluation of the alternatives proposed. There will be a charge for these services based on the fees established by the Independent Pricing and Regulatory Tribunal.

## **7.3 Overhead construction**

### **7.3.1.1 Cables and ratings**

Standard cables approved by Ausgrid for use in overhead network design covered by this network standard are described below. Refer to NS100 Field Recording of Network Assets.

### **7.3.2 Reporting potentially dangerous conditions**

If the Level 3 Accredited Service Provider (Designer) during the design phase, or the Level 1 or 2 Accredited Service Provider during the pre-job hazard assessment check, or during the progress of work, believes that a pole or other network component may be in an unsafe or dangerous condition, the pole or other component must be reported immediately to the local Customer Supply Office for assessment and remedial action.

Refer to Ausgrid's Electrical Safety Rules (Clause 2) for requirements for immediately dangerous situations, such as fallen mains that may be alive.

## **7.4 Overhead conductor rating**

### **7.4.1 11kV**

Thermal rating for overhead bare conductors shall be calculated in accordance with ESAA D(b)5 Current Rating of Bare Overhead Line Conductors using a wind velocity of  $1.0\text{ms}^{-1}$  for Sydney and  $0.5\text{ms}^{-1}$  for the Hunter Valley. The maximum design temperature shall be  $75^{\circ}\text{C}$ .

### **7.4.2 Low voltage**

Thermal rating for overhead bare conductors shall be calculated in accordance with ESAA D(b)5 Current Rating of Bare Overhead Line Conductors using a wind velocity of  $1.0\text{ms}^{-1}$  for Sydney and  $0.5\text{ms}^{-1}$  for the Hunter Valley. The maximum design temperature shall be  $75^{\circ}\text{C}$ .

LV Aerial Bundled Conductor (LVABC) shall be designed for the conditions specified above, but with a maximum operating temperature of  $80^{\circ}\text{C}$ .

### 7.4.3 Overhead services

Overhead services shall be installed in accordance with Section 3 of the Service and Installation Rules of NSW.

#### Service cables

Service cables will be in accordance with those indicated in the Service and Installation Rules of NSW.

#### Street lighting cables

For conventional street light standards, the minimum cable standard is 16mm<sup>2</sup> two-core copper, XLPE insulated PVC sheathed cable. Four core 16mm<sup>2</sup> copper, XLPE insulated, PVC sheathed cables may be used.

Dedicated street lighting circuits shall not be used in overhead developments. Street lights shall be supplied direct from the low voltage network via photo electric cells.

### 7.4.4 Cable installation and bonding

All civil work, construction and bonding of cables must be carried out in accordance with:

- NS125 Construction of Low Voltage Overhead Mains
- NS126 Construction of High Voltage Overhead Mains
- NS128 Specification for Pole Installation and Removal

## 7.5 Distribution substations

### 7.5.1 Types and ratings

Supply negotiations between the client and Ausgrid may conclude that a distribution substation is required to satisfactorily supply the development.

For types and ratings of pole mounted, kiosk and chamber substations available, refer to Annexure A. Further information on these options is available from the Network Standards related to each construction type, as referenced in Annexure A.

Overhead networks may be used to supply underground supplied kiosk or chamber type substations.

J type kiosks are generally not suitable for industrial, commercial or high / medium density domestic supply areas. Approval for the use of J type kiosks in other than low density domestic supply areas will be at the discretion of Ausgrid.

In the case of pole mounted substations and other single transformer substations, interruptions to supply will be necessary for periodic maintenance of equipment and will occur in the event of equipment failure.

Unless approved otherwise by the Manager – Asset and Network Planning; K type kiosks and single transformer high voltage circuit breaker controlled substations are restricted to installations for single industrial customers or single commercial customers. Intending customers should be made aware of the supply interruptions required for maintenance of these substations.

In the case of multiple transformer substations, the firm ratings given in Annexure A are based on one transformer out of service. Maintenance or failure of a single transformer or associated equipment can generally be accommodated without restriction of supply. Loads in excess of the firm rating (up to the non-firm rating) can be accommodated by some substation options but will have the following consequences:

- Load must be restricted to allow periodic maintenance of each transformer.

- An interruption to supply for failure of any transformer or associated equipment will occur. However, restricted supply can be given normally within approximately one hour by re-energising healthy transformers.

The minimum design and construction requirements for pole mounted substations, kiosk substations, surface chamber, basement chamber and upper level substations are as defined in the following Network Standards:

- NS113 Site Selection and Construction Design Requirements for Chamber Substations
- NS114 Electrical Design and Construction Standards for Chamber Type Substations
- NS116 Design Standards for Distribution Equipment Earthing
- NS117 Design and Construction Standards for Kiosk Type Substations
- NS122 Pole Mounted Substation Construction
- NS128 Specification for Pole Installation and Removal
- NS141 Site Selection and Site Preparation Standards for Kiosk Type Substations
- NS167 Positioning of Poles and Lighting Columns

### **7.5.2 Substation siting**

At the time of subdivision development, the required substation sites are to be decided. These sites shall be shown on the subdivision survey plan unencumbered, obstruction free sites.

The substations shall be sited close to the load centre to fully utilise the substation capacity. The electrical network designer shall also consider any requirements to feed future extensions to the subdivision.

Ausgrid reserves the right to approve or reject proposed sites.

All necessary approval shall be obtained for the proposed siting of any substations. Particular concern must be given to the potential aesthetic impact of the proposed site as well as future access requirements. NS143 Easements, Leases and Rights of Way should be consulted whenever other than dedicated roadway is proposed for such installations.

Pole mounted substations must be sited in compliance with NS122 Pole Mounted Substation Construction.

Kiosk substations must be sited in compliance with NS141 Site Selection and Site Preparation for Kiosk Type Substations.

Chamber substations must be sited in compliance with NS113 Site Selection and Construction Design Requirements for Chamber Substations.

## **7.6 Vegetation clearances**

Vegetation clearances must be in accordance with the requirements of ISSC3, Guideline for Managing Vegetation Near Power Lines and NEG-OH21, Vegetation Safety Clearances.

## 8.0 NETWORK CONFIGURATION

### 8.1 11kV Overhead feeders (also 22kV)

Overhead 11kV networks shall be formed as radial feeders with normally open line switches to alternate feeds from adjacent radial feeders. Closed rings are not permitted for overhead 11kV feeders.

The feeders shall be formed as 3 phase 3 wire lines supplying distribution transformers having high voltage delta-connected windings. Single phase distribution transformers may only be connected line to line.

Underground cable sections may be tee connected or looped into the overhead feeder and may supply kiosk or chamber type substations. The feeder so formed however will be treated as an overhead feeder for operating and protection purposes.

Single wire earth return systems (SWER) are not covered by this standard.

### 8.2 33kV and 66kV Overhead feeders

Subtransmission 33kV and 66kV overhead feeders may be configured as radial feeders but usually will be formed as closed rings or multi-feeder networks. Where 33kV feeders are used to supply distribution transformers (33kV/415V) they will be configured as radial feeder.

At this level of the Network design of feeders and their protection will be individually engineered by Ausgrid.

### 8.3 132kV Overhead feeders

132kV overhead feeder arrangements and their protection will be individually engineered by Ausgrid.

## 9.0 PROTECTION OF HV OVERHEAD NETWORKS

### 9.1 11kV/22kV feeders

Protection of all overhead high voltage feeders will be provided by Ausgrid at the source substation or intermediate substation by relaying and circuit-breakers.

### 9.2 General requirements

These feeders will normally be provided with the following:

- 3 phase overcurrent
- earth fault
- high set instantaneous overcurrent
- sensitive earth fault
- an earth fault indicator.

Reclosing will be provided at the source substation initiated by all protection other than sensitive earth fault. The reclosing will be one reclose attempt after a maximum 10 second delay and then lock-out. Reclosing will be rendered non-operative:

- during switching between feeders
- during live line work
- during tree trimming
- on nominated feeders with extenuating circumstances and High Voltage customer connections with extenuating circumstances or the customer Installation Safety Management Plan (ISMP) does not define appropriate maintenance and defect reporting requirements to allow Ausgrid System Control visibility of private network extenuating circumstances, in accordance with Ausgrid's Company Policy (Network) - Bushfire Risk Mitigation –

Implementation of Automatic Reclosing for High Voltage Feeders, on days of declared Total Fire Ban affecting the Weather Forecast District in which they are located. Extenuating circumstances are High Priority Network Defects or circumstances defined in Ausgrid's Company Procedure (System Control) – Bushfire Risk Mitigation.

Back-up protection will be provided in one of several ways.

This protection will improve limitations in the design of the feeder configuration as follows:

- a minimum conductor size will be nominated by Ausgrid for the particular feeder depending on fault levels and protection clearing times. This also applies to any underground cable connected and to the cable sheath
- a maximum feeder impedance will be specified or engineered to ensure minimum fault levels at feeder extremities are adequately detected by protection including back-up protection. All designs must account for these aspects and will be checked for compliance.

### **9.3 Line fuses**

Line fuses may occasionally be used on 11kV and 22kV feeders but their use is kept to an absolute minimum.

### **9.4 Line reclosers**

Pole mounted line reclosers will be used in overhead distribution feeders where nominated by Ausgrid. These will be of a type complying with Ausgrid's specification and will provide protection, reclosing, and remote control (SCADA) facilities.

### **9.5 33kV, 66kV and 132kV feeders**

Protection will be provided by Ausgrid at source substations and zone substations. In general, duplicate protection will be provided comprising a relocation of either distance, pilot wire, overcurrent and earth fault, and intertripping relay.

In most cases suitable pilot cables will be required with 33, 66 or 132kV feeders for protection and intertripping functions and also communications. These pilot cables may be overhead or underground and will be secure, high insulation cables.

Reclosing will not be used on 33, 66 or 132kV feeders as a matter of policy except for a small number of individually approved cases.



## 10.0 PROTECTION OF LOW VOLTAGE OVERHEAD NETWORKS (415V)

All 415V overhead bare conductor or aerial bundled conductor (ABC) networks are to be protected by current limiting HRC fuses at the distribution substation.

Fuse types and application are to be in accordance with Ausgrid's Technical Standard TS4200 Fuse Standards. The fuse size to be used will be nominated by Ausgrid's liaison officer in accordance with TS4200.

**Note:** TS4200 is not a public domain document.

The maximum rating fuse to be used on an overhead low voltage network or distributor is 400A and all fuses shall be fast characteristic as defined in TS4200. Small rating distributor fuses shall be used in small transformer installations as defined in TS4200.

There are limitations on the use of ABC conductors for protection reasons. The maximum impedance of LV network to the extremity of the ABC conductor is defined as follows:

**Table 1 - Fault protection maximum cable lengths**

Fuse Size	Max loop impedance for the distributor	Max distributor length		
		1 x 95	2 x 95	1 x 150
400A	160 + j32 mΩ	200m	400m	300m
200A	280 + j56 mΩ	350m	700m	530m
100A	720 + j144 mΩ	900m	-	1360m

**Notes:**

1. Refer to TS4200 Fuse Standards for fuse sizes.
2. The loop impedance of a LV distributor is defined as the total impedance, measured from a Distribution Centre to the network extremity, of a phase conductor plus the return neutral or other phase conductor.
3. The maximum distributor lengths do not take into account voltage drop considerations.
4. The intention is to clear the worst possible faults in approximately 10 seconds. Fuse clearing times are based on the slowest characteristic compatible with Ausgrid's specified bandwidth for fuse time-current characteristics.
5. Source impedances at the commencement of the distributors have been taken as 6 + j24 mΩ, 85 + j150 mΩ and 165 + j290 mΩ for the 400A, 200A and 100A fuses respectively. These represent long overhead feeders with reasonably high transformer impedances.

The above maximum distributor length could be exceeded for a particular situation provided that the 10 second clearing time is maintained.

6. The above lengths are based on the maximum loop impedance for a distributor with a constant cable configuration, i.e. 1 or 2 cables per phase for their entire length. Where a mixed configuration is used an equivalent proportional length can be used, eg 200m of parallel cable and 100m of single cable for a 400A fuse (see Figure 1).

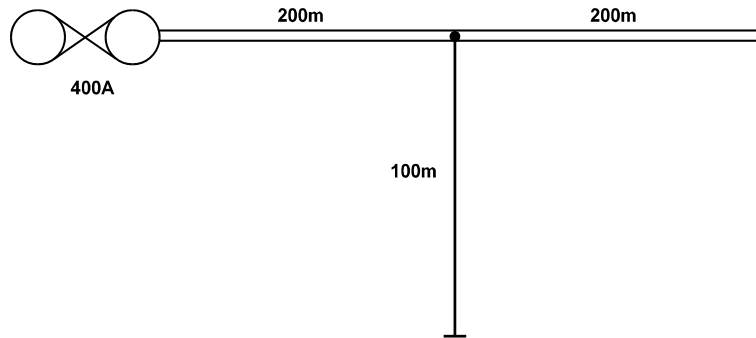


Figure 1 - Mixed cable configuration

## 11.0 INSULATION CO-ORDINATION AND OVERVOLTAGE PROTECTION

### 11.1 General requirements

In general Ausgrid's overhead line designs and standards are based on co-ordinated levels of insulation withstand voltages for the various line configurations and equipment types together with the correct application of surge arresters. Failure performance of the installation is very adversely affected by apparently minor departures from construction standards affecting clearances or configuration.

The Basic Insulation Levels (BIL) applying to the standard designs for 11kV are:

- open wire line 130-150kV
- line switches and fuses 100-120kv
- reclosers 110-120kV
- transformers and substation switchgear 75 or 95kV

Principles to be followed are:

- Every pole substation to have surge arresters at the transformer HV terminals.
- Every pole substation and ground substation to have surge arresters at the transformer LV terminals or LV busbar.
- Every HV underground to overhead connection shall have surge arresters fitted.
- All surge arresters must comply with Ausgrid's specifications and AS1307.2 Metal-oxide surge arresters without gaps for a.c. systems and shall in particular comply with the specification in respect to:
  - spark performance
  - shattering performances.
- Surge arresters are to be installed at line reclosers.
- No surge arresters are to be installed at line switcher or links (except for metal enclosed line switches - no longer to be used.).
- Earthing systems shall comply with the requirements of NS116 Design Standards for Distribution Equipment Earthing.
- Pin insulators on timber crossarms are not to be bonded together (as this reduces BIL and does not make use of the one-quenching properties of timber).

### 11.2 Earthing

All substations are required to have an accompanying electrode type earthing system suitable for its purpose.

The earthing electrodes for Pole Mounted substations are generally installed in the dedicated Roadway or easement area surrounding the pole base.

Special earthing designs and segregation limits may be required in situations relating to swimming pools, communication centres, petrol and liquid fuel centres etc. For the principles of earthing, reference can be made to ENA Doc 025-2010 EG-0 Power System Earthing Guide.

The design and construction of all earthing systems forming part of the works to be vested to Ausgrid shall comply with NS116.

### **11.3 Street lighting**

Street lighting equipment to be installed in association with Overhead supplied developments will be determined by the requirements of the Street Lighting Customer (the local council for streets to be dedicated, or the Community Association in the case of Community Land Title developments under the Community Land Development Act 1989).

Lighting requirements should be determined at an early stage of negotiations between the Electricity reticulation Designer and the Street Lighting Customer. Design parameters which need to be identified include the standard of lighting to be provided and any preferences for lamp types and sizes, luminaire types and standards, and any other requirements for street lighting furniture.

All lighting designs must be referred to Ausgrid for approval. The submission must include a schedule of all street lighting furniture and associated hardware proposed to be used.

Approval of the customer to accept annual charges for the proposed street lighting must be obtained before construction work commences.

The design and construction of street lighting in Industrial/Commercial developments shall comply with NS119 Street Lighting Design and Construction.

## **12.0 DESIGN PARAMETERS**

### **12.1 Assessment of maximum demand**

#### **Individual Customer Development**

The demand shall be assessed by Ausgrid based on appropriate diversity factors being applied to a submitted list of the Accredited Service Providers maximum demands for all items of equipment. These factors should be used in conjunction with discussions with the Accredited Service Provider to ensure there are no mitigating circumstances that would negate or reduce their use.

If a full list of connected loads is not initially available Ausgrid will nominate a load density value in VA per square metre for floor area used.

It is also essential that the assessed maximum demand appropriately incorporates any definitive plans that the Accredited Service Provider has for expanding or augmenting the development in the foreseeable future.

### **12.2 Maximum low voltage distributor loading**

The following design criteria for the initial electrical loading on low voltage distributors must be satisfied:

The designed maximum load on any distributor must not exceed 75% of the distributor's nominal rating, unless nominated by Ausgrid. This provides a reasonable margin for load growth and paralleling requirements. Distributors are nominally rated in accordance with the ambient temperature, the temperature rating of the style of construction and type of conductor and associated cross sectional area of materials used.

The load to be connected to a distribution centre must be balanced across the distributors and their respective phases, unless agreed otherwise.

### 12.3 Maximum voltage drop

The ultimate voltage level to be maintained at the customer terminals should be  $\pm 6\%$  of the normal 240V supply at full load.

The designed maximum voltage drop in a low voltage distributor must not exceed 9V at the extremities when the distributor is loaded to 75% of its nominal rating.

**Note:** Service mains are not regarded as part of the distributor.

The voltage drop in the service mains must not exceed 1% at full load.

The Maximum three Phase Volt Drop Constants for Distributor and Service must be calculated and supplied with the design details.

### 12.4 Quality of supply

The designer shall ensure that his design is satisfactory to supply customer equipment that has the potential to cause interference to other customers. Arc furnaces, welding machines, X ray units and frequently started large motors are examples of equipment that can cause excessive fluctuation of voltage.

Emission limits on customer generated harmonics, flicker and unbalance are mandated by the National Electricity Rules and Service and Installation Rules of NSW.

There is a requirement within the National Electricity Rules (Chapter 5) for maintaining network voltage unbalance within set limits. In addition the Service and Installation Rules of NSW outline the requirements for customer unbalance which are applicable to customers covered by this guideline.

The assessment of step voltage fluctuations is usually made using conservatively high system characteristics and the equipment is regarded as suitable for connection to the system if the point showing the voltage drop and frequency fluctuation is below the curve designated "Border line of Irritation" for industrial areas, non urban areas and primary and secondary distribution systems supplying small populations. The threshold of perceptibility is generally used for transmission and subtransmission systems which supply large populations and for primary distribution systems requiring a high quality of supply. The threshold of objection is included for reference purposes.

### 12.5 Levels of reliability

#### Low Voltage

Alternate supply to LV distributors must be provided from adjacent distribution centres where practicable. Each distributor will normally require two alternate points of supply to allow low voltage paralleling under maximum demand conditions.

Every opportunity must be taken to establish loop feeds where loop roadways exist (ie interconnection between distributors from the same distribution centre or between different branches of the same distributor). Extension of distributors beyond that necessary to provide a paralleling path will not normally be required unless specified otherwise by Ausgrid.

#### High Voltage

During the course of supply negotiations Ausgrid will determine the minimum level of high voltage reliability required and provide this information as part of its design information. In doing so, Ausgrid will take into account the level of reliability of the existing network, type of existing construction (ie. overhead or underground), permissible number of "Tee off connections" allowed, permissible number of substations on a radial supply (both on a temporary and permanent basis), future load growth, and any other network requirements. All costs associated with levels of reliability in excess of Ausgrid's requirements shall be met by the Accredited Service Provider.

## 12.6 Network design

The development of new Overhead areas does not usually target certain industries or commercial ventures. So, electrical load requirements at the initial design and development stages are not known. This makes the task of designing for optimum performance for such developments an impossible task. In these circumstances, Network Designers will need to use previous experience and good judgement in their attempt to produce designs which are economically and operationally acceptable.

To help overcome these difficulties in the absence of reliable load information, the following guidelines should be followed:

- Substation(s), if initially considered necessary, should be strategically positioned to cater for immediate and medium term load requirements. The estimated maximum demand should be based on average developments of a similar nature maximum demand statistics. High voltage mains may be erected on the same poles as low voltage mains.
- In conjunction with new pole mounted substations, fully insulated single pole operated low voltage link switches shall be installed on each LV network distributor on the first pole on either side of the new pole substation.
- Where the pole mounted substation supplies LV distributors without other network paralleling links an exception to this requirement may be acceptable subject to Ausgrid's planning needs and direction. All services connected at these switch poles must be connected to the load side of the links so they can be isolated from the pole mounted substation when the switch is opened. This link switch requirement does not apply to single customer pole mounted substations. The link switches are to be given a unique link number assigned by Ausgrid, refer NS158 Labelling of Mains and Apparatus. The link number must be attached to the link pole and recorded in GIS.
- These switches are installed to allow for isolation of the pole substation, and as such the switch will be in the normally closed position.
- Poles for Low voltage construction should be positioned, generally, every second property boundary on the optimum side of the roadway. The optimum side of the roadway is that side which would minimise the construction cost and ongoing maintenance requirements once service lead in poles and service mains are integrated into the whole development. Note the use of lead in poles is discouraged and will only be accepted by Ausgrid under the most extreme circumstances.
- The last pole of any radial Low voltage distributor shall be earthed in accordance with NS116 to ensure continuity of the MEN system.
- Street lighting design should be based on using conventional street lighting construction (or approved decorative lighting) in accordance with NS119 Street Lighting Design and Construction and the requirements of the street lighting customer.
- Services up to 400 Amps can be supplied from Overhead Distributors.

### Low Voltage services

The Accredited Service Provider is responsible for providing separate service mains to all lots in a new development.

Service mains must be installed from the pole nearest service point of attachment terminated inside the lot boundary. Refer to Service and Installation Rules of NSW for more specific details of service requirements. Under no condition are service mains to cross over the boundary of any property other than that property for which the service is intended.

### Standard symbols

All design and conduction plans will use the standard symbols as detailed in NS104 Specification for Electrical Network Project Design Plans.

## 13.0 LEASES, EASEMENTS AND RIGHT OF WAYS

Leases, licences, easements and right of ways are generally required where distribution centres and mains that will be vested to Ausgrid on completion of the works, are not sited on dedicated roadway.

**Leases** - The requirements for leases and their duration are as listed below.

**Easements** - An easement generally clear of other construction is required for the installation and future maintenance of mains associated with substations. The width of an easement is normally 2 metres for direct laid cables or the approximate width of construction for pit and duct systems, and seven metres wide for overhead reticulation.

**Right of Ways** - A suitable access way, at least 1.2 metres wide is required for personnel and equipment to gain access to substations on private land.

Where required, easements must be provided by the Developer in favour of, and at no cost, to Ausgrid's easement sites must be free of encumbrances and satisfactory for their purpose. The complete restoration of landscaping within easement sites is the responsibility of the Developer.

The Developer must include details of all easements to be created in favour of Ausgrid on the final subdivision plan lodged with the Land Titles Office. If land involved with the required easements is not subject to sub-division, a separate Plan of Easement and the required Transfer of Grant shall be prepared.

Easements are to be created in accordance with:

For Torrens Title Section 88B of the Conveyancing Act, 1919 as amended

For Community Title Section 36 of the Community Land Development Act, 1989.

NS143 Easements, Leases and Rights of Way (details Ausgrid's requirements for easements).

## 14.0 RECORDKEEPING

The table below identifies the types of records relating to the process, their storage location and retention period.

**Table 2 – Recordkeeping**

Type of Record	Storage Location	Retention Period*
Approved copy of the network standard	BMS Network sub process Standard – Company	Unlimited
Draft Copies of the network standard during amendment/creation	HPRM Work Folder for Network Standards (HPRM ref. 2014/21250/5)	Unlimited
Working documents (emails, memos, impact assessment reports, etc.)	HPRM Work Folder for Network Standards (HPRM ref. 2014/21250/5)	Unlimited

\* The following retention periods are subject to change eg if the records are required for legal matters or legislative changes. Before disposal, retention periods should be checked and authorised by the Records Manager.

## 15.0 AUTHORITIES AND RESPONSIBILITIES

For this network standard the authorities and responsibilities of Ausgrid employees and managers in relation to content, management and document control of this network standard can be obtained from the Company Procedure (Network) – Production / Review of Engineering Technical Documents within BMS. The responsibilities of persons for the design or construction work detailed in this network standard are identified throughout this standard in the context of the requirements to which they apply.


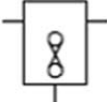
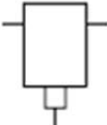







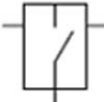

## 16.0 DOCUMENT CONTROL

**Content Coordinator** : Transmission & Distribution Mains Engineering Manager

**Distribution Coordinator** : Engineering Information and Services Manager


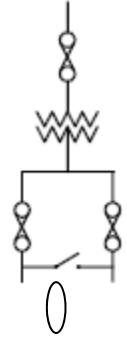
## Annexure A – Distribution Substation Options

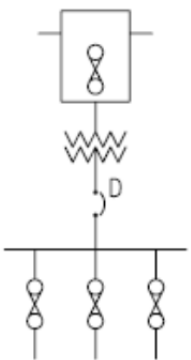
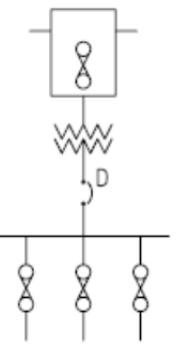
The following table lists distribution substation options that are currently permitted to be connected to 11kV three-phase systems, subject to application limitations indicated in the table, the notes following the table, and application limitations contained in other Network Standards.

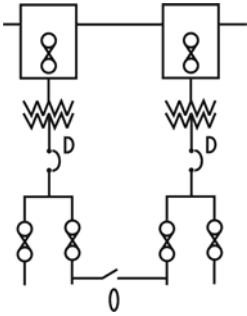
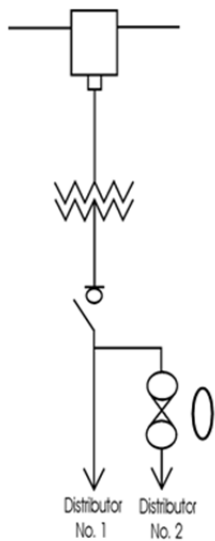
Symbols	
	Fuse: 11kV or LV
	11kV ring main fuse switch unit
	11kV ring main circuit breaker unit
	Transformer 11kV/ 415V nominal
	Low voltage link
	Low voltage air circuit breaker
	Low voltage disconnect
	Interpact switch disconnect (K kiosk only)
	Current transformer
	Isolating and earthing switch (City System only)
	3-way isolating and earthing switch (City System only)
	Circuit-breaker

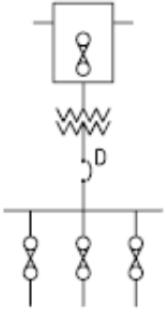



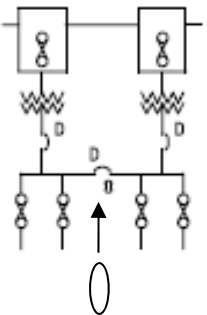
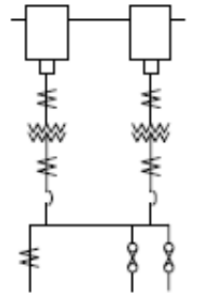
**Table 3 List of permitted distribution substation options**

Option No.	Substation type	Transformers	Approximate Rating Amps per phase (Refer to Note 3)	Application	Supply interruptions or restrictions for routine maintenance (Refer to note 6)
<b>Pole Substations</b>					
1		11kV single phase 16kVA 25kVA 63kVA	*90A (non-firm) *150A (non-firm) *370A (non-firm) * Domestic load cycle	Overhead 11kV areas only  Refer to this Network Standard and NS122	Nil
2		11kV three phase 25kVA 63kVA 100kVA 200kVA 400kVA	*50A (non-firm) *140A (non-firm) *200A (non-firm) *390A (non-firm) *800A (non-firm) * Domestic load cycle	Overhead 11kV areas only  Refer to this Network Standard and NS122	Nil

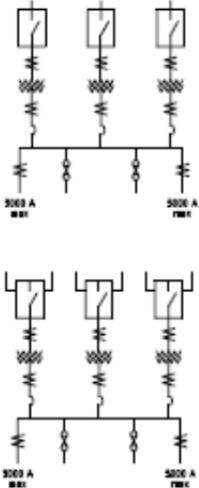
Option No.	Substation type	Transformers	Approximate Rating Amps per phase (Refer to Note 3)	Application	Supply interruptions or restrictions for routine maintenance (Refer to note 6)
<b>Kiosk Substations</b>					
3	"J" Kiosk 	1 x 315kVA  1 x 400kVA	430A (non-firm) *630A (non-firm)  600A (non-firm) *800A (non-firm)  * Domestic load cycle	Refer to NS117 and NS141.	Nil
4	"L" Kiosk 	1 x 400kVA  1 x 600kVA  1x 800kVA  1 x 1000kVA	600A (non-firm) *800A (non-firm)  900A (non-firm) *1140A (non-firm)  1,100A (non-firm) *1470A (non-firm)  1,400A (non-firm)  * Domestic load cycle	Refer to NS117 and NS141.     Domestic load cycles are not to be used for rating of 1000kVA transformers	Nil

Option No.	Substation type	Transformers	Approximate Rating Amps per phase (Refer to Note 3)	Application	Supply interruptions or restrictions for routine maintenance (Refer to note 6)
<b>Kiosk Substations (continued)</b>					
5	<p>Multiple "L" Kiosks</p> 	<p>2 x 800kVA OR 2 x 1000kVA</p> <p>Generally no more than two kiosks will be allowed per premises otherwise a chamber substation shall be utilised, if a greater number of kiosks is envisaged to meet the load demand and the site configuration then this shall be referred to Ausgrid Network Standards for an individual case review prior to any commencement of substation design or premises design finalisation.</p>	<p>2,200A (non-firm)  2,800A (non-firm)  (Rated as individual kiosks)</p>	<p>Where multiple kiosks are installed to supply a single development, a 400A "normally open" interconnector between the 2 LV boards is required.</p>	
6	<p>"K" Kiosk</p> 	<p>1 x 1500kVA</p>	<p>2,000A (non-firm)</p>	<p>Refer to NS117 and NS141.  Refer to Clause 7.5.1 of this standard for the limitations in the use of the "K" kiosk</p>	<p>Interruption every 3 years for:</p> <p>a) functional check of RMCB and protection relay</p> <p>b) Every 6th year: "a)" above and calibration checks on protection relay</p>

Option No.	Substation type	Transformers	Approximate Rating Amps per phase (Refer to Note 3)	Application	Supply interruptions or restrictions for routine maintenance (Refer to note 6)
<b>Chamber Substations – Single Transformer</b>					
7		1 x 750kVA 1 x 1000kVA	1,100A (non-firm) 1,400A (non-firm)	Refer to NS113 and NS114  Underground 11kV Radial or Closed Network Feeders	Nil
8		1 x 1500kVA	2,000A (non-firm)	Refer to NS113 and NS114  Refer to Clause 7.5.1 of this standard for the limitations in the use of the single 1500kVA transformer substation  Underground 11kV Radial or Closed Network Feeders	Interruption every 3 years for:  a) functional check of RMCB and protection relay  b) Every 6th year: "a)" above and calibration checks on protection relay

Option No.	Substation type	Transformers	Approximate Rating Amps per phase (Refer to Note 3)	Application	Supply interruptions or restrictions for routine maintenance (Refer to note 6)
<b>Chamber Substation – Two Transformers</b>					
9		2 x 750kVA  2 x 1000kVA	1400A (firm) 2,100A (non-firm) *2,550A (non-firm) 1900A (firm) 2,800A (non-firm) *3,400A (non-firm)  (The above ratings must not exceed the thermal limit current of the high voltage cartridge fuses)  * Domestic load cycle	Refer to NS113 and NS114  <b>Notes:</b> 1. Non firm ratings can only be applied to Network Substations with capability to divert load during abnormal conditions  2. The bus section disconnector must be “normally open”  Underground 11kV Radial or Closed Network Feeders	Nil
10		2 x 1500kVA  2 x 1500kVA (Dry Type Transformers)	2,900A (firm)  The inclusion of Optical Arc Flash Protection is mandatory  2000A (AN) (firm) Summer 2200A (AN) (firm) Winter	Refer to NS113 and NS114  <b>Note:</b> Option 10 to be used in Customer funded Contestable projects only  Dry Type Transformers AN ratings must only be used when there is no SCADA monitoring  Underground 11kV Radial or Closed Network Feeders	i) Nil if rated firm  ii) If rated non firm then: Interruption or load restriction every 3 years for: a) functional check of RMCBs, ACBs and protection relays  b) Every 6th year: a) above and calibration checks on protection relays  c) Every 12th year: a) and b) above and intrusive maintenance on LV ACBs



Option No.	Substation type	Transformers	Approximate Rating Amps per phase (Refer to Note 3)	Application	Supply interruptions or restrictions for routine maintenance (Refer to note 6)
<b>Sydney City CBD Substations</b>					
12		<p>3 x 750kVA</p> <p>3 x 1500kVA</p> <p>3 x 1500kVA (Dry Type Transformers)</p>	<p>2,700 (firm)</p> <p># 5,000A (firm)</p> <p># 5000A (AF) (firm)</p> <p># The rating shown above is indicative only and is limited by NEP SD02 Arcing Fault Detection Protection of LV Switchboards. The setting of the summated overcurrent is to be individually calculated and will be based on the fault level at the substations LV board.</p> <p>All substations on the Sydney CBD network are to be firm rated</p>	<p>Refer to NS113 and NS114</p> <p>Up to 2 x 3000A busbar or cable supplies</p>	<p>Nil (firm rated)</p>

**Notes:**

1. Length limitations, positioning restrictions and restrictions on exit points from the substation apply to busbar and cable supply options.
2. All substation arrangements shown are nominally 11kV/415V.
3. Unless indicated otherwise, the ratings are based on transformers operating on a commercial load cycle and a system primary voltage of 11kV. They are to be taken as a guide only to the ratings that are generally obtainable. Substation ratings may be restricted by the combined ratings of the services that the substation supplies. Actual ratings will depend on the particular substation equipment installed and other factors including protection requirements and ventilation limitations. Actual ratings will be as determined by Ausgrid.
4. **Firm rating:** The maximum load which can normally be carried by a multiple transformer substation and which allows for 1 transformer being out of service under emergency or maintenance conditions. (It should be noted that these operating conditions must be limited to the minimum possible duration (eg 1 day) and cannot be utilised over long periods (eg days). With Ausgrid's normal "open ring" 11kV feeder arrangement, firm supply does not prevent a substation interruption in the event of a feeder failure. Routine maintenance can generally be undertaken on firm rated substations without the need for an interruption or restriction of supply.

**Non firm rating:** The maximum load that can normally be carried by a distribution centre. A fault on any equipment within the distribution centre will generally result in an interruption to supply and in multiple transformer substations, load restrictions may be required when supply is initially restored until repairs are completed. In substations with 1500kVA transformers, interruptions or restrictions to supply will generally be required to undertake ongoing routine maintenance

5. In the event of failure of equipment or where periodic routine maintenance is required (does not include substations connected to the Sydney CBD network) the load taken by the premises supplied from the substation will be restricted to the capacity that can be provided at the time.
6. The type of high voltage switchgear installed will depend on the transformer rating, the type of substation and whether the substation is supplied from a closed or radial network system.
7. The routine maintenance requirements listed in the table apply to current switchgear contracts. As the switchgear ages, and depending on how the equipment performs over time, there is the potential for the routine maintenance frequency indicated to change. Intending customers must be made aware of the regular supply interruptions required for maintenance of these substations.
8. For a relay protected customer supply (as opposed to a fuse disconnecter) tripping is arranged to actuate the Tx ACB's in lieu of the customer ACB. This scheme means a periodic maintenance outage is not required.
9. All dry type transformers shall be supplied and installed with transformer fans fitted and operative. For substations equipped with SCADA monitoring of the transformer fans (Sydney CBD substations), the Air Forced (AF) Normal and Emergency rating of the dry type transformer may be utilised in determining the rating of the substation. For substations that are not equipped with SCADA monitoring, the Air Natural (AN) Normal and Emergency ratings of the dry type transformers shall be utilised to determine the rating of the substation (firm or non-firm).



## Annexure B – Tables for Assessment of Maximum Demand

### B1 Typical load density values (VA/m<sup>2</sup>) for different types of floor area usage (Nett Areas)

These load density values depend on many factors including:

- the effects of the outside environment on the building structure and type of air conditioning system;
- the effects of heat or electrical equipment loads within the premises;
- the proposed lighting design; and
- the degree of environment control and load management within the premises.

The figures in the Table below may be used as a guide only to typical load densities. Higher load densities may apply for some types of buildings and occupancies.

**Table 4 Guide to typical load densities**

Type of Development		Range VA/m <sup>2</sup>	Average VA/m <sup>2</sup>
Offices -	- Not air-conditioned	40-60	50
	- air-conditioned - cooling only	70-100	85
	- reverse cycle	60-90	75
	- electrical reheat open areas	80-120	100
	- electrical reheat zonal or package units	90-130	110
	- variable volume	60-80	70
Car parking	- open air	0-10	5
	- ventilated	10-20	15
Warehousing	- unventilated	5-15	10
	- ventilated	10-20	15
Shops	- Not air-conditioned	40-100	70
	- air conditioned	60-140	100
Shopping centres (assumed air-conditioned shops)	- Not air-conditioned public areas	60-140	100
	- air conditioned public areas	80-160	120
Industrial	- light	10-20	15
	- if ventilated add	10-20	15
	- if air-conditioned add (see note)	30-50	40
Theatres, halls, etc	- ventilated	50-70	60
	- air-conditioned	80-120	100
Hotels, Taverns, Restaurants (Residential section, use Annexure C)		60-100	80

**Note:** Medium and heavy industrial areas require full details of connected load before an assessment of demand can be made. Only uniformly distributed loads such as lighting and air-conditioning can be assessed using this area usage method.

## B2 Provision for future load growth

In order to make provision for future load growth, the following general allowances may be used:

- (a) Residential premises; 10%.
- (b) Fully air-conditioned, modern offices; 15-20%.
- (c) Commercial premises where computer equipment not installed initially; 20-25%
- (d) Shopping centres and zoned light/medium industrial premises; 25%.

Where advised of specific proposed future equipment to be connected, this should be diversified in order to ensure that the initial installation is adequate or can be economically up rated.

Undeveloped space should also be taken into account and if likely to be developed by the customer. Full discussion on the matter of future load growth is necessary to minimise the costs involved in future re-arrangement of supply.

**Note:** Increased industrial production is frequently achieved by working longer hours rather than installing additional plant, and this has only a minimal effect on maximum demand.

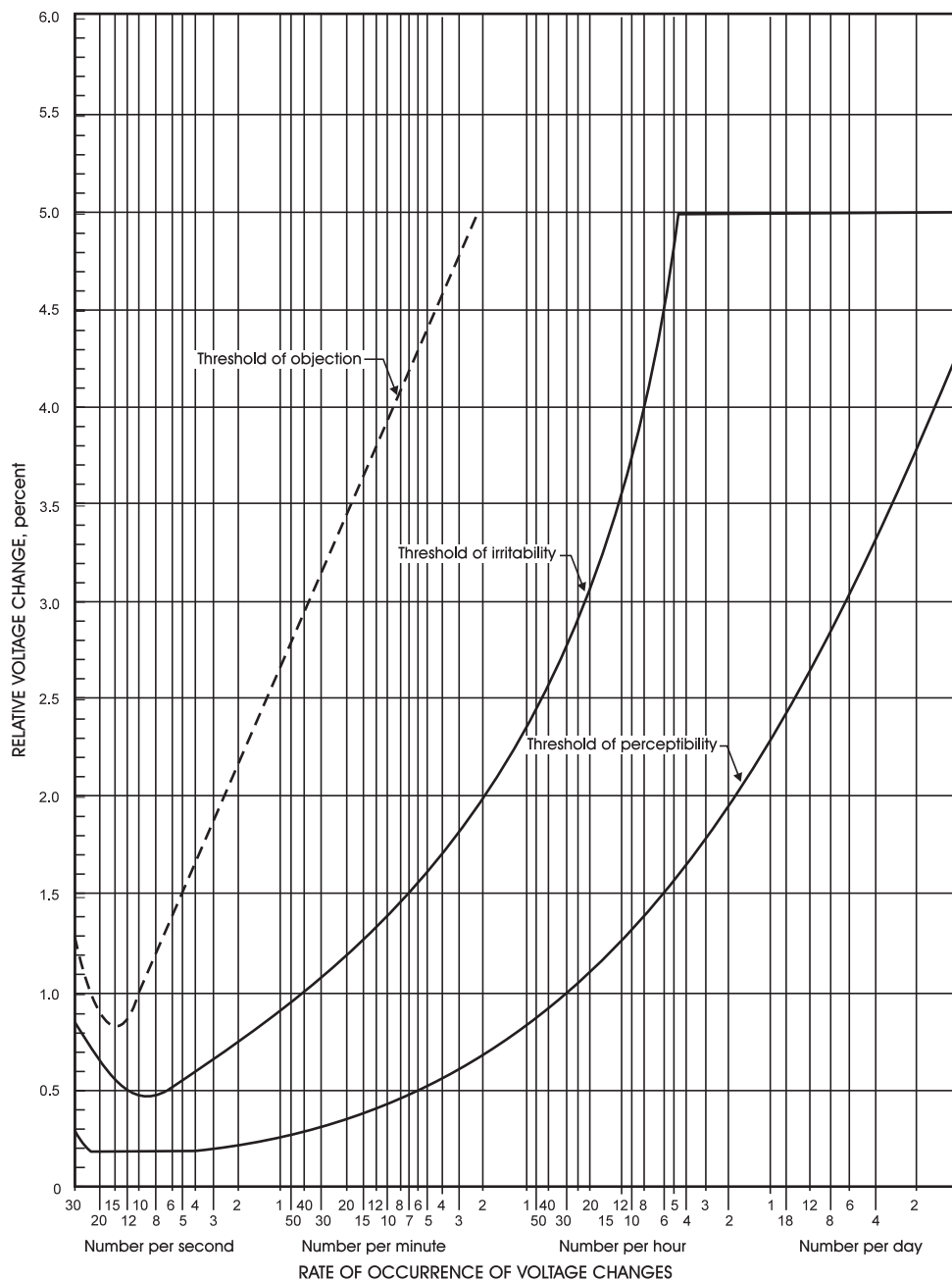
## Annexure C – Flicker Curves

### C1 Voltage fluctuations

If load is switched frequently, it will result in voltage fluctuations above and below the supply systems' steady state values. These voltage fluctuations may cause visual flickering of light sources or even mal-operation of certain voltage sensitive equipment.

In determining whether equipment is suitable for connection to the supply system, the likely voltage drop which will result from the switching of equipment is assessed and the planned frequency of switching determined.

The following figure should be referred to in deciding if equipment is suitable for connection to the point of common supply with other customers.



**Figure C1 Voltage fluctuation thresholds**



## Annexure D – Sample Compliance Checklist



### Network Standard Checklist Form

#### NS109 Design Standards for Overhead Supply Developments and Distribution Centres

Project Identification:	
Prepared by: <Name & Position Title>	Date:

This checklist is for internal Ausgrid use only and does not apply to ASPs or contractors who have specific compliance requirements in relation to Contestable project works. The checklist is unique for each network standard and is available within BALIN and the BMS as a separate form that can be amended as required, completed and saved in TRIM with the other project documentation.

This section is used to identify compliance checks that when applied to the work associated with this Network Standard will satisfy an audit process to establish that the requirements of the standard have been followed. It is expected that applicable items would normally be checked as Comply (Yes) as non-compliance is generally not tolerated.

Where non-compliance is the result of specific site conditions or design decisions this needs to be identified in the notes section of the form for each non-compliance and approval sought from an appropriately authorised Ausgrid manager responsible for design approval per NS261 Compliance Framework for Network Standards.

Should additional information be available to document non-compliance decisions, these can be attached to the checklist form. The checklist and any attached explanatory notes should be saved in the project document repository.

Item	Description	Refer Clause	Completed/Actioned
	<b>Scope</b>		
	Applies to overhead reticulation developments and distribution centres (substations) within and adjacent to the development.		
	<b>Design Information and Network Configuration</b>		
1	All materials to be free of asbestos	5.0	Yes/No/NA
2	Installations must comply with this standard and any referenced standard (other standards provide greater level of detail and apply to specific situations)	1.0	Yes/No/NA
3	New industrial/commercial developments to use NS 112	2.0	Yes/No/NA
4	Street lighting designs to use NS119 and require approval by street lighting customer (usually local council)	2.0	Yes/No/NA
5	Comply with special requirements for installations on rail property and for rail crossings	2.0	Yes/No/NA
6	Division of responsibility for demand assessment , design, supply of materials and construction allocated as specified	6.0	Yes/No/NA
7	Method of supply dependent on maximum demand. Maximum demand assessed by Ausgrid and notified to developer/customer	7.1	Yes/No/NA

8	Ausgrid notified developer the form of construction (overhead/underground in accordance with Policy for ASP/1 Premises connections	7.2	Yes/No/NA
9	Materials meet Ausgrid requirements	7.2.1	Yes/No/NA
10	Maximum design temperature Bare 11kV and LV Overhead conductors is 75°C	7.4	Yes/No/NA
11	Maximum design temperature LVABC conductors is 80°C	7.4	Yes/No/NA
12	Design Wind velocity in accordance with requirements	7.4	Yes/No/NA
13	Street Lighting cable design as required	7.4	Yes/No/NA
14	All OH construction work in accordance with NS125, NS126 and NS128	7.4.4	Yes/No/NA
15	Distribution substation type and design in accordance with Ausgrid notification	7.5.1	Yes/No/NA
16	Substation design and construction in accordance with NS113, NS114, NS116, NS117, NS122, NS128, NS141 and NS167 as appropriate	7.5.1	Yes/No/NA
17	Substation siting approved by Ausgrid	7.5.2	Yes/No/NA
18	Vegetation Clearances in accordance with NEG-OH21 Vegetation Safety Clearances and ISSC3 Guideline for Managing Vegetation near Power Lines	7.6	Yes/No/NA
19	Network configuration of 11, 22, 33 and 66kV Overhead feeders in accordance with principles provided	8.1 and 8.2	Yes/No/NA
20	132kV Overhead design provided by Ausgrid	8.3	Yes/No/NA
	<b>Protection Requirements and Insulation Co-ordination</b>		
21	Protection elements required for HV Overhead networks as listed	9.1 to 9.5	Yes/No/NA
22	Protection requirements for LV Overhead networks as listed	10.0	Yes/No/NA
23	Insulation co-ordination requirements met	11.1	Yes/No/NA
24	Earthing requirements met	11.2	Yes/No/NA
25	Street Lighting requirements met	11.3	Yes/No/NA
	<b>Design Parameters, Leases, Easements and Rights of Way</b>		
26	Maximum demand assessment completed by Ausgrid	12.1	Yes/No/NA
27	Designed maximum load on any distributor must not exceed 75% of distributor's nominal rating.	12.2	Yes/No/NA
28	Load balanced across three phases	12.2	Yes/No/NA
29	Maximum voltage drop at extremities of LV distributor must not exceed 9V at 75% of distributor's nominal rating	12.3	Yes/No/NA
30	Voltage drop at service mains must not exceed 1% at full load	12.3	Yes/No/NA
31	Voltage level at customer terminals must be +/-6% of nominal 240V supply at full load	12.3	Yes/No/NA
32	Emission limits for harmonics comply with Service and Installation Rules NSW	12.4	Yes/No/NA
33	Comply with network voltage unbalance requirements of National Electricity Rules (Chapter 5)	12.4	Yes/No/NA
34	Alternate supply provisions for lv distributors met	12.5	Yes/No/NA
35	Ausgrid requirements for HV Overhead network reliability met	12.5	Yes/No/NA



36	Provision made in submitted development design for future demand growth	12.6	Yes/No/NA
37	LV services installed as required by Service and installation Rules NSW;	12.6	Yes/No/NA
38	All design plans to requirements NS104 Specification for Electrical Network Project Design Plans	12.6	Yes/No/NA
39	Leases, easements and right of ways established at no cost to Ausgrid	13.0	Yes/No/NA
40	Easements registered on final subdivision plan lodged with Land titles office.	13.0	Yes/No/NA
41	Restoration of landscaping within easements is responsibility of developer.	13.0	Yes/No/NA

Notes:

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