Network Standard

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NS109

Title:
Design of Overhead Developments

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Revision

No	Date	Description	Technical Approver	Authorised By
6	16/09/2024	Conversion to new format and addition of protection requirements. Inclusion of a table to limit maximum number/type of UGOHs	Duminda Thenuwara	Murray Chandler
7	28/10/2024	Minor amendments to Annexure B example	Duminda Thenuwara	Jacob Bayley

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List of Annexures

Scope

This Network Standard sets the minimum requirements for design of overhead supply to individual customer developments and subdivisions across the Ausgrid franchise area.

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

Reference Documents

All work covered in this document shall conform to all relevant Legislation, Standards, Codes of Practice and Network Standards.

Ausgrid Documents

NS001 Glossary of Terms

NS100 Field Recording of Network Assets

NS104 Specification for Electrical Network Project Design Plans

NS112 Design Standards for Industrial and Commercial Developments

NS116 Design Standards for Distribution Equipment Earthing

NS117 Design and Construction Standards for Kiosk Type Substations

NS119 Public Lighting Design and Construction

NS125 Construction of Low Voltage Overhead Mains

NS126 Construction of High Voltage Overhead Mains

NS127 Low Voltage Cable Joints and Terminations

NS128 Pole Installation and Removal

NS135 Construction of 33kV, 66kV and 132kV Overhead Mains

NS167 Positioning of Poles and Lighting Columns

NS179 Vegetation Management

NS181 Approval of Materials and Equipment and Network Standard Variations

NS220 Overhead Design Manual

NS290 Selection of Distribution Substations

Other Standards and Documents

AS1307.2 Metal-oxide surge arresters without gaps for a.c. systems

ENA Doc 025-2010 EG-0 Power System Earthing Guide

Service and Installation Rules of New South Wales

Clause	Standard Requirements

1 Methods of supply

1.1 The method of supply shall be determined by Ausgrid and selected from one of the following options:

- Service from the existing low voltage system
- Direct distributor
- Customer substation
- High voltage supply

2 Initial load and line length limitations

2.1 The load to be connected to a substation shall be balanced across the distributors of the substation where practicable.

2.2 After Diversity Maximum Demand (ADMD)

2.2.1 The ADMD appropriate for a subdivision shall be provided by Ausgrid.

2.2.2 The designed maximum diversified load for distributors must not exceed 75% of its nominal 400A rating. Refer to Annexure B for formula and sample calculation.

2.3 Voltage Drop

2.3.1 The designed maximum voltage drop along a low voltage distributor shall not exceed 9V phase-to-earth at the extremities. Refer to Annexure B for sample calculation.

2.3.2 Service mains for the calculation shall not be considered part of the distributor, voltage drop for service mains shall be in accordance with the Service and Installation Rules of NSW.

2.3.3 Where an existing non-compliance is identified, the designer shall inform Ausgrid. The new connection shall not worsen the voltage drop for existing non-complying sites.

2.4 Protection of low voltage overhead networks

2.4.1 All LV overhead networks are to be protected by current limiting HRC fuses at the distribution substation.

2.4.2 The fuse size and type are to be selected in accordance with NS114, NS117 or NS122.

2.4.3 The maximum rating fuse to be used on the overhead network or distributor is 400A and all fuses shall have fast operating characteristics.

2.4.4 There are limitations on the use of overhead conductors for protection reasons. For ABC conductors, at the extremities of all sections of the overhead network, the bolted phase to neutral fault current must be greater than the 10 second fuse current as per Table 1. For bare overhead conductors, at the extremities of all sections of the overhead network, the bolted phase to neutral fault current must be at least 3 times the rating of the fuse.

2.4.5 The bolted phase to neutral fault level at the extremities of the network and compliance with protection criteria are to be calculated using the Fuse Sensitivity Calculator contained in Annexure A.

2.4.6 Where an existing non-compliance is identified, the designer shall inform Ausgrid. The new connection shall not worsen the protection performance for existing non-complying sites.

Table 1 – Fuse operating time

Fuse Size (Amps)	Fault Level (A) for 10s Operating Time	
	Fuse Type	
	J	T
100	350	443
200	800	1000
250	971	1222
315	1152	1533
400	1521	2154

[1] Unless specifically calculated, the fuse 10 second current is to be taken from this table. This represents typical characteristics for fuses used on Ausgrid's network. Site specific fuse characteristics may be used in lieu of this table, refer to Ausgrid for specific fuse sizes and fuse time current characteristics.

[2] The loop impedance of 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.

[3] The maximum distributor length requirements for protection reasons does not consider voltage drop.

3 Design and arrangement

3.1 Overhead construction

3.1.1 All overhead mains design and construction work including standard cable types, sizes, and ratings shall be in accordance with NS125, NS126, NS128, NS135, NS167 and NS220.

Refer to NS100 Field Recording of Network Assets for cable nomenclature.

3.1.2 Overhead services

3.1.2.1 Overhead services shall be installed in accordance with Section 3 of the Service and Installation Rules of NSW and NS124.

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

3.1.3 Street lighting

3.1.3.1 Streetlighting shall be designed and installed in accordance with NS119.

3.1.3.2 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.

3.2 Underground to overhead connections (UGOHs)

3.2.1 The maximum number of the different types of UGOHs that can be installed on a pole are detailed in Table 2 below, provided the placement requirements as detailed in NS127 and NS177 are also met.

Table 2 – Maximum number of UGOHs on pole type

Pole type	Maximum number/type of UGOHs				
Line pole	2 x LV network UGOHs plus 1 x service UGOH max 70mm^2	OR	1 x LV network UGOH plus 2 x service UGOHs max 70mm^2	OR	3 x service UGOHs max 70mm^2
11kV UGOH pole **(one 11kV UGOH)**	2 x LV network UGOHs	OR	1 x LV network UGOH plus 1 x service UGOHs max 70mm^2	OR	2 x service UGOHs max 70mm^2
Transformer/regulator/capacitor pole	1 x service UGOH max 70mm^2				
Pole mounted switch pole (ABS/ELBS/Recloser/Intellirupter)	Nil	OR	1 x LV network UGOH	OR	1 x service UGOH max 70mm^2
Sub-transmission pole (timber)	1 x 11kV network UGOH	OR	1 x LV network UGOH	OR	1 x service UGOH max 70mm^2
Sub-transmission pole (conductive)	Nil				

[1] For each pole type, only one of the maximum number/type of UGOH options given shall be selected for construction

4 Network Configuration

4.1 LV overhead distributors

4.1.1 Distributors shall consist of 1 x 95mm^2 ABC (4 core), 2 x 95mm^2 ABC (4 core), or 1 x 150mm^2 ABC (4 core), depending on the load and voltage drop. Refer to NS220 for conductor selection criteria and electrical properties and ratings.

4.1.2 A maximum of two overhead distributor circuits (street supply or direct distributor) shall be taken from any one pole substation. The maximum rating of any single distributor shall be 400A. The number of distributors will be determined by the size of the transformer (up to 400kVA/800A in accordance with Table 1 of NS290) and the rating of the mains cables.

4.1.3 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.

4.1.4 Where the LV overhead network is supplied by a cable directly from a kiosk or chamber substation, a means of isolation shall be installed between the cable and overhead mains, either via overhead LV link switches at the UGOH (in accordance with the appropriate standard construction drawing) or at ground level via a LV single link pillar installed at any suitable location between the substation and the UGOH.

4.1.5 Low voltage link switches, in accordance with the appropriate standard construction drawing, shall be installed at the extremities of a low voltage distributor to allow for alternative supply from adjacent distribution centres where practicable. Each distributor will require two alternative points

of supply to allow low voltage paralleling under maximum demand conditions. Maximum number of LV link switches permitted on a pole shall be limited to three (refer to standard construction drawings).

4.1.6 Every opportunity shall be taken to establish loop feeds where loop roadways exist (i.e. interconnection between distributors from the same distribution centre or between different branches of the same distributor).

4.1.7 The last pole of any radial low voltage distributor shall be earthed in accordance with NS116 to ensure continuity of the MEN system.

4.1.8 LV overhead network reticulation shall not be permitted in private property.

5 Protection of High Voltage overhead networks

5.1 11kV/22kV feeders

5.1.1 Protection arrangements shall be provided by Ausgrid.

5.1.2 A minimum conductor size shall 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.

5.1.3 A maximum feeder impedance shall 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.

6 Insulation co-ordination and overvoltage protection

6.1 General requirements

6.1.1 The Basic Insulation Levels (BIL) that shall apply 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

6.1.2 Surge arresters shall be installed at pole substations, ground substations, high voltage underground to overhead connections and line reclosers as shown in the standard construction drawings.

7 Earthing

7.1 The design and construction of all earthing systems forming part of the works shall comply with NS116.

8 Ownership

8.1 Low voltage and street light reticulation in community title developments other than on dedicated public roads shall be owned and maintained by the owners of the development and does not form part of Ausgrid's network.

Annexure A: Fuse Sensitivity Calculator

The fuse sensitivity calculator is stored externally to this standard.

Annexure B: Calculation of diversified load and voltage drop

B1 The After Diversity Maximum Demand (ADMD) of a low voltage distributor is a function of the number of lots connected to the distributor and the allocated Maximum Demand for each lot.

The following formulae should be used in estimating the maximum demand and voltage drop of a distributor.

N = Number of customers

Formula for maximum demand for distributor loading:

$$MD = 8 * ADMD + 0.72 * ADMD * N + 0.95 * ADMD * \sqrt{N} \quad \text{kVA}$$

Formula for maximum demand for voltage drop:

$$MD_v = 12 * ADMD + 0.97 * ADMD * N + 1.3 * ADMD * \sqrt{N} \quad \text{kVA}$$

Phase Current = $\frac{MaxDemand * 1000}{3 * V_{start}}$

V_{start} is the voltage at the start of the distributor segment where voltage drop is to be calculated.

Voltage Drop = $\frac{(V / A / km) * Length * PhaseCurrent}{1000}$

Voltage drop constants of conductors (mV/amp-metre) relevant to the particular overhead conductor should be obtained from Table B2.

Notes: a) The After Diversity Maximum Demand appropriate for a subdivision will be specified by Ausgrid.

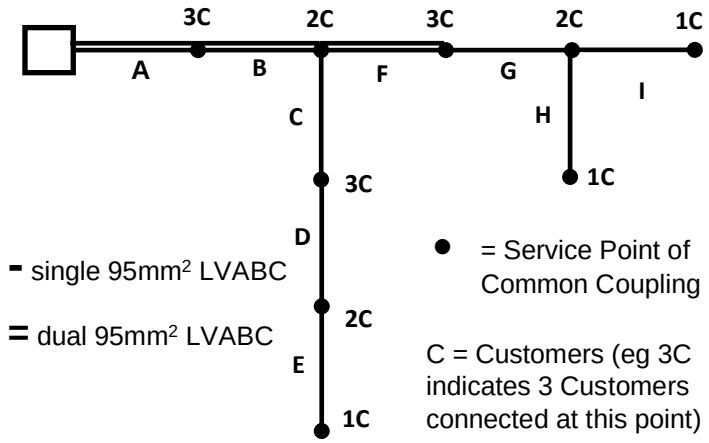
b) *Length* is actual length of cable between poles allowing for sag of conductor. Where actual length is not practicable to determine at the design stage, the distance between poles plus 3% is an acceptable approximation.

An assessment of final maximum load details for each lot in the subdivision is required in order to determine the rating of pole substations and other distribution system requirements. This assessment is determined (in order of preference) based on:

- the client's determination of the load details for the site;
- an estimate based on the floor area for each lot and summated to obtain an approximation of the load requirements of the entire subdivision. An allowance for future load growth may be made; or
- an estimate based on similar developments.
- The developer shall ensure that all necessary distribution centres can be established and where necessary the provision of appropriate property easements on development lots. Generally, all designed distribution centres are to be installed at the time of initial development of the subdivision.

B2 Sample load and voltage drop calculations

B2.1 Calculate the diversified Maximum Demand for the low voltage overhead distributor shown below, and the voltage drop at the extremities of the distributor. The After Diversity Maximum Demand of the subdivision is 5 kVA and the distributor cable size is 95mm^2 LVABC. Length of each section of the distributor cable is 35m (ie actual length of cable between poles allowing for sag).



Distributor Load

Total number of customers connected to section A is 18.

MD = 8 * ADMD + 0.72 * ADMD * N + 0.95 * ADMD * SQRT(N)

= 125 kVA

Phase Current = $\frac{MD * 1000}{3 * V_{start}}$

= 181 Amps

Voltage Drop Calculations (example shown for section A)

Voltage at the start of the Distributor 230V (at the Substation, beginning of section A)

Voltage drop constants should be obtained from Table B2.

MD_v = 12 * ADMD + 0.97 * ADMD * N + 1.3 * ADMD * SQRT(N)

= 175 kVA

Phase current = $\frac{MaxDemand * 1000}{3 * V_{start}}$

= 253 Amps

Voltage drop (in section A) = $\frac{(V / A / km) * Length * PhaseCurrent}{1000}$

= 1.8 Volts

Table B1: Calculations result

Section	Length	No. of Customers supplied through section	Maximum Demand	V_{start}	Phase Current	Voltage drop	Voltage drop at the extremities	Percentage Voltage drop
A	35	18	175.88	230.00	253.45	1.81		
B	35	15	157.92	228.19	230.69	1.65		
C	35	6	105.02	226.54	154.53	2.20		
D	35	3	85.81	224.34	127.50	1.82		
E	35	1	71.35	222.53	106.88	1.52	9.00	3.91%
F	35	7	111.15	226.54	163.54	1.17		
G	35	4	92.40	225.38	136.66	1.95		
H	35	1	71.35	223.43	106.45	1.52	8.09	3.52%
I	35	1	71.35	223.43	106.45	1.52	8.09	3.52%

The designed maximum voltage drop must not exceed 9 volts phase-to-earth at the extremities. For single-phase distributors, the voltage drop calculated must be doubled.

Table B2 - Voltage drop constants for distributor and streetlighting conductors

Overhead conductor	Voltage Drop Constants for Balanced Loading over Three Phases (mV/amp-metre)	
	Phase / Earth[1]	Phase / Phase
415V 4 x 25 AAC XQ ABC	1.493	2.583
415V 4 x 95 AAC XQ ABC	0.407	0.704
415V twin 4 x 95 AAC XQ ABC	0.204	0.353
415V 4 x 150 AAC XQ ABC	0.271	0.469
415V 66 HDCU 19/2.00 - bare	0.480	0.830
415V 114 AAC – 7/4.50 Mercury - bare	0.428	0.740

[1] Use this column for calculation of the designed maximum voltage drop in a low voltage distributor.

[2] For single-phase distributors, the voltage drop calculated from the phase-to-earth constants in the middle column of the above table must be doubled.