Network Standard

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NS125

Title:
Construction of low voltage overhead mains

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0	28/05/2015	Conversion to new template.	NA.	Manager Engineering Information and Services
1	24/06/2015	Clause on selection of conductors, Table on bare conductors, LV ABC identification and connection including fittings, prevention of conductor clashing, rail crossing, Waterway crossing	Matthew Cupples	Chief Engineer
2	1/12/2015	Revision date changed	Matthew Cupples	Head of AEP&S
3	2/10/2020	Full review of the NS	Duminda Thenuwara	Head of AEP&S
4	9/09/2022	LVABC is now mandatory when replacing greater than 1 span of bare wire, and conversion to new NS template.	Matthew Cupples	Mark Ragusa
5	9/05/2024	Amendments to crossarm material clause	Matthew Cupples	Murray Chandler

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Scope

This Network Standard and the associated standard construction drawings set out Ausgrid's requirements for new construction, replacement, and refurbishment of existing low voltage overhead mains.

This standard does not apply to high voltage overhead mains, which are detailed in NS126 Construction of High Voltage Overhead Mains and NS135 Construction of Overhead 33kV, 66kV and 132kV Overhead Mains.

This standard does not apply to low voltage overhead services, which are detailed in NS124 Specification for Overhead Connections up to 400 Amps.

Ausgrid's requirements for overhead line design are detailed in NS220 Overhead Design Manual.

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

NS109 Design Standards for Overhead Supply Developments and Distribution Centres

NS119 Public Lighting Design and Construction

NS124 Specification for Overhead Service Connections up to 400 Amps

NS179 Vegetation Management

NS220 Overhead Design Manual

Other Standards and Documents

AS/NZS 7000 – Overhead Line Design – Detailed procedures

ENA Doc 001-2019 National Electricity Network Safety Code

Service and Installation Rules of NSW

Relevant Industry and SafeWork NSW Guides and Codes of Practice

Acts and Regulations

Electricity Safety Act 1945

Electricity Supply General) Regulation 2014 (NSW)

Electricity Supply (Safety and Network Management) Regulation 2014

Electricity Supply (Safety Plans) Regulation 1997

Work Health and Safety Act 2011 and Regulation 2017

Clause	Standard Requirements

1 Conductor Selection and Details

1.1 Two types of low voltage overhead mains are used on Ausgrid's network:

- Bare conductor; and
- Aerial Bundled Cable (LV ABC)

1.2 LV ABC shall be used for all:

- new overhead mains,
- extensions of existing overhead mains,
- replacement of existing overhead mains greater than one span; and
- infill of more than one span of street lighting mains where continuity of the circuit must be maintained.

1.3 Low Voltage Aerial Bundled Cable (LV ABC)

1.3.1 Where LV ABC is used, cables shall be selected from those listed in Table 1. For current ratings and other electrical properties of the conductors refer to NS220.

Table 1 - LV ABC conductors

Description	Stockcode
2x25 mm² LV ABC	H109298
2x95 mm² LV ABC	H78279
4x25 mm² LV ABC	H109280
4x95 mm² LV ABC	67959
4x150 mm² LV ABC	148080

1.4 Bare conductors

1.4.1 Where bare conductor is used, conductors shall be selected from those listed in Table 2.[1]

Table 2 - Bare conductors

Description	Stockcode
7/4.50 AAC Mercury	H13433
19/3.75 AAC Pluto	H13459
6/1/3.00 ACSR/GZ Apple	H13467
6/4.75+7/1.60 ACSR/GZ Cherry	H13483
3/4/2.50 ACSR/GZ Raisin	H13734

[1] Many other conductors exist on the network, and they may continue to be used for maintenance (such as replacement after a failure) or minor work (such as a pole relocation where a short extension to the mains is required). For current ratings and other electrical properties refer to NS220

2 Crossarm Selection

2.1 Crossarm material

2.1.1 Composite crossarms shall be used where they are included as an option on the standard construction drawing.

2.1.2 Some standard construction drawings do not include a composite crossarm in the length and drilling pattern required. In these cases, a timber crossarm shall be used as shown on the standard construction drawing.

2.2 Crossarm length

2.2.1 Crossarm lengths shall be chosen to meet the design requirements for midspan separation in accordance with NS220 and AS/NZS 7000 – Overhead Line Design. The range of suitable crossarms is shown on each standard construction drawing.

2.2.2 The minimum crossarm length that shall be used for new low voltage mains is 2.1m as per the standard construction drawings.

2.3 Maintenance

2.3.1 Where an existing low voltage mains crossarm is replaced (due to maintenance or a pole replacement), the new crossarm shall be at least 2.1m long in order to maximise conductor separation.

2.3.2 An existing 1.8m crossarm may be replaced with a new crossarm of the same length if it prevents encroachments, such as a breach of conductor clearances to buildings or assets crossing property boundaries under static conditions.

2.3.3 If a 1.8m crossarm would result in encroachments, the mains shall be converted to LV ABC to resolve all encroachments.

3 Streetlighting Circuits

3.1 As per NS119, all new street lighting luminaires shall be connected to the low voltage mains and not to dedicated, switched street lighting circuits. Where continuity of an existing dedicated street lighting circuit is required during maintenance, LV ABC may be installed between existing sections.

3.2 During maintenance, legacy street lighting circuits (such as those using dedicated crossarms, swan-neck insulators, or 5-wire arrangements) shall not be converted to any other legacy arrangements. They shall be maintained as they were, converted to LV ABC for infill between existing sections of dedicated street lighting circuits, or removed and the luminaires connected to low voltage mains.

3.3 Where street lighting crossarms are replaced during maintenance, the same length crossarm may be used.

3.4 Where the low voltage mains are converted to LV ABC, any dedicated street lighting circuit that exists in the same span shall also be converted to LV ABC.

4 Clearance Criteria

4.1 All clearances shall be met at the time the network is built or altered in any way, including construction of new overhead mains, pole replacements or relocations, conductor replacements, and crossarm replacements. This includes the clearances to ground and structures in NS220 and the vegetation clearances in NS179.

5 Construction

5.1 Overhead mains shall be constructed in accordance with the standard construction drawings listed in Annexure A.

5.2 LV ABC installation by pulling-in

5.2.1 For LV ABC, the pulling tension shall not exceed 4 kN.

5.3 Phasing/arrangement of conductors

5.3.1 LV ABC cables are to be arranged so that A phase is the conductor that has only one identifying rib, B phase is the conductor that has two ribs, C phase is the conductor that has three ribs and the Neutral is the multi-ribbed conductor.

5.3.2 Where four-core cable is used on a single-phase network, unused cores shall be capped and remain de-energised.

5.3.3 Where open wire construction is used, it shall be arranged so that the neutral conductor is located nearest to the property line.

5.3.4 Low voltage transposition structures shall not be created with bare mains. Where it is necessary to transpose phases, at least one span shall be converted to LV ABC.

5.3.5 Where there are open points at a structure (including normally-open links, structures with open bonds, and structures with spans terminating on each side of the pole) conductors in the same position shall be of the same phase whether they can be electrically connected or not.

5.3.6 LV ABC Identification

Where the ends of the LV ABC are accessible, the end caps may be removed, and the probes applied directly to the conductor. Where testing is required in the middle of a run of LV ABC, an insulated test point (piercing G-clamp, stockcode H78444) shall be used and is the only method permitted for gaining access to the conductor for testing.

5.4 Installation of spreaders in Bushfire Prone Areas

5.4.1 In bushfire prone areas, low voltage spreaders shall be installed on all spans of bare wires over 30m long as follows:

- Two-wire lines (horizontal construction) - where the shorter cross arm length in the span is less than 1.8m - one spreader (mid-span) for span length between 30m and 45m, two spreaders (spaced equally) for span lengths exceeding 45m.
- Two-wire lines (vertical construction) - where the vertical separation in the span is less than 1.5m - one spreader (mid-span) for span length between 30m and 45m, two spreaders (spaced equally) for span lengths exceeding 45m.
- Three and four-wire lines (horizontal construction) and all vertical construction – as indicated in the Table 3.

Table 3 - Low voltage spreader requirements for 3 and 4 wire lines.

(Horizontal Construction) Shorter cross arm length in span	(Vertical Construction) Vertical separation between outer conductors	One spreader (mid-span)	Two spreaders (spaced equally)
1.8 m[a]	1.5 m	Span 30-45 m	Span > 45 m
2.1 m	1.75 m	Span 45-90 m	Span > 90 m
2.4 m or greater	2.0 m or greater	Span 55-110 m	Span > 110 m

[a] 1.8m crossarms exist on the network however shall not to be used for new constructions as per Clause 2.3.

5.5 Multiple LV circuits

5.5.1 Conductors of the same material installed in the same span shall have the same sag.

5.5.2 For the location of each attachment point on the structure, refer to the standard construction drawings. Refer to NS220 for inter-circuit spacing.

5.6 Mid-span joints

5.6.1 New mains shall not use mid-span joints. Cables and conductors shall be joined at the non-tension bond position of a pole top at erection.

5.6.2 Mid-span joints are permitted for pole relocations and repairs to mains.

5.6.3 Where used on LV ABC, mid-span joints shall be staggered to allow the cores to fit closely together.

5.6.4 To facilitate piecing-in of a conductor, up to two mid-span joints per phase are permitted in a span. If there are existing joints in the span, a section of conductor and the associated joints may need to be removed to comply with this requirement.

5.6.5 There shall be no full-tension joints on twin-and-twist conductors. For alternative installation options see Annexure B.

5.7 Bonds

5.7.1 Bonds (also known as taps) are short pieces of conductor between two sections of conductor under tension. They may be a continuation of the mains or a separate piece of conductor.

5.7.2 All bonds shall be insulated or covered. The rating of the bond shall equal or exceed the rating of the highest rated mains to which it is connected.

5.7.3 Where the bond is not insulated, the conduits shown in Table 4 shall be used to cover the bond.

Table 4 – UV stable, grey plastic flexible conduit

Description	Stockcode
13mm inside diameter	176565
16mm inside diameter	176564
20mm inside diameter	176566

5.7.4 Connections for bonds shall only be installed on conductors that are not under tension. Where this is not possible and a connection to conductors under tension is required (such as a tee-off), the conductors and bonds shall be the same material.

5.7.5 Bimetallic PG clamps shall not be used on mains under tension.

5.7.6 Vertical bonding for LV ABC

5.7.6.1 Vertical bonding must be installed with parallel LV ABC conductors of the same circuit at intervals not exceeding 100 metres and at:

- substations,
- links,
- terminations, and
- tee connections.

5.7.7 Vertical bonding for bare conductors

5.7.7.1 Where vertical bonds are installed for parallel circuits of bare conductors, they shall be insulated with a loop installed 150 mm below the bottom circuit to allow for the placement of temporary line covers.

5.8 Temporary covers

5.8.1 Temporary covers include pipe-type covers (commonly known as Torapoli or tiger tails) and drape-type covers. Before temporary covers are used, both the mains and temporary covers shall be inspected for visual defects.

5.8.2 Mains must not be overloaded and must not sag below minimum clearances due to the addition of temporary covers.

5.8.3 They shall be placed to maintain even sag, and spreaders shall be added if needed.

5.9 LV ABC insulation integrity

5.9.1 To prevent corrosion of the aluminium conductor and maintain the fully insulated system, it is essential that the XLPE insulation has no holes. Any holes in insulation must be repaired, including those caused by G-Clamps or the removal of fittings.

5.9.2 Holes identified in the insulation must be carefully sealed with vinyl-backed mastic tape (stockcode 69807) to restore the insulation and prevent moisture ingress. A single layer is sufficient for holes left by G-Clamps, or 3 layers half-lapped for other damage.

5.9.3 Electrical tape is not suitable for reinstating the insulation or moisture barrier, and insulation piercing connectors (IPCs) shall never be used to cover holes made by G-Clamps.

5.9.4 Cut ends of the cable that are not terminated with an electrical connector shall be individually sealed with a cable end cap. This includes cable ends that will have electrical connectors added at a later date.

5.9.5 The cut ends of the cable remaining on a drum shall be sealed.

5.10 Enclosed LV fuse-switch disconnectors

5.10.1 To prevent moisture ingress into the conductor strands, a drip loop shall be included in the conductor near the termination onto the switch.

5.11 LV ABC piercing connections

5.11.1 Piercing connections shall not be made under electrical load.

5.11.2 IPCs are single use components and shall never be reused.

5.11.3 IPCs shall not be used for sealing holes left by other piercing connectors or test devices.

5.11.4 IPCs shall be installed in accordance with the manufacturer's instructions. In addition to the tools specified by the manufacturer, the tools in Annexure C may be used.

5.12 Redundant mains and hardware

5.12.1 Where overhead mains are redundant, the designer shall make provision in the design to remove redundant assets when work is identified on the pole structure.

5.12.2 All redundant hardware, including connectors, shall be removed at the time it is made redundant. Any other redundant hardware already present shall also be removed.

5.13 Stainless steel bolts and set-screws – lubrication of threads

5.13.1 Before installation of each stainless steel bolt or set-screw, the thread shall be lubricated with anti-seize grease containing nickel (stockcode 177212).

Annexure A Standard construction drawings

Table 5 - LV ABC construction drawings

Description	Construction No.	Drawing No.
LV ABC Intermediate Construction for 30° Maximum Angle	1-70	513981
LV ABC Termination Construction	1-71	513982
LV Open Wire to ABC Through Termination Construction	1-72	513983
LV ABC Intermediate Construction for 30° – 60° Maximum Angle	1-73	514012
LV ABC Through Termination Construction	1-74	514013
LV ABC Corner Pole Construction 60° – 150° Angle	1-75	514014
LV ABC Through Mains Corner Construction	1-76	514015
LV ABC Through Termination Construction with Tee-off	1-77	514016
LV ABC Intermediate Construction with Tee-off	1-78	514017
LV ABC Through Termination Construction with Links	1-79	514052
LV ABC intermediate construction on 500mm standoff bracket for 0° to 30° deviation angle	1-80	206544
LV ABC Offset Arm Construction for 0° to 30° Deviation Angle	1-81	232175
LV ABC Offset Twin Arm Construction for 0° to 30° Deviation Angle	1-82	244670
LV ABC Intermediate Construction on 500mm Standoff Bracket for 30° – 60° Maximum Angle	1-83	206546
LV Horizontal Pin Construction with LV ABC Tee Off Construction	1-84	206624
LV Open wire to ABC Through Termination Construction with Links	1-89	206623
LV ABC Parallel Circuit Bonding Arrangements	-	186336
LV ABC Constructed on Conductive Poles Below High Voltage Supply	-	565720

Table 6 - Bare overhead construction drawings

Description	Construction No.	Drawing No.
LV Horizontal Pin Construction	1-1	513900
LV Offset Arm Arrangement	1-2	513901
LV Angle Arrangement	1-3	513902
LV Termination Arrangement	1-10	513903
LV Through Termination Arrangement	1-11	513904
LV Corner Pole Termination Arrangement	1-12	513940
LV Corner Pole Through Mains Construction	1-13	513905
LV Corner Pole (Tee-off) Termination Arrangement	1-14	513906
LV Railway Termination Construction	1-15	513945
LV Through Mains with Links	1-50	513971
HV, LV and communications crossarm details		228823
LV through termination for maintenance and legacy replacements only	1-11(A)	234378

Annexure B Connections to twin-and-twist

Electrical and mechanical connections to twin-and-twist conductors shall be performed as detailed in Table 7.

Table 7 - Twin-and-twist conductor connection options

Connection	Description
Bonds to copper conductors (including tails to switchgear, copper single UGOHs, PTs etc.)	Connect insulated copper tails to the mains with split bolts. The split bolts fully encapsulate both of the conductors as well as the bonding cable. This eliminates slipping out of the side and shares the electrical load between the conductors.
Wavecon UGOH's	All Wavecon UGOH's shall be terminated into LV links or a LV ABC link box. This allows for the tail between the link and the main to be covered copper and can be connected to the main with the use of the split bolt procedure mentioned above.
Bonds to aluminium conductors	Tails from aluminium conductors (both bare and LV ABC) cannot be connected directly to the copper twin-and-twist conductors. Instead, connect insulated copper tails as described above, and then connect the copper tail to the bare aluminium or LV ABC using PG clamps or IPCs respectively.
Low voltage services	Spread the two conductors and install a service connector on the larger conductor. If there isn't already a split bolt clamp around the two mains conductors (such as from a bond), then install a split bolt no more than 300mm away from the service connector, but not so close that it bends the conductor.
Straight through attachment to pin insulators	Keeping both conductors together, locate them in the top or side groove of the low voltage pin insulator as appropriate. Use a hand-tie around both conductors together, treating them as one.
Terminations	Keeping both conductors together, take them around the low voltage shackle insulator and back adjacent to the conductor under tension. Use pieces of tie wire to make a throat tie around both conductors together, treating them as one. More detailed instructions are given on the following page.
Mid-span full tension splices	As McIntyre sleeves are no longer available, there is no available solution for mid-span full tension connections. Instead, terminate the conductors at the pole either side of the break, and replace with a single copper conductor appropriately rated for the load and bonded as described above. There shall be no mid span sleeving on twin-and-twist conductors.

Methods for tying twin-and-twist conductors to insulators are shown in Table 8.

Table 8 - Twin-and-twist conductor insulator tie drawings

Description	Drawing No.
Termination tie for twin and twist conductors	251901
Side tie for twin and twist conductors	251902
Top tie for twin and twist conductors	251903

Annexure C Approved tools

Table 9 - Battery powered tools for installing IPCs

Type	Manufacturer	Model	Notes
Impact wrench	Hilti	SIW 6AT-A22	The tool shall be set to Level 3. The tool shall only be used on connectors involving 95mm² or 150mm² LV ABC mains.
Drill driver	Any	Any	The tool shall be set or limited to a rotational speed of less than 500 rpm. The tool shall not use any impact or hammer action.