Network Standard

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NW000-S0064 NS214 GUIDE TO HV LIVE WORK DESIGN PRINCIPLES

ISSUE

For issue to all Ausgrid and Accredited Service Providers' employees involved with the design of overhead mains to facilitate the use of HV Live Work methods, and is for reference by field, technical and engineering employees.

Ausgrid maintains a copy of this and other Network Standards together with updates and amendments on 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Where this standard is issued as a controlled document replacing an earlier edition, remove and destroy the superseded document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 Work Health and Safety Regulation 2017 (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

Scope and Risks Addressed

This Network Standard identifies the factors that should be taken into account by designers of overhead mains to facilitate the application of HV Live Work on Ausgrid's network. This standard is limited to scope identified below and provides controls for associated risks as listed below:

- ☐ Applies to new construction and to where existing assets that are being replaced.

Where to for more information?

Section 1, 2

HV Live Work Design Principles

Considerations that can be made to overhead designs to facilitate the use of HV Live Work Methodologies include:

- ☐ Designs should where possible avoid conditions which will lead to ferroresonance, the Ferranti effect and other induction hazards
- ☐ Larger separation between HV and LV circuits can be specified to aid working from EWP baskets during HV Live Work.
- ☐ HV Live Work methods can be used to replace in-line poles where the new pole is installed in either the same hole, or near and in line to the original pole.
- ☐ Use of HV Live Work methods on angle poles is subject to assessment of the mechanical loading careful placement of poles may be used to reduce mechanical loading.
- ☐ Positioning of new poles should consider reducing mechanical loading, avoiding the need to extend the length of conductors, and the positioning of an EWP basket outside of the unexpected collapse direction

Where to for more information?

Section 5

Tools and Forms

Annexure A – Sample compliance checklist

HV Live Work Design Principles (cont'd.)

- ☐ HV Live Work methods can be used during conductor replacement to:
  - Install/remove rollers
  - Install permanent bonds, tie offs and conductor ties
  - Installing LV conductors under live HV conductors after a thorough risk assessment is carried out
- ☐ Positioning of switching points at least 3 metres from new untested polymeric surge arresters and 30m from any new untested porcelain surge arresters
- ☐ Special care must be taken where HV parallel circuits are used especially considering phase to earth faults and clearing times
- ☐ Positioning of poles should consider length of bridging connections to facilitate use of HV Live Work bridges/bonds
- ☐ Consideration should be given to safe weight lifting limits to ensure these do not exceed limits for HV Live Work.
- ☐ Designs should consider the minimisation of fault levels to protect HV Live Work sites

Where to for more information?

Section 5

Tools and Forms

Annexure A – Sample compliance checklist

HV Live Work Design Principles (cont'd.)

- ☐ Introduction of earth planes, such as street light brackets on HV poles can restrict use of HV Live Work methods
- ☐ Careful selection of network apparatus can reduce whole of life assets costs
- ☐ Reviewing planned designs with HV Live Work crews can highlight any problems with future maintenance of the design and provide an opportunity for amendment to ensure suitability for future HV Live Work.
- ☐ Equipment should be pressure tested before being commissioned in the vicinity of HV Live Work sites

Where to for more information?

Section 5

Tools and Forms

Annexure A – Sample compliance checklist

Network Standard
NS214
Guide to HV Live Work Design Principles

Contents

1.0 PURPOSE

This Network Standard identifies the factors that should be taken into account by designers of overhead mains to facilitate the application of HV Live Work on Ausgrid's network. The designer must balance these issues with construction costs, the requirements of other Ausgrid Network Standards, and any job specific design instructions issued by the local Ausgrid office, identifying the desired outcomes of the specific project.

2.0 SCOPE

This guideline applies to the design of overhead mains to facilitate the use of HV Live Work methods. Design for use of HV Live Work methods is only to be carried out during projects driven through maintenance or construction programs. Poles are not to be replaced just to facilitate use of HV Live Work Methods.

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.

3.2 Ausgrid documents

- Company Form (Governance) - Network Technical Document Endorsement and Approval
- Company Procedure (Governance) - Network Technical Document Endorsement and Approval
- Company Procedure (Network) – Network Standards Compliance
- Company Procedure (Network) - Production / Review of Engineering Technical Documents within BMS
- Electrical Safety Rules
- Electricity Network Safety Management System Manual
- High Voltage Live Work Manual
- NS125 Specification for LV Overhead Conductors
- NS126 Specification for Design and Construction of High Voltage Overhead Mains
- NS135 Specification for the Design and Construction of Overhead Sub-Transmission Lines
- NS181 Approval of Materials and Equipment and Network Standard Variations
- NS212 Integrated Support Requirements for Ausgrid Network Assets
- NS220 Overhead Design Manual
- Tree Safety Management Plan

3.3 Other standards and documents

- AS/NZS 7000:2010, Overhead Line Design – Detailed procedures
- AS/NZS 1418.10:2011 Cranes Hoists and Winches – Mobile Elevating Work Platforms
- ENA Doc 001-2008 National Electricity Network Safety Code

3.4 Acts and regulations

- Electricity Supply (General) Regulation 2014 (NSW)
- Electricity Supply (Safety and Network Management) Regulation 2014
- Work Health and Safety Act 2011 and Regulation 2017

4.0 DEFINITIONS

ABC	Aerial Bundled Conductor
Accredited Service Provider (ASP)	An individual or entity accredited by the NSW Department of Planning and Environment, Energy, Water and Portfolio Strategy Division, in accordance with the Electricity Supply (Safety and Network Management) Regulation 2014 (NSW).
Business Management System (BMS)	An Ausgrid internal integrated policy and procedure framework that contains the approved version of documents.
CCT	Covered Conductor Thick
Document control	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.
EWP	Elevating Work Platform
EHV	Extra High Voltage
HAZOP	Hazard and Operability study - a method to identify potential hazards and operating issues with the design and construction of equipment and plant.
HV	High Voltage
HV Live Work	Work performed on overhead HV mains and apparatus, whilst they are alive, utilising either hot stick method which uses insulating sticks, insulating barriers and tools or the glove and barrier method. All HV Live Work must be carried out by certified persons who hold a current HV Live Work Authorisation.
LV	Low Voltage
Network Standard	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.
Review date	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.

5.0 HV LIVE WORK DESIGN PRINCIPLES

5.1 General

The following factors should be taken into account by designers of overhead mains. The designer must balance these issues with construction costs, Ausgrid Network Standards (NS125, NS126, NS135, NS220, etc) and the job specific Design Information as issued by the local Ausgrid office.

5.2 Ferroresonance, Ferranti effect and induction hazards

Ferroresonance is a phenomenon that occurs typically when single phase switching is carried out on a transformer that is supplied by a long length of underground cable, or overhead mains under light load conditions, and can cause potentially destructive over-voltages (up to five times system voltage).

The Ferranti Effect is a phenomenon that affects long transmission lines which draw a substantial quantity of charging current. If such a line is open circuited or very lightly loaded at the receiving end, the voltage at the receiving end may become greater than the voltage at sending end (up to twice system voltage). It is due to the voltage drop across the line inductance (due to charging current) being in phase with the sending end voltages.

Magnetic Field HV Induction refers to the way the magnetic fields associated with heavily loaded overhead lines can induce currents and create hazardous voltages in other nearby lines which run parallel to it.

Electric Field HV Induction refers to the way the electric fields associated with capacitively coupled HV overhead lines can create hazardous voltages in other nearby lines which run parallel to it or on metallic objects in the intervening air gap.

Backflash arises when a localised earth surge voltage appears and flashes over to energised conductors to reach remote earth. This arises in thunderstorms and/or in severe EHV switching surges, in places such as near EHV Feeder under-crossings.

These phenomena should always be avoided because of the potentially hazardous situations they create and the damage they can cause. This is particularly so where HV Live Work is carried out. Designers should be careful to avoid designing lines with conditions which will lead to the above phenomena.

5.3 Separation between LV and HV mains

Vertical separation between LV and HV mains for areas where the 11kV network can be worked on using HV Live Work methods shall be in accordance with NS220.

The separation to be used for any particular project shall be nominated by the local Ausgrid Project Officer.

Spur lines should always be designed and constructed with live-line circuit to circuit separations. Where HV Live Work can be carried out, the larger separation between HV and LV is necessary to permit typical EWP baskets to pass between the HV and LV mains, saving repositioning time for the EWP on both sides of the pole.

Although the separation between energized conductors can often be temporarily increased to facilitate HV Live Work, by the use of HV Live Work Sticks and /or insulated cranes, the feasibility and cost effectiveness is limited at lower voltages and closer dressed clearances.

The ability of HV Live Work crews to manoeuvre EWPs is constrained by the availability of appropriately tested insulation other HV Live Work equipment necessary to maintain Minimum Approach Distances (MAD), as required in Ausgrid's HVLW Manual.

For HV Live Work by Stick or Glove and Barrier Methods, EWPs are fitted with HV insulation bucket inserts and chassis insulators, which are useful for controlling risks associated with inadvertent contact with energised mains or apparatus. HV Live Work crews using Glove and Barrier Method rely on this insulation and planned EWP movements to maintain set clearances in air. Lower voltage conductors and earthed structures, such as poles and crossarms, must have appropriate HV Live Work tested insulation applied, prior to any HV Live Work being carried out.

Before commencing the design of any overhead mains the designer must liaise with Ausgrid's local Project Officer to determine whether HV Live Work separations are required, and design the line accordingly.

5.4 Pole replacements

Subject to the live mains being able to be safely supported throughout, HV Live Work methods can generally be used to replace in-line poles, with the new pole being installed in the same hole or near and inline to the old pole. However differences between the old and new pole height and/or the pole-top construction type used impact on the ability to use HV Live Work methods.

The use of HV Live Work methods to replace angle poles is dependent upon mechanical loading calculations. Designers should calculate the design loadings in anticipation of the potential use of HV Live Work methods.

The designer may also consider the position of the new pole such that the mechanical loading of conductors is eased and to avoid the need for additional conductor length during the changeover. Attention should also be given to positioning the new pole such that the HV Live Work EWP is able to be positioned so the HV Live Work crew can stay aloft and out of the unexpected collapse direction hazard zone.

5.5 HV Live Work on Covered Conductor – Thick (CCT)

When designing for HV Live Work, it should be considered that limited HV Live Work methods are used when installing or maintaining CCT.

For further information on High Voltage Live Work methods used on CCT contact Ausgrid.

5.6 HV Live Work worksites near HV surge arresters

Porcelain or polymeric surge arresters **must not** be installed or removed from service using HV Live Work methods: that is, it is **not acceptable** for HV Live Workers to be within 30m of porcelain or 3m of polymeric surge arresters whilst they are being commissioned.

For this reason designers should allow for switching points, either permanent or HV Live Work temporary, from any new untested surge arresters.

Particular attention should be given to surge arresters at CCT/Bare Conductor interfaces and at UG/OH poles.

5.7 HV parallel circuits

When designing HV parallel circuits, the arcing fault energy let-through (fault clearing time * (fault current)*2) must be minimised. It should be noted that for parallel circuits, the fault clearing time is often faster and fault currents are higher, than for non-parallel arrangements. Phase to earth faults are of primary concern, as HV Live Work crews generally work on only one phase at a time, with other circuits and phases being covered, separated and mechanically secured.

5.8 Ergonomic and apparatus handling limits

Designers must take into account the safe weight lifting limits for lineworkers including the effects of leverage when HV Live Work stick method is involved.

Consideration should also be given to pole placement where conductor bridges and bonds may be excessively long, which can render the particular construction or maintenance job beyond the scope of HV Live Work methods or necessitate the use of more time-consuming and expensive HV Live Work methods than would otherwise be necessary. For example, the length of necessary bridges/bonds should be limited to those which are compatible with the standard HV Live Work temporary bridges, etc - it should be noted that at 66kV the use of HV Live Work stick methods limit the length of bridges/bonds to 2m. Similarly the calculated weight of conductors to be moved by HV Live Work methods can dictate the range of procedures which can be used, and if the conductor movement loading is too high the available methods are limited and may add to the time and effort to achieve the intended result. Careful consideration of these issues at the design stage can significantly improve efficiencies.

5.9 Fault levels

Network configuration/switching arrangements can greatly influence the fault level at any particular HV Live Work site and consequently the safety and feasibility of carrying out HV Live Work. The impact of HV Live Work site incidents can be significantly reduced through lower fault levels. In the case of through-faults, higher fault levels (which generally exist in urban areas) can cause problems at HV Live Work sites where the resulting violent conductor movements can dislodge conductors and temporary insulation i.e. mechanical and insulation “bucking-off” risks.

Such risks can be minimised through the careful selection of network configuration/switching arrangements which result in lowest prospective fault currents. For example: arranging for the network to be supplied from only one power transformer rather than two operating in parallel.

5.10 Earth potentials

Placement of additional earth planes, such as a street lights and riser brackets, on the same poles which also carry HV mains, can limit the use of HV Live Work methods on that pole.

5.11 Whole-of-life asset costs and site specific issues

If new network apparatus are intended to be maintained throughout its life utilising HV Live Work methods, the compatibility of the apparatus and available HV Live Work methods must be assessed early in the design phase.

5.12 Direct liaison with HV Live Work crews

The HV Live Work Manual provides for rehearsal and audit review mechanisms for ongoing innovation and improvement of HV Live Work methods and procedures

Wherever doubt exists regarding designs that facilitate the use of HV Live Work methods, direct liaison with HV Live Work crews and/or other experienced employees should not be overlooked; i.e. when in doubt – ask!

6.0 RECORDKEEPING

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

Table 1 – 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 (Trim ref. 2014/21250/282)	Unlimited
Working documents (emails, memos, impact assessment reports, etc.)	HPRM Work Folder for Network Standards (Trim ref. 2014/21250/282)	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.

7.0 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.

8.0 DOCUMENT CONTROL

Content Coordinator : Manager - Transmission and Distribution Mains Engineering

Distribution Coordinator : Senior Engineer – Guidelines, Policies and Standards

Annexure A – Sample Compliance Checklist

Network Standard Checklist Form

NS214 - Guide to HV Live Work Design Principles

Project Identification:	
Prepared by:	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
	Scope		
	This Network Standard applies to the design of overhead mains to facilitate the use of HV Live Work methods.		
	HV Live Work Design Principles		
1	Conditions introducing the phenomena of ferroresonance, the Ferranti Effect and electromagnetic induction have been avoided	5.2	Yes/No/NA
2	Separation of HV and LV circuits have been followed to facilitate HV Live Work work from an EWP basket	5.3	Yes/No/NA
3	Replacement pole position has been carefully considered to facilitate HV Live Work pole Replacement of in-line poles	5.4	Yes/No/NA
4	Pole placement has been carefully considered to facilitate HV Live Work pole Replacement of angle poles	5.4	Yes/No/NA
5	Consideration has been given to whether conductor type is CCT.	5.5	Yes/No/NA
6	Circuit design provides a minimum separation of 3m from polymeric or 30m from porcelain diverters for HV Live work sites.	5.6	Yes/No/NA
7	Where designing HV parallel circuits consideration has been given to the resultant fault levels (especially phase to earth) and fault clearance times	5.7, 5.9	Yes/No/NA
8	Consideration has been given to safe weight lifting limits	5.8	Yes/No/NA
9	Consideration has been given to length of bridges/bonds to facilitate use of HV Live Work temporary bonds/bridges which have limited lengths.	5.8	Yes/No/NA

Item	Description	Refer Clause	Completed/ Actioned
10	Awareness of the introduction of earth planes (such as street light brackets) on HV poles can restrict use of HV Live Work methods.	5.10	Yes/No/NA
11	Choice of network asset types to facilitate the minimisation of whole of life costs	5.11	Yes/No/NA
12	Liaison with HV Live Work crews to validate designs for suitability to HV Live Work	5.12	Yes/No/NA

Notes:

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