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Technical Note

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Subject: Withdrawal of EP 10 01 00 06 SP HV Aerial Line Standards for Design and Construction

This technical note is issued by the Asset Standards Authority as a notification to remove from use RailCorp document EP 10 01 00 06 SP *HV Aerial Line Standards for Design and Construction*, Version 4.0.

EP 10 01 00 06 SP is a legacy document and shall be used for reference purposes only. ASA standard T HR EL 10001 ST *HV Aerial Line Standards for Design and Construction,* Version 1.0 supersedes this document.

Authorisation

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Superseded by T HR EL 10001 ST

Engineering Standard
Electrical
High Voltage Aerial

EP 10 01 00 06 SP

HV AERIAL LINE STANDARDS FOR DESIGN AND CONSTRUCTION

Version 4.0

Issued June 2012

Engineering Standard

Owner:	Chief Engineer Electrical		
Approved by:	Neal Hook Chief Engineer Electrical	Authorised by:	Neal Hook Chief Engineer Electrical

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Document control

Version	Date	Summary of change
	June 2008	Last Technical review
3.0	May 2010	Application of TMA 400 format
4.0	June 2012	See table below

Summary of changes from previous version

Summary of change	Section
Document re-formatted and re-organised	
References updated	2
Scope and application clarified	1
General design parameters added	3.1
Configuration requirements added	4
Requirements for HV aerial routes expanded	5
Requirements for support structures added, including clarifications on the limitations on the use of steel structures	6
Guy arrangements updated	13
Earthing arrangements updated	14
Survey requirements updated; details of survey data format deleted	16
Design and asset data requirements updated	17&20 App B
Requirements for construction staff and materials added	18&19
List of type approved insulators added	App A

Superseded by T HR EL 10001 ST

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1 Scope and application

This document sets out the design and construction standards for new high voltage aerial lines, and for the rehabilitation of existing HV aerial line infrastructure.

Where existing HV aerial lines are to be modified, the design and construction of the modification shall be such that the resultant configuration shall comply with this document. Where it is not practical to do so, the Designer shall list all non-compliances and the proposed design approach to mitigate the risks associated with the non-compliances. Acceptance of the mitigation measures by the RailCorp Nominated Engineering Authority is required prior to the commencement of Detailed Design.

A design is not required for a “like for like” replacement of an existing pole, provided that:

- The existing pole is located in accordance with the as-built design.
- The replacement pole is located within one metre of the existing pole.
- The ground level has not changed from the as-built design.

Pole mounted substations and switches are not part of the HV aerial line system. The requirements for such equipment are not part of the scope of this document. However, the loads due to such equipment shall be considered in the structural design of the poles. The design of the HV aerial line shall ensure that all relevant clearance requirements are met.

This document complies with the requirements of the RailCorp Safety Management System at the time of issue.

2 References

2.1 Codes of Practice

NSW Maritime – Crossings of NSW Navigable Waters: Electricity Industry Code

NSW Department of Water and Energy – Code of Practice for Electricity Transmission and Distribution Asset Management

2.2 Australian Standards

AS 1154.1: 2009	*Insulator and conductor fittings for overhead power lines – Part 1: Performance, material, general requirements and dimensions*
AS 1154.3: 2009	*Insulator and conductor fittings for overhead power lines – Part 3: Performance and general requirements for helical fittings*
AS 3818.1: 2009	*Timber – Heavy structural products – Visually graded – Part 1: General requirements*
AS 3818.4: 2010	*Timber – Heavy structural products – Visually graded – Part 4: Cross-arms for overhead lines*
AS 3818.11: 2009	*Timber – Heavy structural products – Visually graded – Part 11: Utility poles*
AS 3891.1: 2008	*Air navigation – Cables and their supporting structures – Marking and safety requirements – Part 1: Permanent marking of overhead cables and their supporting structures for other than planned low-level flying*
AS 4100: 1998	*Steel structures*

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AS 4435.1: 1996	*Insulators – Composite for overhead lines – Voltages greater than 1000 V a.c. – Part 1: Definitions, test methods and acceptance criteria for string insulator units*
AS 4435.4: 2005	*Insulators – Composite for overhead power lines – Voltages greater than 1000 V a.c. – Part 4: Definitions, test methods, acceptance criteria for post insulator units*
AS 4899: 2007	*Pin insulators – Porcelain and glass for overhead power lines – Voltages greater than 1000 V a.c.*
AS 5604: 2005	*Timber – Natural durability ratings*
AS 6947: 2009	*Crossings of waterways by electricity infrastructure*
AS 60305: 2007	*Insulators for overhead lines with a nominal voltage above 1000V – Ceramic or glass insulator units for a.c. systems – Characteristics of insulator units of the cap and pin type.*
AS/NZS 2878:2000	*Timber – Classification into strength groups*
AS/NZS 2947.1:1999	*Insulators – Porcelain and glass for overhead power lines – Voltages greater than 1000 V a.c. – Part 1: Test methods – Insulator units*
AS/NZS 2947.4:1999	*Insulators – Porcelain and glass for overhead power lines – Voltages greater than 1000 V a.c. – Part 4: Test methods – Insulator strings and insulator sets*
AS/NZS 4435.2: 1999	Insulators – Composite for overhead power lines – Voltages greater than 1000 V a.c. – Part 2: Standard strength classes and end fittings for string insulator units
AS/NZS 4677:2010	Steel utility service poles
AS/NZS 4680:2006	*Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*
AS/NZS 4792:2006	*Hot-dip galvanized (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process*
AS/NZS 7000:2010	*Overhead line design – Detailed procedures*
HB 331: 2012	*Overhead line design*

2.3 RailCorp documents

EP 08 00 00 13 SP	*Overhead wiring fittings and materials*
EP 10 00 00 04 SP	*Aerial line easement conditions*
EP 10 00 00 05 SP	*Aerial line current ratings and standard conductors*
EP 10 01 00 05 SP	*Requirements for electric aerials crossing RailCorp infrastructure*
EP 12 10 00 22 SP	*Buildings and structures under overhead lines*
EP 21 00 00 01 SP	*Insulation coordination and surge arrester selection*
EP 95 00 30 05 SP	*RailCorp Network Management Plan Chapter 4 – Bush Fire Risk Management*
EPD 0013	*Technical reviews*
EPE 0001	*Substations, high & low voltage installations – Design competencies and authorities*
EPE 0002	*Mains installation (OHW, HV aerial lines, HV and 1500V cables) – Design competencies and authorities*
ESC 215	*Transit Space*
ESC 540	*Service Installations within the Rail Corridor*
ESC 550	*Access Roads*
SMS-06-GD-0268	*Working around Electrical Equipment*
SMS-11-GD-0244	*Personnel Certifications – Electrical Authorisations*

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2.4 RailCorp drawings

The RailCorp Intranet / Internet Engineering site, under Electrical \ Electrical Design Information, contains two lists of drawings:

- HV Aerial Line Arrangements
- HV Aerial Line Fittings.

These drawings are applicable for design and construction of RailCorp HV aerial lines.

2.5 Other references

ENA Doc 015-2006	*National guidelines for prevention of unauthorised access to electricity infrastructure*
ENA Doc 023-2009	*ENA guidelines for safe vegetation management work near live overhead lines*
ISSC 3	*Guideline for Managing Vegetation Near Power Lines*
ISSC 20	*Guidelines for the management of electricity easements*

3 General

The design and construction of RailCorp HV aerial lines shall comply with the requirements of the Code of Practice for Electricity Transmission and Distribution Asset Management, *AS/NZS 7000*, and this document.

Single wire earth return (SWER) systems shall not be used.

3.1 General design parameters

Unless otherwise specified by RailCorp and approved by the RailCorp Chief Engineer Electrical, the general design parameters listed in Table 1 shall be used.

Provision for live line working	Not required. However, where multiple circuits are supported on the same structure, adequate clearances shall be provided to allow for working on the lower circuit with the upper circuit live. See section 4.2.
Design life	50 years
Security level (in accordance with *AS/NZS 7000* section 6)	Level III
Maximum conductor operating temperature	70 ^{o}C
Reliability	See *EP 21 00 00 01 SP* for required outage rates.
Insulation co-ordination / BIL	Refer to *EP 21 00 00 01 SP*

Table 1 – General design parameters

3.2 Environmental considerations

Design and construction of HV aerial lines shall ensure that the requirements of the RailCorp Environmental Management System are complied with for the full asset life cycle.

The impact from birds and other wild life shall be considered in the design of HV aerial line routes and pole top arrangements.

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4 Configuration

4.1 Cables and aerial lines

A high voltage feeder may consist of aerial lines or cables, or a combination of both. The decision to adopt an aerial or cable route shall be based on technical feasibility and risks, and whole of life costs. The decision for the chosen configuration and associated supporting evidence shall be documented for each project.

Where a high voltage feeder consists of a combination of aerial lines and cables, the configuration of the feeder shall satisfy the following provisions:

- Each aerial section, between cable terminations or between a cable termination and the aerial line termination at a substation, must have at least 4 spans and shall not be less than 500m.
- The length of cable between two aerial line sections shall not be less than 500m.

A shorter length of cable between two aerial line sections may be accepted if the following issues are satisfactorily addressed in the design:

- Reliability of underground to overhead (UGOH) terminations
- Feeder fault finding
- Reclosure procedures
- Design and maintenance of earthing system
- Overvoltage issues associated with harmonics
- Management of buried assets

4.2 Multiple HV circuits on poles

The RailCorp high voltage network is generally designed with “N-1” redundancy. Feeders with a voltage of 33kV or higher shall not be supported on the same pole without the prior approval of the RailCorp Chief Engineer Electrical.

An 11 kV feeder may be supported under another feeder with a voltage of 33 kV or higher on the same pole, provided that the separation between the circuits allow for the maintenance of the 11kV feeder while the upper circuit is live. The minimum separation at the structure between the 11kV circuit and the 33kV or 66kV above is 1.8m (0.8m working zone per *AS/NZS 7000* + 1.0m safe approach distance per *SMS-06-GD-0268*) under all wind and temperature conditions.

HV conductors of external parties shall not be supported on RailCorp structures without the prior approval of the RailCorp Chief Engineer Electrical.

Superseded by T HR EL 10001 ST

5 HV aerial line route

To minimise interface issues and risks associated with external parties, HV aerial line routes should be located within the rail corridor as far as practicable.

HV aerial line routes within the rail corridor shall comply with the requirements of *ESC 540*.

Where it is necessary to locate the route outside of the rail corridor, arrangements shall be made, via the RailCorp Project Design Manager, with the RailCorp Property Division to arrange for relevant agreements with external authorities and / or the acquisition of easements. See *EPD 0013* for the definition of Project Design Manager.

Refer to *AS/NZS 7000* and *ISSC 20* for typical easement widths.

Where support structures are to be located on or adjacent to roadways, particular attention should be paid by the Designer to the risk of vehicular impact. Support structures shall be located to have this risk minimised.

5.1 Maintenance and construction access

Adequate and safe access shall be provided for persons and plants for the construction and maintenance of the HV aerial line. As far as practical, support structures shall be located so that the structure and conductor support arrangements may be accessed by elevated work platforms.

Easements may have to be arranged and access roads may have to be constructed to comply with this requirement. Access roads shall comply with the requirements of *ESC 550*.

5.2 Vegetation clearance

Clearance to vegetation shall comply with the requirements of *ISSC 3* and *ENA Doc 023:2009*. The arrangement to achieve the required vegetation clearance shall comply with the RailCorp Safety Management System and Environmental Management System.

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5.3 Buildings and structures under HV aerial lines

Bare RailCorp 2kV or 11kV aerial lines shall not pass over buildings or extensions from buildings. Where it is not practical to avoid such situations screened ABC may be used over buildings.

Bare RailCorp 33kV or 66kV aerial lines shall not pass over buildings (and extensions from such buildings) which are normally occupied or which have a water service connected. Case by case approval may be granted for 33kV or 66kV lines to pass over buildings that are not normally occupied (eg signalling relay rooms) if there is no practical alternative. In such cases all practical measures will be required to reduce the likelihood of the line falling.

Signalling location cases are not considered to be “buildings” for the purpose of this requirement.

Bus shelters of the small free-standing type may be placed under RailCorp HV aerial lines if there is no practical alternative and appropriate risk mitigations are put in place. Bus shelters that are interconnected to larger structures are not permitted under RailCorp HV aerial lines.

Refer to *EP 12 10 00 22 SP* for earthing and bonding requirements for buildings and structures under HV aerial lines.

5.4 Crossing of RailCorp structures

Crossing of railways and other RailCorp structures shall comply with the requirements of *EP 10 01 00 05 SP*.

Crossing of RailCorp main line tracks shall be avoided as far as practicable. Crossing over three or more main line tracks shall be approved by the RailCorp Chief Engineer Electrical prior to Detail Design and construction.

5.5 Crossing of waterways

Crossing of waterways shall comply with the requirements of *AS 6947: 2009* and NSW Maritime Crossings of NSW Navigable Waters: Electricity Industry Code.

5.6 Bush fire risks

HV aerial line routes shall not be located in bush fire prone areas without the prior approval of the RailCorp Chief Engineer Electrical. The application for such approval shall clearly demonstrate that all other options are not practical after thorough investigation has been done by the Designer.

Feeders with HV aerial line routes in bush fire prone areas shall be identified, designed and constructed in accordance with *EP 95 00 30 05 SP*.

Superseded by T HR EL 10001 ST

6 Support structures

6.1 Location

The minimum horizontal dimension between the face of the structure and the design centreline of the track shall comply with the requirements of *ESC 215*.

Structures shall be located to minimise the risk due to impact from vehicles or other mechanical plant.

6.2 Identification

Support structures shall have identification signs showing the HV aerial line feeder number and structure identification number. A structure supporting multiple feeders shall have the feeder number signs displayed and arranged in the same order as the feeders are supported on the structure.

A structure shall only have one structure number. The structure number shall be associated with the feeder with the highest voltage attached to the structure.

Structure identification signs shall comply with drawing *EL0001095*.

Identification signs shall be mounted on structures at a height of approximately 2m above ground level, and shall be attached to the structure by:

- Suitable clouts for wood poles
- Glued to steel poles with a suitable neutral cure silicone sealant. Signs shall be shaped to the structure surface profile prior to gluing.

6.3 Wood poles

6.3.1 Specification

Wood poles shall be fully de-sapped, select grade and without full-length preservative treatment, in accordance with *AS 3818.11*.

Wood poles shall be of hardwood timber species of Strength Group S1 or S2 in accordance with *AS/NZS 2878* and Natural Durability Class 1 or 2 in accordance with *AS 5604*.

Refer to RailCorp drawing *EL0016949* for dimensions of poles with timber species of Strength Group S1. Poles with a length exceeding 18.5m shall not be used in designs without the prior approval of the RailCorp Nominated Engineering Authority.

See drawing *EL0016948* for the range of pole lengths and strength rating designations. New poles shall have nominal pole strength ratings of 8kN or more. Poles supporting new underground to overhead (UGOH) arrangements shall have a minimum nominal strength rating of 12kN.

Where modifications are to be made to an HV aerial line, the residual strength of existing poles shall be determined by pole base examinations.

Poles shall be marked and branded in accordance with *AS 3818.1* and *AS 3818.11*.

Superseded by T HR EL 10001 ST

6.3.2 Pole cap

The head of poles shall be fitted with pole caps in accordance with drawing *EL0001095*.

6.4 Steel poles

Steel poles shall not be installed within the rail corridor when an overhead earthwire is attached to the pole.

Steel poles shall comply with *AS/NZS 4677*.

Steel poles shall be galvanised to *AS/NZS 4680* and *AS/NZS 4792*.

6.5 Other types of support structures

Support structure types other than wood poles and steel poles are currently not approved.

6.6 Pole steps

Pole steps in accordance with drawing *EL0017974* shall be provided for all wood poles. The pole steps shall be installed 125mm +/- 20mm into the timber of the pole radially to the pole axis. Holes for pole steps shall be bored a minimum of 175mm deep.

Steel poles shall be provided with ferrules for attachment of pole steps. The design of the ferrules and pole steps shall be approved and accepted by RailCorp for each project.

Pole steps shall be installed at 450mm intervals on two sides of the pole that are ideally displaced by 120° along the pole circumference. The nominal distance between pole steps on each side is 900mm.

The first pole step shall be installed at a minimum height of 3m from ground level.

7 Foundations

7.1 Foundations for wood poles

Refer to drawing *EL0016949* for typical embedment depths for wood poles of Strength Group S1 in normal soil conditions.

Poles are to be concreted in the holes to a level 500mm below ground level. The concrete shall have a radial thickness of at least 100mm and completely fill the void between the pole and the undisturbed soil. Above the concrete the hole shall be backfilled with clean fill.

Any water accumulated in the hole shall be removed before standing the pole.

Foundations of poles located in sloping ground or areas with unusual soil conditions shall be designed by a civil engineer with appropriate delegated engineering authority.

Refer to drawings *EL0162213*, *EL0149232* and *EL0162262* for previous practices used for poles in the RailCorp network.

7.2 Foundations for steel poles

Foundations for steel poles shall be designed by a civil engineer with appropriate delegated engineering authority on a project by project basis.

Superseded by T HR EL 10001 ST

7.3 Underground services search

An underground services search shall be conducted during design and confirmed prior to construction to ensure that poles and foundations are clear of all underground services. Where underground services are present in the vicinity of the foundation, appropriate control measures are to be implemented to protect against damage to such services.

8 Pole top

The pole top is designed to provide appropriate support of the conductors as well as providing adequate clearances between conductors and/or obstructions.

Standard pole top arrangement drawings are listed in the RailCorp Intranet / Internet Engineering site.

Where pin type insulators are used, all wood / metal interface areas shall be painted with a conductive paint.

In addition to the requirements of *AS/NZS 7000*, the minimum clearances shown in Table 2 shall be complied with for wood pole supports under the following conditions:

- Conductor temperature 70 °C and 0 Pa wind
- Conductor temperature 50 °C and 500 Pa wind

Nominal voltage (kV)	Minimum clearance for wood pole supports (m)
132	1.52
66	0.69
33	0.40
11	0.20

Table 2 – Minimum conductor clearances to crossarms, pole steps, pole or strut

8.1 Crossarms

8.1.1 Types

Crossarms shall be of solid timber or galvanised steel. Other types of crossarms are currently not approved.

Refer to the standard pole top arrangement drawings listed in the RailCorp Intranet / Internet Engineering site for dimensions of standard crossarms.

8.1.2 Position

When not shown on the pole top arrangement, the top crossarm shall be positioned 300mm from the top of the pole.

Crossarms shall be fitted to the side of the pole nearest to the start of the aerial line as indicated by the pole numbering. The only exceptions are where the aerial line crosses a railway or another aerial line. In such cases, crossarms shall be fitted on the side remote from the crossing span.

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8.1.3 Attachment to wood poles

The pole is to be notched 35mm +/- 5mm for the attachment of crossarms.

Crossarms are to be attached to poles by pole bands. See drawing *EL0020464*.

8.1.4 Timber crossarms

Grade 1 natural sawn Tallowood crossarms to *AS 3818.4* and *AS 3818.1* are preferred.

Grade 1 natural sawn crossarms to *AS 3818.4* and of hardwood species of Strength Group S1 in accordance with *AS/NZS 2878* and Natural Durability Class 1 in accordance with *AS 5604* are acceptable as alternatives.

Crossarms shall be protected from end splitting and checking within 48 hours of sawing by:

- The application of "Caltex Timber Seal" or equivalent approved by RailCorp.
- Installation of gang nails (end plates) with a minimum thickness of 1.2mm covering at least 50% of the end grain.
- Painting the top surface of the crossarm with one coat of Dulux Acrylic One Step Prime paint or equivalent and two coats of Dulux Weather Shield Acrylic paint or equivalent, colour Gray green or Pale Eucalypt.

8.1.5 Steel crossarms

Steel crossarms shall comply with *AS 4100*, and galvanised to AS/NZS 4680 or *AS/NZS 4792* as appropriate.

9 Conductors

9.1 Standard conductors

See *EP 10 00 00 05 SP* for the range of RailCorp standard conductors and the nominal current ratings.

The maximum design conductor operating temperature is 70 ^{o}C.

9.2 Configuration

Copper conductors shall not be located above aluminium conductors. This requirement is applicable to multiple circuits on a pole, and to the installation of overhead earthwires.

Superseded by T HR EL 10001 ST

9.3 Clearances

Refer to *AS/NZS 7000*, *AS 6947*, *EP 10 01 00 05 SP*, *ENA Doc 023-2009* and *ISSC 3* for conductor clearance requirements.

Ground clearance requirements shall be satisfied with a conductor temperature of 70 °C and 0 Pa wind. Designers shall consider the need to allow for possible changes to ground levels.

Horizontal clearance requirements shall be satisfied with a conductor temperature of 50 °C and 500 Pa wind. Unless prior acceptance has been obtained from the RailCorp Nominated Engineering Authority, the horizontal clearances of conductors to the boundaries of the rail corridor, boundary fences and easements calculated under such conditions shall comply with the structure clearance requirements of *AS/NZS 7000*.

9.4 Conductor support arrangements

Refer to pole top arrangement drawings listed on the RailCorp Internet / Intranet Engineering site.

Helically formed armour rod with elastomer insert shall be used at support arrangements for aluminium conductors in tension. See Drawing *EL0017064*.

9.5 Conductor sag and tension

AAC conductors without vibration dampers are to be tensioned to Drawings *EL0008743-9* and *EL0019132*.

AAC conductors with vibration dampers are to be tensioned to Drawings *EL0016102-9*.

Copper conductors without vibration dampers are to be tensioned to Drawings *EL0016093* to *EL0016101*.

Apart from “slack tension” spans, variations to the standard design conductor sag and tension shall not be made without the prior approval of the RailCorp Nominated Engineering Authority. In particular, the same design conductor sag and tension should be used for all aerial sections of a HV feeder.

Refer to RailCorp layout drawings for design conductor tensions for existing installations. Consult RailCorp Engineering if such information is not shown on layout drawings.

New conductors are to be pre-tensioned to 35% CBL for one hour, then sagged for a temperature of 10 °C below the ambient temperature.

Refer to *AS/NZS 7000* for methods for measurement of conductor temperatures and tensions. Due to its many practical disadvantages, the dynamometer method shall not be used.

Superseded by T HR EL 10001 ST

10 Overhead earthwire

10.1 Configuration

Overhead earthwire is not required for 11kV aerial lines.

Overhead earthwire shall be installed for the full length of the aerial feeder for voltages of 33kV and above.

For modifications to existing installations, the extent of overhead earthwire coverage may be reduced with justification by a cost benefit analysis. The resultant configuration shall provide for the following as a minimum:

- A minimum of 800m of overhead earthwire adjacent to system substations.
- A minimum of 800m of overhead earthwire from an underground to overhead (UGOH) arrangement.
- All new poles shall be designed to be suitable for overhead earthwire installation.

10.2 Overhead earthwire conductors

Overhead earthwire conductors shall be chosen from the range of standard conductors in *EP 10 00 00 05 SP*. The minimum wire diameter of the conductor strands shall be 2.5mm.

10.3 Shielding angle

The shielding angle shall not exceed 40° at 500Pa wind with a conductor temperature of 15 ^{o}C. Refer to Drawings *EL0013170-2*.

10.4 Support arrangements

Overhead earthwire may be supported from the pole or from extension brackets mounted on the pole.

Refer to arrangement and fitting drawings listed in the RailCorp Internet / Intranet Engineering site.

10.5 Earthing of overhead earthwires

Overhead earthwires are to be earthed at each support pole, except at locations nominated by an approved and accepted earthing design. The earthing design shall list all support locations at which the overhead earthwire is not connected to earth, and detail the reasons for such omissions and the impacts on the electrical infrastructure. All such locations shall be clearly identified on the layout drawings. A cross reference to the earthing design shall also be provided on the layout drawings.

The down earth lead shall be spaced from the surface of the pole with a nominal distance of 275mm by pole stand off supports (drawing *EL0015788*). The vertical distance between a pole stand off support and any crossarm or insulator support shall not be less than 400mm.

A cable guard shall be provided for the down earth lead up to a minimum height of 2.4m from ground. See Drawing *EL0284008*.

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At joint use poles the down earth lead shall be insulated or segregated from other utilities equipment and earthing systems to provide a minimum 2.0m clearance between exposed earthing systems.

Refer to drawings *EL0017446-8* for typical arrangements for the down earth lead, and Drawing *EL0284008* for details of connection to pole earth electrodes.

11 Insulators

Only insulators that have been type approved by the RailCorp Chief Engineer Electrical are to be used in the RailCorp network.

Currently approved insulators are listed in Appendix A. Where an existing insulator is to be replaced by another insulator type, all design parameters at the pole top shall be checked and confirmed prior to the replacement.

11.1 Suspension and termination arrangements

Porcelain and glass insulator strings and insulator units shall comply with *AS/NZS 2947.1*, *AS/NZS 2947.4*, and *AS 60305*. Glass insulator units (Fitting 453/15) shall also comply with Drawing *EL0009366*. The composition of glass insulator strings used with wood pole supports is given in Table 3. Refer to project specific designs for applications with steel pole supports.

Composite insulators shall have a silicone rubber housing and comply with *AS 4435.1* and *AS/NZS 4435.2*.

Couplings shall be of the tongue and clevis type complying with *AS 1154.1*.

Voltage (kV)	Arrangement	No of units in insulator string (Note)
11	Termination	2
	Suspension	1
33	Termination	3
	Suspension	3
66	Termination (without overhead earthwire)	6
	Termination (with overhead earthwire)	5
	Suspension (line deviation > 30°; without overhead earthwire)	6
	Suspension (line deviation > 30°; with overhead earthwire)	5
	Suspension (line deviation ≤ 30°; without overhead earthwire)	5
	Suspension (line deviation ≤ 30°; with overhead earthwire)	4
132	Termination	10
	Suspension	Not used

Table 3 – Composition of glass insulator strings used with wood pole supports

Note – See *EP10010005SP* for insulation requirements for spans crossing railway tracks.

Superseded by T HR EL 10001 ST

11.2 Pin insulator arrangements

Pin insulators shall be *SLP/11/180* per *AS 4899*.

Pins for timber crossarms shall be type A/130/7 per *AS 4899* and comply with Drawing *EL0017195*.

Pins for steel crossarms shall be type A/130/7 per *AS 4899* and modified in accordance with Drawing *EL0017195*.

Conductors may be attached by helical fittings complying with *AS 1154.3* or, for copper conductors only, by binding arrangement in accordance with Drawing *EL0038125*. Helically formed armour rod with elastomer insert shall be used for aluminium conductors

11.3 Line post insulator arrangements

Porcelain line post insulators shall comply with *AS/NZS 2947.1*.

Composite line post insulators shall comply with *AS 4435.4*.

Refer to the arrangement drawings listed in the RailCorp Internet / Intranet Engineering site for application.

11.4 Guy insulators

See provisions in section 13.1.3.

12 Conductor fittings and accessories

All conductor fittings and accessories shall be compatible with the conductor and installed in accordance with the manufacturer's instructions.

12.1 Full tension line splices

Full tension line splices shall be either compression joints complying with *AS 1154.1* or helical preformed splices to *AS 1154.3*. The type test requirements shall include the electrical heat cycle test and short time current test.

Helical preformed splices shall not be used with conductors with 7 strands or less.

Full tension line splices shall not be installed:

- Within 1.2m of a conductor support location.
- In spans crossing railway tracks, water, major roads, other aerial lines, RailCorp structures, or over buildings.

12.2 Non-tension splices

Non-tension conductor splices shall comply with *AS 1154.1*. The type test requirements shall include the electrical heat cycle test and short time current test.

Conductor clamps to Drawings *EL0017671* and *EL0017672*, or non-tension compression joints may be used.

Superseded by T HR EL 10001 ST

12.3 Anchor fittings

Anchor fittings shall be helical preformed fittings complying with *AS 1154.1* and *AS 1154.3*. The electrical heat cycle test is not required.

12.4 Vibration dampers

Vibration dampers shall be Stockbridge type complying with *AS 1154.1*.

Spiral vibration dampers shall not be used.

Where used, the specification of the vibration damper and the locations at which the vibration damper are to be installed shall be detailed by the Designer on layout drawings.

12.5 Aircraft warning markers

Refer to *AS 3981.1* for requirements for aircraft warning markers.

Where required, the locations at which aircraft warning markers are to be installed shall be detailed by the Designer on layout drawings.

12.6 Bird diverters

Bird diverters are to be installed when required as a measure for mitigating the risk of conductor strike by birds.

Bird diverters shall comply with *AS 1154.1*.

13 Guy arrangements

Guy arrangements are used when the permissible design load limits of poles are exceeded. The guy arrangement shall be designed to take the full applied load rather than just the portion by which the load exceeds the pole capacity.

13.1 Guy arrangements for timber poles

Timber poles may be guyed using stay poles or ground anchors.

Guying to another aerial line support pole is acceptable. However, back to back horizontal guy wires between poles shall not be used except for temporary support of damaged poles.

13.1.1 Stay pole

Refer to RailCorp drawing *EL0011634* for dimensions of stay poles with timber species of Strength Group S1.

Stay poles shall otherwise comply with the requirements of section 6.3.

Refer to Drawings *EL0497822-3* for stay pole arrangements.

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13.1.2 Ground anchor

Refer to Drawings *EL0497824-5* for guy arrangements using ground anchors.

All driven ground anchors shall be type approved by the RailCorp Chief Engineer Electrical, and shall be proof loaded to three times the maximum load shown on the relevant arrangement drawings. A proof loading certificate shall be provided for each installation by the installer.

Sight guards shall be provided on all ground anchor installations to mitigate the risk of mechanical impact damage.

13.1.3 Guy insulator

Guy insulators shall be provided for all guy arrangements. Refer to Drawings *EL0497822 – 5* for arrangements, and Appendix A for approved guy insulators.

13.1.4 Earth connection

Guy wires and rods below the guy insulator shall be effectively earthed to achieve a resistance to earth of 10 ohm or less.

Refer to drawings *EL0497822-5* for earthing arrangements.

13.2 Guy arrangements for steel poles

Guy arrangements for steel poles shall be designed on a job by job basis.

14 Earthing

An earthing design shall be done for the HV aerial line installation and associated equipment for each project as part of the earthing design for the overall project.

Connection to earth shall be made to:

- Overhead earthwire at each support structure. See section 10.5.
- Cable screens and the base of surge arresters at underground to overhead (UGOH) arrangements.
- Guy wires and rods below the guy insulators.
- Steel poles

15 Signs

15.1 Access road direction signs

Access road direction signs in accordance with drawing *EL0001096* are to be installed at appropriate locations where necessary to identify the correct route to gain access to an aerial line feeder.

15.2 Feeder and support structure identification signs

See section 6.2 for feeder and support structure identification signs.

See sections 6.3.1 and 6.4 for markings required for support structures.

Superseded by T HR EL 10001 ST

15.3 Crossings of navigable waters

Signs shall be installed in accordance with the requirements of NSW Maritime Crossings of NSW Navigable Waters: Electricity Industry Code and *AS 6947*.

16 Survey

Survey requirements for each project shall be specified by the Designer, but shall include all the details required on layouts and profile drawings as listed in sections 17.2 and 17.3. Where there is an existing HV aerial line, the survey shall include:

- Ambient temperature
- Conductor support heights at each pole
- Height of each conductor at mid-span
- Photograph(s) of the pole top arrangement at each pole facing the direction of increasing pole numbers

17 Design documentation

Refer to EPD 0013 Appendix A for typical design documents required at each stage of design. The actual design documentation required for each design stage of a project shall be determined by the Designer and agreed by the RailCorp nominated engineering authority at the beginning of the design process.

17.1 Proposed HV system and recticulation diagrams

Proposed HV system and recticulation diagrams shall be prepared for every project, and each stage of the project. The proposed diagrams shall be based on relevant diagrams of the existing network and show:

- Proposed changes to existing feeders
- Proposed changes in connectivity to the RailCorp electrical network
- Lengths of proposed aerial and cable sections of each HV feeder

Proposed HV system and recticulation diagrams shall be approved by all relevant RailCorp stakeholders. Examples of such proposed diagrams are available on the RailCorp Engineering intranet site.

17.2 Layout drawings

HV aerial line layouts shall be based on detailed route survey and shall comply with the RailCorp CAD Manual. Layouts shall be drawn on A1 size drawings with a scale of 1:500. Where prior approval has been obtained from the RailCorp Principal Design Engineer Mains, it is permissible to have details of overhead wiring and HV feeders shown in combined layout drawings.

The following information shall be shown on layout drawings as a minimum:

- Conductor specification and tensioning data. This information is generally shown in the first sheet of a drawings set.
- Reference to other relevant design documents, including profile drawings, survey files, design software used, earthing design, etc
- Details associated with each support pole (see Appendix B):
  - Pole number
  - Pole length / strength / rake
  - Pole top arrangement

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  - Pole location, preferably given in coordinates
  - Angle of deviation at the pole
  - Non-standard sinking depth, if applicable
  - Non-standard earthing arrangement (see section 10.5)
  - Reference to non-standard foundation design, if applicable

- Sketches of any non-standard pole top arrangements showing alterations to standard arrangements. Such sketches shall be located as close to the applicable poles as practicable.
- Span lengths
- Locations of guy poles or anchors, and applicable guy arrangements in accordance with the designations detailed in Appendix B.
- A Virtual Span Table on each sheet detailing the virtual spans applicable to the spans on that sheet.
- RailCorp property boundaries and actual fence lines
- Details of easements and easement boundaries
- Locations of signs, vibration dampers and aircraft warning markers
- Other relevant details located within a corridor with a width of 8m on each side of the centreline of the HV aerial line route, including

  - Railway tracks and stations
  - Buildings and structures
  - Roads and kerb lines
  - Other aerial services
  - Other “obstructions” (eg trees, light posts, etc) to the HV aerial line

17.3 Profile drawings

HV aerial line profiles shall be based on detailed route survey and shall comply with the RailCorp CAD Manual. Profiles shall be drawn on A1 size drawings with a horizontal scale of 1:500, and an appropriate vertical scale.

The following information shall be shown on profile drawings as a minimum:

- Reference to other relevant design documents, eg layout drawings, survey files, etc
- Overhead earthwire conductor profile at 40 ^{o}C, phase conductor profiles at 70 ^{o}C, and associated ground clearance envelope
- Profile of ground line below the conductors
- Details associated with each support pole (see Appendix B):

  - Pole number
  - Pole length / strength / rake
  - Pole top arrangement
  - Pole location, preferably given in coordinates
  - Heights of pole top, crossarms / post insulator supports
  - Angle of deviation at the pole

- Span lengths
- Locations and heights of “obstructions” located within a corridor with a width of 8m on each side of the centreline of the HV aerial line route, including

  - Railway tracks and stations
  - Buildings and structures
  - Roads and kerb lines
  - Other aerial services
  - Other “obstructions” (eg trees, light posts, etc) to the HV aerial line

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Where an HV aerial line crosses other aerial services, separate profiles shall be drawn of the crossing spans to show the minimum clearance between the conductors based on the worst combination of loading and ambient conditions. The conditions shall be indicated on the profile drawings.

17.4 Temperature / tension and sag table / charts

Temperature / tension and sag tables / charts shall be provided for stringing of all conductors including overhead earthwires.

17.5 Access road maps

Where access roads have been constructed for the purpose of accessing the HV aerial line route, maps showing their locations and routes shall be provided.

17.6 Non-standard arrangement drawings

Where the Designer proposes to use an arrangement that is not covered by any RailCorp standard arrangement drawings, the proposed arrangement shall be detailed in a drawing complying with the RailCorp CAD Manual.

All materials required for the arrangement shall be detailed and specified on the drawing.

17.7 Supporting calculations

Supporting calculations shall be provided by the Designer to demonstrate:

- Adequacy of specified pole strengths
- Adequacy of pole foundations
- Adequacy of strength of specified crossarms
- Correct overhead earthwire shielding angles
- Provision of adequate clearances

18 Construction staff

All HV aerial line construction staff shall be suitably authorised in accordance with RailCorp SMS document *SMS-11-GD-0244*.

19 Materials

19.1 Materials procurement, testing and acceptance

The supply, testing and acceptance of HV aerial line materials shall comply with the quality assurance requirements stipulated in *EP 08 00 00 13 SP* “Overhead wiring fittings and materials”.

19.2 Materials handling

Materials shall not be handled in a manner that may cause damage to the materials.

Poles shall not be dropped to the ground from jinkers.

Insulator shall be inspected for damage and cleaned with a dry clean cloth prior to installation.

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20 Commissioning tests

The following tests shall be undertaken prior to the commissioning of new or modified HV aerial lines.

20.1 Visual inspection

A visual inspection shall be undertaken and shall include the following as a minimum:

- General condition of the aerial line route and installation
- Visible signs of component damage and / or defects due to workmanship
- Confirmation that the aerial line installation is in accordance with the approved and accepted design and relevant standards
- Confirmation that all required clearances have been checked and recorded.

20.2 Phase identification check

An identification check shall be carried out to confirm that “A” phase at start is “A” phase at the end of the aerial line, and likewise for “B” and “C” phases.

20.3 Electrical continuity

Electrical continuity shall be tested by measuring the loop resistance from one end over the full length of the aerial section for each pair of conductors, including the overhead earthwire. The test shall be conducted with an injection current of 10A dc.

This test is passed if:

- The measured value is not greater than 105% of the calculated value at the temperature at which the test is conducted
- The measured values for each phase conductor do not vary by more than 2% from those of the other phase conductors.

20.4 Insulation resistance

The test shall be conducted with a 5kV dc insulation resistance tester and with all feeder cables, surge arresters and earths disconnected.

The measured value under dry weather conditions shall not be less than 1 MΩ per kilometre for each phase conductor.

20.5 Electrical phase check

An electrical phase check shall be carried out against a known supply to check that the aerial line has the correct phase relation to the system.

21 Data set associated with HV aerial lines

The following data shall be maintained for all HV aerial line assets. This data shall be the property of RailCorp and shall be maintained by the Maintenance Provider responsible for maintaining the aerial lines.

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21.1 As-built design documentation

As-built design documentation shall be provided by the Project Manager responsible for the construction or modification of the HV aerial line within 30 days of each stage of commissioning.

All as-built design documents shall be accepted by the RailCorp Principal Design Engineer Mains and lodged with the RailCorp Plan Room. As-built design documents shall include:

- All For Construction design documents listed in section 17 and updated to as-built status
- Information for updating RailCorp's Feeder Data Book:
  - Extent, length and conductor details of each aerial section for all relevant HV feeders
  - Extents, lengths and conductor details of overhead earthwires
- Information for updating RailCorp's asset information system, in a format specified by the relevant RailCorp Asset Engineer Electrical.
- Digital colour photographs of
  - The pole top arrangement at each pole facing the direction of increasing pole numbers
  - Locations with critical clearance constraints or other "obstructions"

21.2 RailCorp Geographic Information System (GIS)

HV feeder data on the RailCorp GIS shall be updated based on the accepted as-built layouts and profile drawings.

21.3 Other asset information

Relevant information in the RailCorp asset information system, including:

- Identification and number of HV feeders
- Identification number and year of installation of each supporting structure
- For wood poles, timber species of each pole

Superseded by T HR EL 10001 ST

Appendix A RailCorp type approved insulators for HV aerial lines

Insulator description	RailCorp Fitting No	RailCorp Drawing	Application	Type approved insulators	RailCorp stock code
70kN Ø 255mm toughened glass disc	453/15	EL0009366	Units in suspension or termination insulator strings	Morlynn CT100/146	001059351
11kV porcelain pin insulator	T1/11	EL0017195 (Item 1)	11 kV pin insulator arrangement	Morlynn P11	001058668
33 kV porcelain line post insulator	T1/24	-	Support of bridge conductor from crossarm for 33kV “anchor & bridge” arrangements	Morlynn H11461	001879311
33kV porcelain line post insulator	-	EL0005694	33 kV line post insulator arrangement	Morlynn H11286	-
33kV silicone composite station post insulator	-	EL0455661 (Item 28)	33kV UGOH arrangement	K-Line KL35SPT2M12 NO	002071736
66kV cycloaliphatic station post insulator	-	EL0052208 (Item 28)	66kV UGOH arrangement	EMC Pacific SP1690-12-24	-
66kV composite string insulator	-	-	66kV suspension and termination arrangements; use of this insulator is subject to approval on a case by case basis.	K-Line KL69HCT16	-
120 kN composite string insulator	453/16	EL0216729	Guy insulator	K-Line KL46Hey10	001873447

Superseded by T HR EL 10001 ST

Appendix B Designation of pole details and pole top arrangements on layout and profile drawings

Details of pole and pole top arrangements shall be designated on layout and profile drawings in accordance with the example given below.

101	**1**.	Pole Number
17.0/12/.25	**2**.	Pole Length/Strength/Rake
T21/56	**3.**	Earth wire arrangement
2.5	**4**.	The distance in metres between: the pole band of the earth wire arrangement, and the top crossarm (of pole band) of the lower arrangement. Note: In the case of an earth wire raiser this distance refers to the separation in metres between the top kingbolt of the raiser and the top crossarm (or pole band) of the lower arrangement.
A B C	**5**.	Phasing of first circuit from the top of the pole.
33/10	**6**.	Pole-top arrangement for the first circuit from the top of the pole.
3.5	**7**.	The distance in metres between the bottom crossarm (or pole band) of the upper arrangement, and the top crossarm (or pole band) of the lower arrangement. Note: Items 5, 6, & 7 are repeated for each circuit down the Pole.
T14/1	**8**.	Arrangements for special items such as guys etc.
7.5G400	**9**.	Stay pole length/G (guy)/ground line dia. (mm)
X =	**10**	Coordinate of pole location
Y =	**11**	Coordinate of pole location

Where the conductor phasing is unknown and conductor identification is required numbers may be used, ie “1”, “2”, and “3” may be used instead of “A”, “B” and “C”.