Engineering Standard

Electrical

CRN ET 002

REQUIREMENTS FOR ELECTRIC AERIALS CROSSING CRN INFRASTRUCTURE

Version 1.1

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Document control

Revision	Date of Approval	Summary of change
V2.0	March 2005	EP 10 01 00 05 SP Requirements for Electric Aerials Crossing CRN Infrastructure
V1.0	January 2012	Conversion to CRN Electrical Standard CRN ET 002
V1.1	August 2016	Review and update

Summary of changes from previous version

Section	Summary of change
various	Update from CRIA to TfNSW

Contents

1 References

Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines - Electricity Supply Association of Australia's publication HB C(b)1-1999.

Guide to the Inspection, Assessment and Preservation of Wood Poles – Electricity Council of NSW's publication EC8.

AS1379 – 2007 and supplement 1 2008 — The specification and manufacture of concrete

AS/NZS 7000:2010 — Overhead line design—detailed procedures

Appendices

- ~ F Timber poles
- ~ G Lattice steel towers (self supporting and guyed masts)
- ~ I Concrete poles
- ~ J Composite fibre poles
- ~ K Steel poles

AS/NZS 2878 – 2000 — Timber - Classification into Strength Groups

AS/NZS 2947 - 1999 — Insulators - Porcelain and glass for overhead power lines - Voltages greater than 1000 V a.c.

AS 3608 - 2005 — Insulators - Porcelain and glass, pin and shackle type - Voltages not exceeding 1000 V a.c.

AS 4065 - 2000 — Concrete Poles for Overhead Lines and Street Lighting.

AS 4435 - 1996 — Insulators - Composite for overhead lines – Voltages greater than 1000 V a.c

Definitions

AHD	Australian Height Datum.
Conductors	. Electric cables, bundled aerial cables and transmission lines
Crossing	All components used for the construction and support of electric aerials that cross JHR CRN railway tracks, including conductors and structures.
Crossing span	The bay of an electric aerial that crosses JHR CRN railway tracks or sidings Any overhead conductor
Electric Aerial	Includes construct, erect and carry.
ISG	Integrated Survey Grid.
Open overlap	The portion of the overhead wiring between two anchor structures, where the overhead wiring of two adjoining wire runs overlap and terminate. The operation of circuit breakers, switches or the removal of jumpers can electrically separate the adjacent runs of overhead wiring from each other.

Pole raiser	A metal bracket, which is not an integral part of a structure, which is attached to the top of a structure for the purpose of increasing the structure height.
Structure	Includes poles, towers, stay wires, crossarms, insulators, equipment and all attachments.

2 Scope and application

This publication sets out the design and construction specification for all electric aerials that cross the Transport for New South Wales (TfNSW) infrastructure with emphasis on electric aerials that cross the TfNSW railway tracks.

The electric aerials are associated with the transmission, distribution and supply of electricity by the JHR CRN and others.

The specification is applicable to transmission line structures including stay wires, crossarms, insulators, conductors, equipment and attachments.

This publication is also applicable to the renewal of existing electric aerials which cross TfNSW infrastructure.

This Standard supersedes the technical components of the State Rail Authority of New South Wales's "Electric Wires, Etc. Agreement".

The design, construction and the quality of materials used for electric aerials crossing JHR CRN infrastructure shall comply with the requirements of HB C(b)1-1999 "Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines" and the additional requirements specified in this document.

All clearances specified shall be those under the most unfavourable conditions of temperature and loading as set down in HB C(b)1-1999 "Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines".

Where electric aerials cross electrified railway tracks additional special requirements are imposed, such as the minimum operating voltage of electric aerials and prohibited areas where such aerials shall not be erected.

The requirements for cable crossings suspended from bridges or similar structures are contained in RailCorp publication EP 08 00 00 14 SP, "Services Erected above Overhead Wiring" – available on the ASA website

The requirements for under track crossings are contained in publication Refer to "Right of Way" standard CRN CS 540 Service Installations in The Rail Corridor.

3 Requirements for electric aerials crossings JHR CRN railway tracks or sidings

3.1 Structures

All structures supporting a span of electric aerials over JHR CRN railway tracks or sidings shall be so located that in the event of failure no part of them will fall within 1.8 m of the outside rail of any railway track. Where it is not practicable to locate structures as specified, structures may be erected at a distance nearer the railway tracks provided they are stayed to the satisfaction of JHR CRN. JHR CRN may require any structure supporting a crossing span to be stayed away from the railway tracks. These requirements apply in all instances regardless of whether the structure is situated on or outside land vested in or under the control of JHR CRN

All structures supporting a span of electric aerials over JHR CRN railway tracks shall be designed and maintained to achieve 50% of the applicable safety factor nominated in section 4.8 – “Factors of safety” when two-thirds of the conductors in the span adjacent to the crossing span are broken. The sag of the remaining conductors shall not infringe the applicable clearances nominated in section 4.4.6 – “Conductor Heights”.

In cases where the crossing span consists of only one or two conductors, the supports shall achieve 50% of the applicable safety factor nominated in section 4.8– “Factors of safety” with all of the conductors in the adjacent span broken.

3.1.1 Wood poles

Unless otherwise agreed to in writing all timber poles erected in connection with spans crossing JHR CRN infrastructure shall be hardwood poles strength group S1 or S2 to AS 2878 and durability class 1 to AS 2209. The poles may be either fully de-sapped or full length preservative treated.

Wood poles supporting spans of conductors over railway tracks shall have the sapwood removed from the base of the pole to a level 500 mm above the ground and the pole base shall be chemically treated as recommended in the Electricity Council of NSW’s “Guide to the Inspection, Assessment and Preservation of Wood Poles - EC8”.

The sapwood may be left on full length pressure treated poles.

3.1.2 Concrete poles

Concrete poles shall comply with AS 4065 and shall be suitable to be guyed.

A copy of the results of the type tests of any crossing poles shall be submitted to JHR CRN.

3.1.3 Steel poles

Steel poles must be galvanized and satisfy the safety factors stated in 4.8 – “Factors of safety”.

A copy of the results of the type tests, or engineering drawings certified by a practicing qualified structural engineer shall be submitted to JHR CRN.

3.1.4 Steel towers

Steel towers must be galvanized and satisfy the safety factors stated in section 4.8 – “Factors of safety”.

A copy of the results of the type tests or engineering drawings certified by a practicing qualified structural engineer shall be submitted to JHR CRN.

3.2 Foundations

An underground services search shall be carried out to identify any JHR CRN or other underground services which may be damaged by the excavation or boring of holes for the foundations of any structure on a rail corridor

3.2.1 Wood pole foundations

Wood poles shall be concreted in the holes to a level 500 mm below the ground surface. The concrete shall comply with AS 1379. The concrete shall have a radial thickness of at least 100 mm and completely fill the void between the pole and the undisturbed soil.

Poles installed in rock shall be set at a minimum depth of 1.5 m. Above the concrete the hole shall be back filled with clean fill.

3.2.2 Concrete or steel structure foundations

Concrete or steel structures shall have foundations designed and certified by a qualified Engineer.

3.3 Angle of crossing

The angle of crossing between the conductors and the railway tracks shall not be less than 45.The angle of crossing may be reduced to 30 if the use of such an angle avoids the locating of an angle structure at either end of the crossing span.

3.4 Conductors

3.4.1 4.4.1 Conductor types and sizes

The conductors used for crossings shall be of a size not less than that specified in Table 4.4.1.

Conductor Material	Conductor Size
Aluminium high voltage bundled aerial cable with 19/2.00 mm high tensile galvanised steel catenary	7/2.00 mm
Aluminium low voltage bundled aerial cable	7/2.63 mm
Hard drawn copper	7/2.32 mm
Aluminium or aluminium alloy	7/1.75 mm
Steel core aluminium	7/3.00 mm
Steel core aluminium	6/1/1.25 mm
Galvanised steel	3/4/1.75 mm
Galvanised steel	3/2.75 mm

Table 4.4.1 – Conductors for crossings.

3.4.2 Conductor terminations

Crossing span conductors shall be terminated on the supporting structures either side of the railway track.

Conductors operating at less than 1000 V shall be terminated with shackle insulators that meet the requirements of AS 3608.

Conductors operating at 1000 V and above shall be terminated with tension insulator sets that meet the requirements of AS 2947 or AS 4435. If it is impracticable to use termination insulators then suspension insulators that meet the requirements of AS 2947 or AS 4435 can be used, provided that:

- Bolted type suspension clamps are used that are capable of holding the conductor's breaking load tension without the conductor pulling through the clamp.

- The structure attachments for the insulators allow sufficient freedom of movement for the insulators to align in the direction of load under broken wire conditions.
- The minimum clearances specified in this document are maintained in the event of the conductor in the adjacent span breaking and allowing the insulators to swing into the crossing span.

Where bolts are used through wooden crossarms for terminating purposes the centre line of any bolt hole shall not be less than 200 mm from the end of the crossarm, unless an anti-splitting bolt is installed 50 mm from the end of the crossarm at 90 degrees to the termination bolt where the termination bolt hole shall not be less than 150 mm from the end of the crossarm.

3.4.3 Conductor bridges

Bridges connecting crossing spans shall not be connected to conductors where they are in tension.

3.4.4 Steel conductors

Steel conductors shall not be installed in crossing spans over electrified tracks or in coastal areas.

Locations within 25 km of the seashore will normally be considered as coastal areas but special consideration will be given to areas of high altitude less than 25 km from the coast.

In inland areas steel conductors shall not be installed within 3.0 km of industrial plants that discharge air pollutants which form acids with airborne moisture.

3.4.5 Conductor vibration dampers and armour rods

Vibration dampers or armour rods shall be fitted in all cases where aluminium, aluminium alloy or steel cored aluminium conductors are used on suspension type crossings

3.4.6 Conductor heights

3.4.6.1 Above non electrified tracks

The height of conductors above the top of the highest rail for non-electrified tracks under the worst sag condition shall not be less than that shown in Table 4.4.6

Aerial crossing voltage (U)	**Aerial crossing minimum height above rail**	
	Goobang Junction to Broken Hill and new crossings and alterations on the **Australian Inland Rail Expressway***	**Elsewhere**
U < 2 000 V	10.0 m	7.6 m
2 000 V ≤ U < 132 000 V	10.0 m	8.8 m
U ≥ 132 000 V	10.7 m	10.7 m

. **Table 4.4.6.1 – Height of conductors above non–electrified tracks.**
* See Appendix 2 for route

3.4.6.2 Above electrified tracks

The height of aerial crossing conductors above 1500 Vdc overhead wiring and support structures shall be in accordance with Table 4.4.6.1

Aerial crossing voltage **(U)** (U < 2000 V Not permitted)	**Aerial crossing minimum height above OHW or support structure**			
	OHW	**OHW mast**	**OHW portal**	**Portal with walkwa**
2 000 V ≤ U ≤ 33 000 V	3.7 m	1.5 m	3.7 m	4.5 m
33 000 V < U ≤ 132 000 V	4.5 m	2.5 m	4.5 m	5.0 m
U > 132 000 V	To be determined by CRN.			

Table 4.4.6.2 – Height of conductors above electrified tracks

OHW: 1500 Vdc overhead wiring conductors and associated 1500 Vdc equipment.

OHW mast: A mast, column or pole attached to OHW.

OHW portal: Structure consisting of two or more masts supporting a horizontal beam used to support OHW.

Portal with Walkway: Any portal with a walkway that crosses over the top of OHW and or railway tracks including signal bridges and other portals that may not be attached to OHW

3.4.7 4.4.7 Spacing of conductors

3.4.7.1 Different circuits on different structures (unattached crossing)

Aerial conductors of different circuits (not including earth wires) shall not cross each other if they are not attached to the same structure.

3.4.7.2 Different circuits on the same structure (attached crossing)

Where two circuits of different voltage cross each other and are attached to the same structure, conductors of a higher voltage shall be placed above a lower voltage circuit. The vertical separation between conductors of the different circuits at any point on the structure under normal working conditions shall not be less than those specified in HB C(b)1-1999.

3.4.7.3 On same structure (same or different circuits and shared spans)

This section shall apply to conductors of the same circuit or conductors of different circuits carried on the same structures and sharing the same spans.

Where two circuits of different voltage are carried on the same structures and share the same spans, conductors of a higher voltage shall be placed above a lower voltage circuit.

Any two conductors having a difference in nominal voltage with respect to each other shall have vertical, horizontal or angular separation from each other in accordance with the requirements of HB C(b)1-1999.

3.5 Clearances between conductors and structures

The clearances between conductors and the structures to which they are attached shall not be less than the clearances shown in Table 4.4.7.4. The clearances are under conditions of maximum swing and exclude locations adjacent to points of support at pin type insulators.

Voltage	Clearance
Where the voltage does not exceed 1000 V	0.20 m
Above 1000 but not exceeding 22 000 V	0.40 m
Above 22 000 but not exceeding 33 000 V	0.50 m
Above 33 000 but not exceeding 66 000 V	0.60 m
Above 66 000 but not exceeding 132 000 V	1.10 m
Above 132 000 V	By Approval

Table 4.4.7.4 – Clearance of conductors from structures under maximum swing conditions

3.6 Stay wires

Stay wires shall not be buried in the ground and shall be provided with a suitable sight board or a safety rail protecting the stay wire from the ground surface to a point

1.7 m above ground surface.

Stay wires are to be attached by wrapping the wire around the pole or by the use of pole bands.

4.6 Insulation co-ordination of crossing span

The following insulation co-ordination measures shall be taken for all conductors operating between 1000 V and 66 000 V which cross tracks or sidings.

The insulation between the structure and the conductor on both sides of a crossing span shall have a wet power frequency flash over 40 kV greater than that of the adjacent spans.

3.7 Accessories and hardware

All steel cables and ferrous metal fittings such as insulator pins, shackles, straps, struts, clevises, bolts and the like shall be galvanized to the relevant Australian Standard.

All bolts and other fastenings where they pass through wooden crossarms shall be coated with a compound for protection against wood acids. The compound shall be in accordance with the recommendations of the crossarm manufacturer.

Bolts shall not be used through wood poles for the terminations of conductors or the attaching of crossarms or any stay wires. Pole bands or double crossarm arrangements are to be used for this purpose.

Bolts may be used through concrete poles for the terminations of conductors or the attaching of crossarms or any stay wires provided that stainless steel sleeves are cast into the pole to hold the bolts.

Where single crossarms and pole band arrangements are used the crossarm shall be attached to the side of the pole remote from the railway tracks.

3.8 Factors of safety

The minimum factors of safety used in the design of the crossing shall be as specified in Table 4.8. The factors of safety for components are relative to the ultimate strength of the material.

When applying these factors of safety allowance shall be made for conditions of loading as set down in HB C(b)1-1999.

Item	**Factor of Safety**
Concrete poles	4
Steel towers	3.5
Steel crossarms	3.5
Wood poles	6
Wood crossarms	6
Conductors-copper	3
Conductors –aluminium and aluminium alloys	4
Conductors-steel cored aluminium	3
Conductors-steel	4
Low voltage bundled aerial cable - aluminium	4
High voltage bundled aerial cable – aluminium with high tensile galvanised steel catenary	3
Porcelain & glass insulators	3
Composite insulators	4
Steel aerial earth wires	5
Steel guy wires	5
Mild steel anchor rods	5
Earth for anchors (weight of earth = 1 600 kg/m3)	4

Table 4.8 – Factors of safety for crossing design

3.9 Prohibited configurations for crossings

Conductors operating at a voltage of less than 2 000 V and any other aerial service that may conduct electricity e.g. telegraph and communications cables shall not be installed directly over electrified railway tracks.

- Conductors shall not be installed directly over overhead wiring open overlaps. Crossing spans shall not cross other crossing spans unless erected on the same pole line.
- Pole raisers shall not be used to carry earth wires on crossing spans.
- Conductors shall have no joints in tension in the crossing span.
- Coach screws shall not be used for terminating purposes.

3.10 Data set associated with electric aerial crossing railway tracks and sidings

The following data shall be maintained, registered and stored by the relevant JHR CRN Maintenance Provider for each electric aerial crossing railway tracks or sidings:

- The schedule “Country Regional Network - Electric Aerial Crossing Data Sheet” duly completed for each electric circuit (the schedule is shown in Appendix 1).
- The “as constructed” plan of the electric aerial crossing.
- The “as constructed” profile of the electric aerial crossing.
- Underground services search for JHR CRN underground services as well as other underground services for any proposed foundations on the rail corridor.

The plan and profile shall be clearly dimensioned and show:

- The track kilometerage of the crossing from Sydney.
- The location of any structures and their distance from the railway tracks and from any electric aerials or structures on the rail corridor.
- The ISG co-ordinates and the AHD levels of the structures at each end of the crossing span.
- The AHD levels of the electric aerial heights at the structures.
- The dimensioned clearances over JHR CRN infrastructure under worst case conditions.
- The Northern compass point.
- Any buildings or similar structures within 20 m of the route.
- The structure material.
- Dimension of the structure.
- The conductor size.
- The crossing span length.
- Crossing span voltage.
- Method of conductor attachment.
- Number of conductors.
- Minimum and maximum tension of conductors.
- In the electrified area the distance to the adjacent overhead wiring support structures and their identification numbers.

The applicant shall submit the above documentation as a proposal for JHR CRN approval. JHR CRN or its nominated representative shall carry out a compliance inspection prior to the commissioning of any electric aerial crossing railway tracks or sidings. The report shall be registered and stored by the relevant JHR CRN Maintenance Provider.

Electric aerial crossing over railway tracks or sidings shall not be installed, altered or renewed without JHR CRN approval.

4 Requirements for electric aerials over or under other JHR CRN infrastructure

Electric aerials over or under JHR CRN property or infrastructure other than railway tracks shall be designed and constructed in accordance with HB C(b)1-1999.

The minimum size conductors used for electric aerials over or under other JHR CRN infrastructure shall be of a size not less than that specified in section 4.4.1 – "Conductor types and sizes", except that 7/1.25 mm hard drawn copper may be used were the spans are limited to a maximum of 30 m and do not form part of any run, which crosses railway tracks or sidings.

4.1 Data set associated with electric aerial over or under other JHR CRN Infrastructure

The following data shall be maintained, registered and stored by the relevant JHR CRN Maintenance Provider for each electric aerial over or under other JHR CRN infrastructure:

- The "as constructed" plan of the electric aerial over or under other JHR CRNinfrastructure.
- The "as constructed" profile of the electric aerial over or under other JHR CRN infrastructure.
- Underground services search for JHR CRN underground services as well as other underground services for any proposed foundations on the rail corridor.
- The plan and profile shall be clearly dimensioned and show:
- The location of any structures and their distance from the railway tracks and from any electric aerials or structures on the rail corridor
- The ISG co-ordinates and the AHD levels of all structures.
- The AHD levels of the electric aerial heights at the structures.
- The dimensioned clearances over JHR CRN infrastructure under worst case conditions.
- The Northern compass point.
- Any buildings or similar structures within 20 m of the route.
- The structure material.
- Dimension of the structure.
- The conductor size.
- Span lengths.
- Voltage.
- Method of conductor attachment.
- Number of conductors.
- Tension of conductors.
- In the electrified area the distance to adjacent overhead wiring support structures and their identification numbers.

The applicant shall submit the above documentation as a proposal for JHR CRN approval. JHR CRN or its nominated representative shall carry out a compliance inspection prior to the commissioning of any electric aerial over or under other JHR CRN infrastructure. The report shall be registered and stored by the relevant JHR CRN Maintenance Provider.

Electric aerial crossings over or under other JHR CRN infrastructure shall not be installed, altered or renewed without JHR CRN approval

Appendix 1 - Electric Aerial Crossing Data Sheet

Location and voltage details			
Nearest railway station:			
Line voltage:	kV	Distance from Sydney (km):	km
Is the crossing on the Australian Inland Rail Expressway? (Yes or No):			
Conductor details			
Number of conductors:		Size of conductors:	mm
Type of conductors:		UTS of conductor:	N
Cross sectional area:	mm^2	Outside diameter of conductor:	mm
Minimum operating temp.	°C	Maximum operating temp.	°C
Tension @ minimum operating temp. (no wind):	N	Tension @ maximum operating temp. (no wind):	N
Modulus of elasticity:	GPa	Co-efficient of linear expansion:	$x10^{-6}$ /°C
Weight per unit length of conductor (w_0):	N/m	Length of crossing span **(CSL) Diagram 1:**	m
		Angle between crossing span and tracks **(CA) Diagram 1:**	°

Pole details	**Down side pole**	**Up side pole**
Pole material (wood, concrete or steel):		
Length of pole:	m	m
Depth in ground:	m	m
Pole diameter at ground level:	mm	mm
Ultimate fibre stress for wood pole:	MPa	MPa
Min. failing bending moment at ground line for concrete and steel poles:	kNm	kNm

Crossarm details	Down side crossarm details	Up side crossarm details
Crossarm material (timber or steel):		
Length of crossarm:	m	m
Vertical thickness of crossarm:	mm	mm
Horizontal thickness of crossarm:	mm	mm
Distance from support to load:	m	m
Crossarm config.(single or double):		
Ultimate fibre stress for timber crossarm:	MPa	MPa
Section modulus for steel cross-arm (Z):	$x10^6mm^4$	$x10^6mm^4$

Pole relative levels	Down side pole levels	Up side pole levels
Ground RL:	m	m
Lowest attachment RL:	m	m
Next attachment RL:	m	m
Next attachment RL:	m	m
Next attachment RL:	m	m

Rail details

Rails under the crossing span listed in sequence from the Down Pole: (See Diagram 1)	Distance from centre line of down pole to the running edge of the listed rail:	Relative level of listed rail under the rossing span:
1st Rail:	m	m
2nd Rail:	m	m
3rd Rail:	m	m
4th Rail:	m	m
5th Rail:	m	m
6th Rail:	m	m
7th Rail:	m	m
8th Rail:	m	m

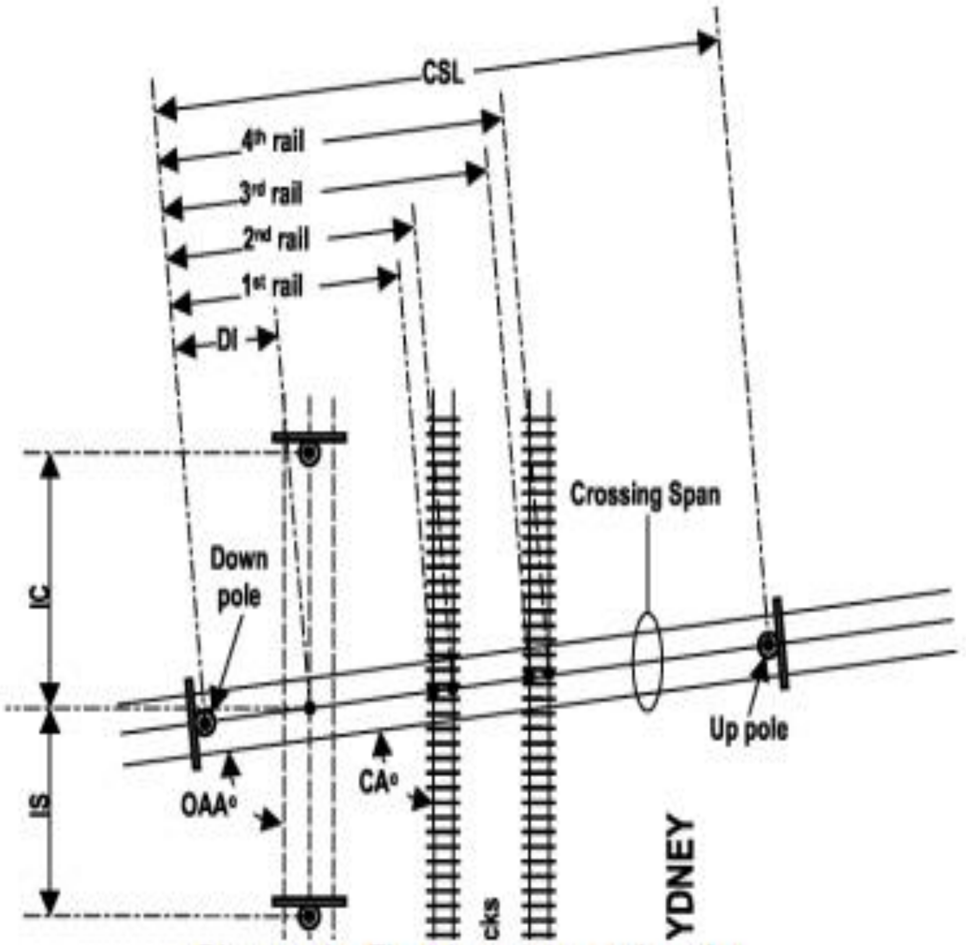

Diagram 1 – Electric aerial crossing plan

Other aerials that cross above or below the crossing span			
Owner:		Angle between crossing span and other aerials **(OAA) Diagram 1:**	
Size:			
Type:		Distance from the down pole to the intersection point of the aerials **(DI) Diagram 1:**	m
Voltage	kV		
Distance from the aerials intersection point to the Sydney side pole of the other aerials **(IS) Diagram 1:**	m	Distance from the aerials intersection point to the country side pole of the other aerials **(IC) Diagram 1:**	m
RL of the crossing span conductors at the intersection point with the other aerials and temp. at the time of measurement:	m	RL of the other aerial conductors at the intersection point with the crossing and temp. at the time of measurement:	m
	ºC		ºC

NOTE: The Down side is the right hand side when facing Sydney

Appendix 2 - Australian Inland Rail Expressway Map

Appendix 2 – Australian Inland Rail Expressway Map