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Electrical

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Transmission Line Standard for Design and Construction

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The technical content of this document has been approved by the relevant ARTC engineering authority and has also been endorsed by the ARTC Safety Committee.

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About This Standard

This document sets out the policy requirements and establishes the design and construction standards for new transmission line routes.

The standard is generally, though not wholly, applicable for the rehabilitation of existing transmission line infrastructure.

The standard is applicable to all High Voltage (over 1000 V) Overhead Transmission Lines owned by ARTC.

This document has an updated reference number and supersedes RailCorp publication EP 10 00 00 01 SP – “Transmission Line Standard for Design and Construction” Version 2.0 dated November 2001.

Document History

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List of Amendments –

ISSUE	DATE	CLAUSE	DESCRIPTION
1.1	05/01/2005		Reformatted to ARTC Standard
1.2	11/03/2005	Disclaimer	Minor editorial change

Contents

1 Main characteristics of transmission lines

1.1 General requirements

Statutory requirements	Transmission lines designed and constructed to this standard will comply with the E A of NSW publication, “Code of Practice for Electricity Transmission and Distribution Asset Management”.
General design notes	The design and construction standard for ARTC Transmission Lines is contained in this document. For details not contained in this document ,refer to ESAA publication HB C(b)1-1999, "Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines". For alterations to existing ARTC transmission lines refer to ARTC standard arrangements in Section 10 of this document.
Insulation co-ordination / BIL	Refer to **PDS 17** “Insulation Co-ordination and Surge Arrester Selection".
Outage rates	Refer to **PDS 17** “Insulation Co-ordination and Surge Arrester Selection”.
Surge arresters	Refer to **PDS 17** “Insulation Co-ordination and Surge Arrester Selection".
Environment	Environmental impact statement shall be provided for new transmission line feeders.
Crossing electrified tracks with ARTC transmission lines	Refer to **PYS 02** “Requirements for Electric Aerials Crossing ARTC Infrastructure”. Low voltage aerial conductors are not permitted to cross electrified tracks.
ARTC transmission lines crossing other Utilities transmission lines	ARTC transmission lines shall cross above other utility services of the same or lower voltage.
Transmission line layouts	See section 11.3.1 of this document
Details to be shown on the final transmission line profiles for new transmission lines, deviations of existing transmission lines and respacing of poles.	See section 11.3.2 of this document

Requirements for design alterations to transmission lines	See section 11.3.3 of this document.
Access maps	Shall be provided for all transmission lines constructed.

1.2 Testing to be performed prior to commissioning

Electrical continuity, loop resistance test	Loop resistance measured from one end over the full length of the transmission line for each pair of conductors, i.e. 3 tests for a 3-phase system without an earth wire, 6 tests for a 3-phase system with earth wire. Tests to be conducted by injecting 10 A dc. The loop resistance must not be greater than 105% of the calculated resistance based on the conductor resistance alone at the temperature at which the test is conducted. The loop resistance test results for each phase should not vary by more than 2%.
Insulation resistance test	With feeder cables, surge arresters and earths disconnected, a 5 kV insulation tester is applied to each phase of the transmission line for 1 minute and the insulation resistance recorded. The dry resistance value to be greater than 1 M~ divided by length of the transmission line in kilometres.
Phase identification checks	Confirm that phase "A" at start is phase "A" at end, and likewise for phases "B" and "C".
Electrical phase check	Confirm that phase “A” is phase “A” against another known supply at the same voltage, and likewise for phases “B” and “C”.
Transmission line inspection	Includes quality checks on field measurements, component installation, clearance checks e.g. to terrain / obstructions, etc.
Electrical phase sequence test	For dead end transmission lines to verify the electrical phase sequence.

2 Access and right of way

2.1 General

Definition of access	The means of getting to a transmission line. Access may require the passage of vehicles through railway, public and/or private properties. In certain instances access may be via boat or foot. Special keys may be required to gain access through certain gates (usually gates on non-railway property).
Definition of right of way	The legal right for the Maintenance Provider to use a parcel of land for the purposes of gaining access to a transmission line.
Definition of easement	The legal right for the ARTC to use a parcel of land to construct, maintain or operate a transmission line Owners of properties which have an easement on their property will have restrictions on the use of their property within the bounds of the easement, e.g. buildings, tall trees, etc.

2.2 Access

Construction of access roads	The construction of new transmission lines may also require the construction of access roads to the transmission line.

2.3 Access road direction signs

Erection of access road direction signs	Access road direction signs are required in remote areas to identify the correct route to gain access to a transmission line feeder in accordance with drawing A1/90175, “Access road and direction signs”.

2.4 Right of way

General	The right of way shall be clear of obstructions at all times so that access to the transmission line feeder can be gained.
Easements	Easements shall be cleared of obstructions that come within the statutory clearances of transmission lines. Refer to **PYS 01,** "Transmission Line Easement Conditions", for details of limitations imposed within easements.
Vegetation clearances	Refer to Electricity Association of NSW document ISSC3, "Guide to Tree Planting & Maintaining Safety Clearances Near Power Lines".
Metal buildings and structures under a transmission line	Where a metal buildings and structures exists under a high voltage transmission line, this metal building or structure shall be effectively earthed. If the transmission line conductors fall, the earthed metal building or structure would then cause the transmission line protection to trip. Refer to RailCorp publication **EP 12 10 00 22 SP** “Buildings and Structures Under Overhead Lines”, for earthing specifications.

2.5 Warning signs

General	Warning signs shall be installed where transmission lines cross navigable waters in accordance with the conditions of the licence for the crossing.
Water crossing notice	See Maritime Services Board drawing Q9/8075, "Water Crossing Notices – Specifications & Notes".
Water crossing notices for tidal waters	See Maritime Services Board drawing Q9/8078, "Water Crossing Notices – Overhead Electric Cable for Tidal Waters".
Water crossing notices for non-tidal waters	See Maritime Services Board drawing Q9/8077, "Water Crossing Notices – Overhead Electric Cable for Non-Tidal Waters".

3 Wood pole support

3.1 General

Conductor minimum electrical clearances from any phase to a crossarm, pole step, pole or strut.	For new work refer to ESAA publication HB C(b)1-1999, "Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines" for minimum electrical clearances. Clearances shall be increased to provide acceptable outage rates. For alterations to existing transmission lines use ARTC standard arrangements and clearances Voltage — Clearance 132kV — 1520mm 66kV — 525mm 33kV — 400mm 11 & 2kV — 200mm
Horizontal clearance of pole from centre line of nearest railway track	Refer to ARTC Civil “Structures Transit Space- Structure Gauge 1994” document C 2104.
Earth grid at pole Alternative for poles installed without earth grid	For transmission lines with a nominal voltage greater than 11kV each pole shall have an earth grid installed at the butt of the pole and the lead shall extend to ground level, in accordance with drawing E/79042 “Transmission lines – Grounding of Aerial Earth Wire – Earth Connection Details“. 13mm extendable deep driving rods, copper clad with flush joints driven a minimum of 2.4 metres deep beside pole.
Earth wire cover board	An earth wire cover board is required on poles to protect the earth wire up to a minimum height of 2.4 m from ground.
Segregation of bare down earth wires from other utilities equipment	Down earth wires on poles are to be insulated or segregated from other utilities equipment and earthing systems to provide a minimum 2.0m clearance between exposed earthing systems.

3.2 Wood pole

Design loading conditions	Refer to ESAA publication HB C(b)1-1999, "Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines" for loading conditions applied to poles.
Safety factor (bending moment)	4 : 1 minimum
Pole strength	See drawing D/81571, "Fully Desapped Wood Poles - Design Data Loading".
Timber species and pole dimensions	Preferred See drawing D/81572, “Fully Desapped Timber Poles – Dimensions and Specifications”. Alternative See Electricity Authority of NSW drawing EAS 1.1.1 "Wood Poles" Table "A" for strength group S1, durability class 2 and Table "B" for strength group S2, durability class 1 & 2. Strength groups to AS/NZS 2878", durability classes 1 and 2 to AS 2209. **Bloodwood species not acceptable.**
Pole lengths and depth in ground	See drawings D/81571 "Fully Desapped Wood Poles - Design Data Loading"and D/81572 “Fully Desapped Timber Poles – Dimensions and Specifications”.
Foundations	Poles that can endanger any equipment in the area of the running tracks must be concreted in accordance with **PYS 02** “Requirements for Electrical Aerials Crossing RAC Infrastructure”.
Pole foundations without concrete	See drawing E/55237, “Pole Foundations Without Concrete – Normal and Special Hole Depths”.
Pole foundations with concrete	See drawing E/51432 “Pole Foundations – Diameters and Depths of Holes”.
Notching of pole for crossarms	Pole to be notched 35mm ± 5mm to attach crossarms.
Handling of poles	Poles shall not be dropped to the ground from jinkers in a manner that may cause significant damage to the pole.
Hole for pole	Before standing a pole, water accumulated in the hole must be removed.

3.3 Pole steps

Drawing	See drawing D/80493, “Pole Step”.
Spacing / installation	Install 900 mm ± 50 mm apart on each side of the pole, opposite sides staggered 450 mm. Opposite side pole steps should ideally be displaced by 1/3 of pole circumference (120°). Pole steps shall be installed 125 mm ± 20 mm into the timber of the pole radially to the pole axis. Holes for pole steps shall be bored a minimum of 175 mm deep.
Minimum height to first step	A minimum of three (3) metres above the ground.

3.4 Pole cap

General	Pole caps shall be fitted to the heads of poles.
Drawing	See drawing D/82307, “Standard Pole Cap”.
Installation	In accordance with drawing D/82307 “Standard Pole Cap”.

3.5 Pole identification

General	Poles shall have two distinct identification signs. A unique transmission line feeder number and pole identification number. Poles supporting multiple feeders shall have the feeder number sign of each feeder displayed and arranged on the pole in the same order as the feeders are supported on the pole. A pole shall have only one pole number displayed. The pole number shall be the pole number of the highest voltage feeder attached to the pole.
Pole and feeder number signs	See drawing A2/90174 “Transmission Lines – Pole and Feeder Number Signs”.
Location of pole and feeder number signs	To be mounted at a height of approximately 2 m from ground level.
Fixing of signs	Attach to pole with four 32 mm x 8 g galvanised clouts.
Record	A record of this information shall be kept by the Maintenance Provider.

3.6 Pole date / species stamp

General	The pole shall be stamped with the date of manufacture and the species of timber used, as shown in Electricity Authority of NSW drawing "Wood Poles", EAS 1/1/1.
Record	A record of this information shall be kept by the Maintenance Provider.

4 Steel support structure

4.1 General

Conductor minimum electrical clearances from any phase to a crossarm, pole step, pole or strut.	Refer to ESAA publication HB C(b)1-1999, "Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines" for minimum electrical clearances.
Horizontal clearance of pole from centre line of nearest railway track.	Refer to ARTC Civil “Structures Transit Space- Structure Gauge 1994” document C 2104.
Earthing of uninsulated metalwork or concrete which forms part of an overhead line support that is located within 2.4 m of the ground line.	Refer to ESAA publication HB C(b)1-1999, "Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines" for earthing conditions applied to fabricated metal structures and poles.

4.2 Steel support

Design loading conditions	Refer to ESAA publication HB C(b)1-1999, "Guidelines for Design & Maintenance of Overhead Distribution & Transmission Lines" for loading conditions applied to fabricated metal structures and poles.
Step and touch potentials	Refer to ESAA publication HB C(b)1-1999, "Guidelines for Design & Maintenance of Overhead Distribution & Transmission Lines" for earthing conditions applied to fabricated metal structures and poles.
Protective coating	Metal structures and poles shall be galvanised to AS/NZS 4680 “Hot-dip galvanised (zinc) coatings on fabricated ferrous articles” and AS/NZS 4792 “Hot-dip galvanised (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialised process”.

Steel support continued	
Foundations	Fabricated metal structures and poles shall be installed on bolted foundations, the top of the foundation shall be a minimum of 300 mm above ground line.
Pole foundation bolts	Pole foundation bolts shall be manufactured from 316 stainless steel.
Earthing of pole	See drawing D89263 “Transmission Lines-Steel Pole Earthing Connection Details”.

4.3 Identification

General	Steel support structures shall have two distinct identification signs. A unique transmission line feeder number and structure identification number. Structures supporting multiple feeders shall have the feeder number sign of each feeder displayed and arranged on the structure in the same order as the feeders are supported on the structure. A structure must have only one structure number displayed. The structure number is the structure number of the highest voltage feeder attached to the structure.
Structure and feeder number sign	See drawing A2/90174 “Transmission Lines – Pole and Feeder Number Signs”.
Location of structure and feeder number signs	To be mounted at a height of approximately 2m above ground level.
Fixing of signs	Glued to the structure with suitable neutral cure silicone sealant suitable for use on galvanised material. Signs shall be shaped to the support structure surface profile prior to gluing.
Record	A record of this information shall be kept by the Maintenance Provider.

4.4 Manufacturer’s stamp

General	Steel poles shall be stamped with the manufacturer, date of manufacture, overall length and stress rating in a position where it can be read from the ground.

5 Pole top

5.1 General

The pole top is designed to provide appropriate support of the conductors as well as providing clearances between conductors and/or obstructions in accordance with statutory requirements.

Standard arrangements	Refer to Section 10 , Pole top arrangement drawings for a list of the preferred standard pole top arrangements.
Top crossarm position	When not shown on pole top arrangement, the top crossarm shall be positioned 300mm from the top of the pole.
Painting of wood / metal interfaces	Wood / metal interfaces shall be painted with a conductive paint for pin type insulator arrangements only, as shown on the pole top arrangement drawings.
Pole top dressing	Refer to pole top arrangements in Section 10.

5.2 Insulators

Insulators are required to support the conductor's weight and radial load and provide the electrical isolation between the conductor and it's support.

Types :	
Suspension and termination arrangements	See drawing E/84918 "Toughened Glass Disc Insulator – Clevis Type". Polymeric insulators. Only polymeric insulators with a continuous outer silicone shell over the insulator rod shall be used. For existing transmission lines - Insulators to AS 4435.1 Used to replace suspension and termination insulators where breakages are experienced because of vandalism or lightning strikes. The replacement polymeric insulator must have a compatible coupling length, electrical and mechanical characteristics to the insulator arrangement being replaced. The pole top design parameters must be checked to ensure electrical clearances and mechanical loadings are suitable for the use of the proposed polymeric insulator. Optional For the design and construction of new transmission lines.

Types :	
Pin type arrangement	Used up to 11kV. See drawing D/80730 “11kV Pin Insulator Assembly”. 11kV Pin Type Pin type A/130/7 to AS 1154 Part 2 Insulator Type SLP 11/180 to AS 1154 Part 2 Appendix B (Ftg. No. T 1/22)
Line post arrangement	For use on 132kV See drawing W/85365 “Solid Core Line Post Insulator”. Two additional shackles shall be installed between the insulator and the conductor attachment fitting to allow a degree of longitudinal movement. Optional usage 66kV see NGK catalogue DA 85202 C “Line Post Insulator” 33kV. See drawing X/88285 Sheet 1 & 2 “Tie Top Line Post Insulator”. To carry the conductor around pole in anchored and bridged arrangement. See drawing X/88285 Sheet 1 & 2 “Tie Top Line Post Insulator”.
Number of insulators in series	Normal insulation, unless otherwise specified is :- 132kV Termination Arrangements 10 – 254 x 146 disc insulators (Ftg. No. 453/6) 66kV Suspension Arrangements Line deviation up to 30^{o} (i) With Earth Wire 4 - 254 x 146 disc insulators (Ftg. No. 453/6) (ii) Without Earth Wire 5 - 254 x 146 disc insulators (Ftg. No. 453/6) Line deviation greater than 30^{o} (i) With Earth Wire 5 - 254 x 146 disc insulators (Ftg. No. 453/6) (ii) Without Earth Wire 6 - 254 x 146 disc insulators (Ftg. No. 453/6) 66kV Termination Arrangements (i) With Earth Wire 5 – 254 x 146 disc insulators (Ftg. No. 453/6) (ii) Without Earth Wire 6 – 254 x 146 disc insulators (Ftg. No. 453/6)

Number of insulators in series	33kV Suspension and Termination Arrangements With or Without Earth Wire 3 – 254 x 146 disc insulators (Ftg. No. 453/6) 11kV Suspension Arrangement 1 - 254 x 146 disc insulator (Ftg. No. 453/6) or 2 – 180 x 146 disc insulators (Ftg. No. 453/7) 11kV Termination Arrangements 2 – 254 x 146 disc insulators (Ftg. No. 453/6) 2kV The normal insulation for 2kV lines for future work shall be the same as 11kV lines. The two 180 x 146 disc insulators may be replaced by one 180 x 146 disc insulator.
Pin type insulator binding	See drawing E/69528 “Pin Type Insulators – Binding of Conductors”. or Helical preformed conductor tie manufactured to Australian standard AS 1154.3.
Care when installing insulators	Care shall be taken when installing insulators to ensure that they are not chipped or otherwise damaged. Before erection they shall be cleaned using a clean dry cloth.

5.3 Conductor insulator attachment

Refer to Section 10 – pole top arrangements.

5.4 Insulator attachment arrangement

Refer to Section 10 – pole top arrangements.

5.5 Conductor terminating arrangement

Refer to Section 10 – pole top arrangements.

5.6 Cross arms

Standard arrangements	Refer to Section 10 – pole top arrangements.
Timber species	Preferred - Natural, sawn Tallowwood to AS 3818.4 and AS 3818.1, durability class 1, strength group S2, grade 1, F27 Alternative - Natural, sawn to AS3818.4 and AS 3818.1, durability class 1, strength group S1, grade 1, F27.
Protection from splitting and weathering	Cross-arms shall be protected from end splitting and checking within 48 hours of sawing by the application of "Caltex Timber Seal" or equivalent approved by ARTC and gang nails (end plates) minimum 1.2mm thick covering at least 50% of the end grain. The top surface of the crossarm shall be painted with one coat of Dulux Weather Prime Acrylic paint or equivalent and two coats of Dulux Weather Shield Acrylic paint or equivalent, colour Avocado Green or Light Olive Green.
Location of cross arm	Cross arms shall be fitted to the side of the poles nearest to the start of the transmission line as indicated by the pole numbering. The only exceptions are where the transmission line crosses a railway line, a telephone line or another power line. In such exceptions, the cross arms shall be fitted on the side of the pole remote from the crossing span.
Pole band attachment	See drawing E/76805 “Crossarm Attachment – Double Pole Band Arrangement”.

5.7 Cross arm attachment to pole

Refer to Section 10 – pole top arrangements.

5.8 Earth Wire Arrangement

Standard arrangements	See drawings E/79168, E/79275, F/80616, D/89258, D/80144 sheets 1 & 2 for typical earth wire arrangements.
Extent of overhead earth wire coverage	Installed on all new transmission lines 33kV and above, for the whole length of the feeder. Aerial earth wire to be earthed at each pole. On existing 33kV and above transmission lines, for 800 metres adjacent to substations and cable to aerial terminations. Aerial earth wire to be earthed at each pole. Overhead earth wires are not used on 11kV transmission lines.
Overhead earth wire coverage	See drawing D/82204 sheets 1 to 3, “Conductor Spacing – Earth Wire General Arrangements”. Still air : 5°C, 30° shield angle. 500 Pa wind : 15°C, 40° shield angle. Also see **PDS 17** “Insulation Co-ordination and Surge Arrester Selection”.
Overhead earth wire raisers	See drawing D/81193 sheets 1 and 2, “Earth Wire on Pole Tops – Extension Bracket – Type 3 and 4”. Earth wires are not to be terminated on an earth wire raiser.
Pole stand off supports	See drawing D/81679 sheets 1 and 2, “Pole Top Earthing – Earth Wire Support”.

6 Conductors

6.1 General

Conductor details	See Energy Authority drawings EAS/3/1/1, 2 and 3, “Conductor Data”
Standard conductor sizes	Refer to **PDS 19** “Transmission Line Current Ratings and Standard Conductor Sizes”.
Current rating	Refer to **PDS 19** “Transmission Line Current Ratings and Standard Conductor Sizes” for information about current ratings of specific conductors.
Design operating conditions	For conductor ground clearances, use 70°C and 0 Pa wind. For conductor lateral clearances, use 50°C and 500 Pa wind.
Ground clearances	Refer to ESAA publication HB C(b)1-1999, "Guidelines for Design & Maintenance of Overhead Distribution & Transmission Lines" for details of statutory clearances to be observed.
Railway track and transit space clearances	Horizontal clearance to Transit Space Envelope - refer to ARTC Civil “Structures Transit Space- Structure Gauge 1994” document C 2104 and ESAA publication HB C(b)1-1999, "Guidelines for Design & Maintenance of Overhead Distribution & Transmission Lines". Vertical clearance from the design track level refer **PYS 02** “Requirements for Electric Aerials Crossing ARTC Infrastructure” under the conductor design operating conditions.
Other clearances	Refer to ESAA publication HB C(b)1-1999, "Guidelines for Design & Maintenance of Overhead Distribution & Transmission Lines"
Clearance to telephone or signal conductors	Refer to Australian Standard SAA CCM06 – 1998
Maximum conductor temperature	Maximum conductor operating temperature is 70^0C.

General continued	
Tension details for all aluminium conductors (AAC)	See drawing D/85101 sheets 1 to 8, “Virtual Span and Sag Tabulations - All Aluminium Conductors (18% UTS) up to and including 37/3.75 mm” for use without vibration dampers; See drawing D/80848 sheets 1 to 8, “Virtual Span and Sag Tabulations - All Aluminium Conductors (35% UTS) up to and including 37/3.75 mm” for use with vibration dampers.
Tension details for aluminium conductor steel reinforced (ACSR)	Refer to ESAA publication HB C(b)1-1999, "Guidelines for Design & Maintenance of Overhead Distribution & Transmission Lines" for tension details.
Tension details for copper conductors	See drawings D/80847 sheets 1 to 9, “Virtual Span and Sag Tabulations – Copper Conductors – All Sizes”.
Tension details for metal screened high voltage aerial bundled cable with support conductor (MSHVABC)	Only MSHVABC with support conductor shall be used. Refer to ESAA publication HB C(b)1-1999, "Guidelines for Design & Maintenance of Overhead Distribution & Transmission Lines" for tension details.
High voltage aerial bundled cable (MSHVABC)	High voltage aerial bundled cable (MSHVABC) manufactured to AS 3599-1. Galvanised catenary for MSHVABC manufactured to AS 1222-1.
High voltage aerial bundled cable (MSHVABC) earthing requirements.	The MSHVABC screens and support conductor shall be earthed. Poles without earth down wires
	See drawing B/89080 “Transmission Lines 11kV Aerial Bundled Cable to Bare Aerial Conductors Arrangement 11 /49” Poles with earth down wires
	The MSHVABC screen and support conductor shall be connected at each cable termination to the pole earth down wire. At intermediate supports the HVABC support conductor shall be connected to the pole down earth wire.
Standard arrangements	See section 10 of this document.

General continued	
Care when installing conductors	All conductors and earth wires shall be run out in such a manner that abrasion of the conductor is not possible. Conductors are not to be dragged over rough terrain and should be erected without touching the ground wherever possible. (Any scratching or other departure from the original smooth condition of the outer layer may result in an unacceptably high level of corona discharge and consequential radio interference.)
Pretensioning	New conductors and earth wires shall be pretensioned corresponding to 35% of the conductor ultimate tensile strength (UTS) for a period of 1 hour, then sagged for a temperature of 10°C below conductor temperature.
Sag checks after erection	The measurement of sags shall be by accurate sighting in selected spans using sight boards or, in the case of long spans and where required by the terrain, using survey instruments. Sagging by measurement of tension only is not permitted.

7 Conductor connections

7.1 General

Location of joints	No joint in a conductor or overhead earth wire shall be made within 1.2 m of the attachment point at a suspension structure.
Locations where joints are not permitted	Joints are not permitted in spans crossing railway lines, water, telephone lines or roads controlled by the RTA, nor in unusually long spans over difficult terrain.

7.2 Splice arrangements

Recommended splice arrangements	Helical in-line wrap-on manufactured to Australian Standard AS 1154.3 for all conductors except 7 strand conductors, or Full tension compression joint installed to manufacturer's instruction for all conductors.

7.3 Feeder connections

General	Feeding by joining directly on to a transmission line conductor in tension is not permitted.
Feeder connection	See drawing D/80326 sheets 1 and 2, “Conductor Clamp” for copper and aluminium conductors, or Non tension compression joint installed to manufacturer’s instructions.

8 Conductor accessories 8.1 General

Conductor accessories are additional components that aid in the safe and reliable operation of the transmission line system.

8.2 Vibration dampers

Type	Stockbridge type or similar. Spiral vibration dampers shall not be used.
Installation	Vibration dampers shall be installed as per manufacturer's instructions.
Where used	Vibration dampers are installed in spans nominated by the designer.

8.3 Aircraft warning markers

Where used	Refer to Australian Standard AS 3891.1 1991, “Permanent Marking of Overhead Cables and their Supporting Structures.”.

8.4 Bird flight diverters

Installation	Bird flight diverters shall be installed in accordance with the manufacturer's instructions.
Where used	Bird flight diverters are installed on conductors in spans that have a history of birds colliding with conductors causing excessive feeder outages.

9 Guy arrangements

9.1 General

Where used	Transmission line poles are guyed when the maximum applied load exceeds the safe working loads outlined in drawing D/81571 “Fully Desapped Wood Poles - Design Data Loading”.
Acceptable guying arrangements	Stay pole arrangements and ground anchor arrangements are acceptable forms of guying. Guying to another transmission line pole is deemed acceptable provided the pole can safely cope with the additional loading.

9.2 Stay pole

Loading	See drawing D/83229 "Guy Stay Poles type "G" - Design Data Loading".
Dimensions and specifications	See drawing D/83228 "Guy Stay Poles type "G" - Dimensions and Specifications".

9.3 Ground anchor

Standard arrangement	See drawings E/55335, E/63043 “Guys - Ground Anchors”
Alternative arrangement	Driven ground anchor. Anchor material shall be galvanised cast spheroidal iron or galvanised ductile iron. Tendon material shall be 24mm. galvanised mild steel or high tensile steel rod. All driven ground anchors shall be proof loaded to 3 times the maximum tension shown on the relevant arrangement drawings for the T14/- standard ground guy arrangement. A proof loading certificate for each installed ground anchor shall be provided by the installer to the relevant Maintenance Provider.
Installation depth	See drawing E/47126 “Ground Anchors – Holes for Varying Classes of Soils”.
Sight board	See drawings E/62218 and E/62219 “Ground Anchors” for details.

9.4 Stay (guy) wire arrangement

Stay pole standard arrangements	See drawings E/62216, E/62217 “Stay Poles – Guys”. (Fibreglass guy insulator to be used in place of item 5.)
Ground anchor standard arrangements	See drawings E/62218, E/62219, E/62273 “Ground Anchors”. (Fibreglass guy insulator to be used in place of item 1.)
Size of guy wire	Galvanised 7/ 8 SWG steel wire to be used.

9.5 Guy insulator

Material	Fibreglass insulators shall be used in line with the guy.
Guy strain insulator	Dulmison catalogue number FGS890CW.
Position installed	The guy insulator shall be installed in the guy wire in the position nominated in the Guy arrangement drawing.

9.6 Earth connection

Stay pole earth connection	Guy wire below guy insulator shall be effectively earthed if the guy wire is less than 2.4 m from the ground by installing a copper earth wire down the stay pole to an earth spike. The guy wire earth shall be protected by means of a cover board to a minimum height of 2.4 metres above the ground.
Ground guy earth connection	See drawings E/62218, E/62219, E/62273 “Ground Anchors”.

10 Pole top arrangements

10.1 11 kV two phase arrangements

Preferred arrangements		Non Preferred arrangements	
Arrangement	**Drawing**	**Arrangement**	**Drawing**
11/1	D/80383		
11 /2	D/803 80		
11 /3	D/803 80		
11/4	D81973		
11 /5	D/81973		
11 /6	D/803 82		
11 /7	D/803 82		
11 /8	D/803 81		
11 /9	D/803 81		
11/10	D80379		
11/11	D/81755		
11/12	D/81692		
11/13	D/81072		
11/14	D/81693		
11/15	D/82208		
11/16	D/82263		
		11/17	D/81043
		11/18	D/81760
		11/19	D/81760
		11 /20	D/81761
		11 /21	D/81761

10.2 11 kV three phase arrangements

Preferred arrangements		Non preferred arrangements	
Arrangement	**Drawing**	**Arrangement**	**Drawing**
11/22	D/82282		
11/23	D/82300		
11/24	D/82300		
11/25	D/82300		
11 /26	D/82313		
11 /27	D/82313		
11/28	D/82983		
11/29	D/83344		
11/30	D/86875		
11/31	D/86875		
11/32	D/86876		
11/33	D/86876		
11 /34	D/86877		
11/35	D/82209		
11/36	D/86877		
11/37	D/86878		
11/38	D/86878		
		11/39	D/82211
11 /40	D/82241		
11/41	D82247		
11 /42	D/82247		
11 /43	D/82247		
11 /44	D/82261		

Preferred arrangements		Non preferred arrangements	
Arrangement	**Drawing**	**Arrangement**	**Drawing**
11/45 MSHVABC	A3/89070		
11/46 MSHVABC	A3/89073		
11/47 MSHVABC	A3/89073		
11/48 MSHVABC	A3/89079		
11/49 MSHVABC	A3/80080		
11/S1	D/89250		
11/S2	D/89250		
11/S3	D/89251		
11/S4	D/89251		
11/T1	D/89252		
11 /T2	D/89252		
11/T3	D/89253		
11/T4	D/89253		

10.3 33kV arrangements

Preferred arrangements		Non preferred arrangements	
Arrangement	**Drawing**	**Arrangement**	**Drawing**
		33/1	D/80384
		33/2	D/80384
33/3	D/80385		
33/4	D/80385		
		33/5	D/80386
		33/6	D/80386

Preferred arrangements		Non preferred arrangements	
Arrangement	**Drawing**	**Arrangement**	**Drawing**
		33/7	D/80387
		33/8	D/80387
33/9	D/80388		
33/10	D/80388		
33/11	D/80389		
33/12	D/80389		
		33/13	D/80390
		33/14	D/80391
33/15	D/80392		
33/16	D/80393		
		33/17	D/80390
		33/18	D/80391
33/19	D/80392		
33/20	D/80393		
33/27	D/80397		
33/28	D/80397		
33/29	D/80398		
33/30	D/80398		
33/31	D/80399		
33/32	D/80399		
		33/33	D/80400
		33/34	D/80401
33/35	D/80402		
33/36	D/80403		
33/37	D/80404		

Preferred arrangements		Non preferred arrangements	
Arrangement	**Drawing**	**Arrangement**	**Drawing**
33/37A	D/85290		
33/38	D/80404		
33/38A	D/85290		
33/39	D/80404		
33/39A	D/85290		
33/40	D/80404		
33/40A	D85290		
33/41	D80405		
33/41A	D80405		
33/42	D80405		
33/42A	D80405		
33/43	D/80406		
33/43A	D/80406		
33/44	D/80406		
33/44A	D/80406		
33/45	D/81054		
33/46	D/81054		
33/47	D/81124		
33/48	D/81124		
33/49	D/81124		
33/50	D/81124		
33/51	D/81055		
		33/52	D/81056
33/53	D81050		
33/54	D81050		

10.4 33kV and 11 kV arrangements

Preferred arrangements		Non preferred arrangements	
Arrangement	**Drawing**	**Arrangement**	**Drawings**
33/21	D/80394		
33/22	D/80394		
33/23	D/80395		
33/24	D/80395		
33/25	D/80396		
33/26	D/80396		

10.5 66kV arrangements

Preferred arrangements		Non preferred arrangements	
Arrangement	**Drawing**	**Arrangement**	**Drawings**
60/1	F/29119		
60/2	F/29127		
60/3	F/29300		
60/4	F/29301		
60/5	F/29250		
60/7	F/29362		
60/8	F/29367		
60/9	F/29377		
60/10	F/29380		
60/12	F/29667		
60/15	E/37088		
		60/16	E/37089
		60/18	E/37193
		60/19	E/37193

Preferred arrangements		Non preferred arrangements	
Arrangement	**Drawing**	**Arrangement**	**Drawings**
60/C/1	F/30450		
60/C/2	F/30451		
60/C/11	F/31558		
60/C/12	F/31558		
60/C/13	F/31415		
60/C/14	F/31580		
60/C/15	F/31580		
60/C/16	F/31685		
		60/C/17	E/37200
		60/C/18	E/37200
		60/C/19	E/37202
		60/C/20	E/46126
		60/C/21	E/37196
		60/C/22	E/46126
		60/C/23	E/37201
		60/C/24	E/37201
		60/C/27	E/37486
		60/C/28	E/37486
60/C/29	E/37573		
60/C/30	E/37573		
60/C/31	F/30450		
60/C/32	E/37505		
60/C/35	E/30452		
60/C/36	E/30453		
60/C/37	F/30456		

Preferred arrangements		Non preferred arrangements	
Arrangement	**Drawing**	**Arrangement**	**Drawings**
60/C/38	F/30457		
60/C/39	F/30458		
60/C/40	F/30459		
60/C/41	E/37587		
60/C/42	E/37587		
60/C/51	E/39912		
60/C/52	E/39912		
		60/C/53	E/40211
		60/C/54	E/40211
60/C/61	E/40256		
60/C/62	E/40255		
		60/C/66	E/40212
60/C/77	E/40717		
60/C/88	E/40255		
60/C/78	E/40717		
		60/C/84	E/37200
		60/C/85	E/37200
		60/C/86	E/37202
		60/C/65	E/40212
		60/C/87	E/46126
		60/C/88	E/37196
		60/C/89	E/46126
		60/C/90	E/37486
		60/C/91	E/37486
60/C/92	E/47436		

Preferred arrangements		Non preferred arrangements	
Arrangement	**Drawing**	**Arrangement**	**Drawings**
60/C/93	E/48227		
60/C/94	E/48227		
60/C/95	E/48227		
60/C/96	E/48227		
66/T 1	D/89254		
66/T2	D/89254		
66/T3	D/89254		
66/T4	D/89255		
66/SDL	D/89256		
66/SDR	D/89256		
66/SVL	D/89257		
66/SVR	D/89257		

10.6 132kV arrangements

Preferred arrangements		Non preferred arrangements	
Arrangement	**Drawing**	**Arrangement**	**Drawings**
132/1	D/85187		
132/2	D/85188		
132/3	D/85447		
132/4	D/85521		

11 Data set associated with aerial transmission lines

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

During the construction of new aerial transmission line routes it is imperative that the precise details of the transmission line location is recorded. The details shall be recorded over the transmission line route in respect to existing features and permanent reference marks.

Any alterations or additions resulting from maintenance or construction activities affecting the transmission line or the transmission line route shall similarly be recorded.

The data is required to :

- record and document the installation of the transmission line.
- enable the transmission line to be accurately and efficiently shown on the Australian Rail Track Corporation's (ARTC) High Voltage transmission Line Layout Drawings and (GIS) Geographic Information System.
- allow compilation of route details for future pole renewals, deviations and alterations.

The recording of survey data for pole replacements may in some instances be supplanted by manual measurement and data recording when the pole replacement can positively and accurately be tied to permanent structures or features previously shown on the original transmission line route survey and the transmission line remains in the original route position.

11.1 As-constructed survey

11.1.1 General description

The "as-constructed survey" of the transmission line is required for the preparation of plots and profiles for maintenance and future design purposes. To this end, the survey should be of a traverse and radiation nature along the route of the transmission line, recording the required details as set out below. The survey shall be controlled and adjusted from state survey control marks and benchmarks or to approved Railway survey control marks of which the Integrated Survey Grid (ISG) and / or Map Grid of Australia (MGA) and Australian Height Datum (AHD) co-ordinates are known. Alternative methods of survey producing the same results may be approved by ARTC's nominated Engineering Authority.

The fixed data format is shown in Appendix B and Appendix C while the Feature Code Description is shown in Appendix A.

11.1.2 Survey details

Levelling shall be one way to fourth order accuracy, either connected to state survey marks and bench marks or to approved Railway survey control marks.

Accuracy of survey shall be within 100mm in horizontal and 50mm in vertical with

respect to the local survey control marks and infrastructure.

The survey is to be adjusted to ISG or MGA and AHD over the whole route.

The survey shall be tied to either state survey marks or approved Railway survey control marks at intervals of 0.5 to 1.0km along the route of the survey for both horizontal and vertical control purposes. The survey shall be adjusted to close on these control marks along the route. In cases where survey control marks cannot be located or are not available, then approved State or Railway control marks shall be placed and co-ordinated onto ISG or MGA and AHD.

A minimum of three survey control marks must be used to provide Horizontal adjustment.

11.1.3 Transmission line detail

The survey shall include the following details of the Transmission Line:

(i) Location

The location (ISG or MGA position) of all support poles for the transmission line (includes guy poles and anchors) and (AHD) level at base of poles.

(ii) Construction and Arrangement

The construction and arrangement of the conductors on the poles. This includes:

- Recording of the field pole number.
- Height of the pole and height of the underside of each crossarm or attachment height of conductors on line post insulators.
- The girth of the pole (as a circumference measurement not a diameter or radius).
- Arrangement of conductors on the pole. A sketch drawn facing the pole in the direction of ascending pole numbers indicating the number of crossarms and/or line post insulators and position of conductors.
- Noting of any transpositions of conductors between poles.
- Reference to any other services attached to the pole and details thereof, ie. Local Electricity Distributor, Communications Cables, street lighting, etc.

11.1.4 Details of obstacles

Location and height of any obstacle within 8m either side of the centre line of the transmission line. Examples are streetlights, buildings, advertising signs, overhead wiring structures, etc.

Information shall be provided in the form of a relative level taken at the base of the obstacle and a height in metres to the top of the structure or object.

11.1.5 Ground levels

Ground levels along the route of the transmission line sufficient to indicate any major

change in grade. A minimum of 3 levels per span will be required. A level at mid-span is required (where practical).

11.1.6 Location of SRA boundary fence

Location of State Rail Authority (SRA) boundary fence adjacent to the poles and at major angles in the boundary fence where within the area covered by the layouts (generally not a real property survey). However, where the location of the boundary is crucial to the design then a real property survey shall be performed.

11.1.7 Location of street intersections

Where the transmission line is in public roads, the location of street intersections and kerb lines shall be recorded.

11.1.8 Details of electrical and communications crossings

Location details of all overhead power and communications crossings shall be recorded, providing information as follows:

- Location of intersection of the Transmission Line and the other bodies service.
- Ground level at the point of intersection.
- Height of the Transmission Line conductor in nearest proximity to other bodies service.
- Height of the other bodies service in nearest proximity to the Transmission Line.
- Location and relative level at the base of other Authority's terminal poles either side of transmission line, together with the height in metres to the conductors on these poles. The pole top arrangement on these poles shall be recorded (NOTE: Heights should be given at point of attachment of conductor in case of other services).

When recording mid-span conductor heights the ambient temperature shall also be recorded.

11.1.9 Details of rail location and level

Location and relative level of the rail nearest each pole where rail is within 10m of the pole.

11.2 Documentation of survey work

11.2.1 Field notes

Details of survey shall be recorded on standard field sheets and shall include all necessary documentation, diagrams, and sketches (size 200mm x 120mm). These field sheets will form part of the final documentation and will become the property of the Australian Rail Track Corporation.

Details of control marks used and any horizontal and vertical adjustments of the

traverse are to be documented and provided.

A listing of feature codes (if used) for the survey shall also be included. A listing of suggested feature codes is shown in Appendix A.

11.2.2 Co-ordinate listing

A co-ordinate listing of the survey is required. As the survey is adjusted to ISG or MGA and AHD datum the format of the listing will be: Point No., easting, northing, relative level, point code (if used), and comments. The listing shall be maintained in an electronic format. Each list file of the survey data shall be an ASCII file and of fixed record format

A paper plot is required to accompany each list file. The plot shall be suitably annotated to indicate the transmission line route and detail.

The comments should indicate all height information pertaining to obstructions, height and spread of trees, pole cross-arms, conductor heights, girth of poles, etc.

The co-ordinate listing shall contain a complete record of the survey work performed. The list file(s) containing details of the survey shall be provided.

The data supplied shall be in the format as listed above and shall be complete. A sample Coordinate listing format is shown in Appendix B and a sample of fixed data (space delimited) is shown in Appendix C.

11.2.3 Paper plot

A hard copy plot is required to accompany each list file. The plot shall be suitably annotated to indicate the transmission line route and survey details. The plot is to be signed as work executed and a record of the transmission line installation.

11.2.4 Photographs

Colour photography shall be provided along the transmission line route. The photography is required to augment the detail survey and provide a pictorial view of the route sufficient to allow the identification of design constraints and restrictions.

Photographs shall be provided, taken at each pole looking along the route and in the same direction. Photographs of each pole top arrangements of other bodies poles shall be provided where their services cross the ARTC transmission line route.

The photographs shall be clearly marked to identify the location along the route where they were taken and the direction facing (ie.Facing in the direction of increasing pole numbers).

11.3 Layouts and profiles

Layout and profile drawings shall be provided to AS 1100.101 “Technical drawing - General principles” and shall include ARTC’s standard drawing title block.

11.3.1 Layouts

Final transmission line route shall be plotted on A1-size polyester film Drawing Sheets at a scale of 1:500. These layouts shall be based on detailed route survey and shall be provided in archival quality plastic film or polyester drawing sheets. The transmission line layout may be a combined overhead wiring and transmission line layout.

Alternative methods producing the same results may be approved by ARTC's nominated Engineering Authority.

11.3.1.1 Required Information

Information to be shown on layout drawings is listed below:

- Conductor Details (to be shown on the first sheet of the series).
- Construction details, including conductor and pole materials and standards and pre-tensioning.
- Span between adjacent poles.
- Deviations of the Transmission Line at each pole.
- Conductor phasing on each pole by letters arranged in the same configuration as the conductors eg. A

  B C

Where the conductor phasing is unknown and conductor identification is required numbers may be used eg, 1

2 3

- Standard pole top arrangement shall be called up as follows

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 etd

7.5G400 **9** Stay pole length/G (guy)/ground line dia. (mm)

- Pole top diagrams for non-standard arrangements shall be drawn adjacent to the pole location clarifying the alteration from the standard design arrangement.
- The maximum ground line-bending moment in Newton Metres (Nm) on each pole under worst case design conditions.
- Position of nearest railway track, adjacent to pole only.
- Kerb line of any roads adjacent to transmission line.

(i) Property boundaries in vicinity of the transmission line together with property information relating to land over which the transmission line route passes - ie. Lot Nos., Deposited Plan Nos., Ownership of land, Boundaries and Details of Easements, etc.

(ii) Property boundaries in vicinity of the access roads together with property information relating to land over which the access roads pass - ie. Lot Nos., Deposited Plan Nos., Ownership of land, Boundaries and Details of Easements, etc.

(iii) State Survey Marks and Integrated Survey Grid Information.

- Any other aerial services adjacent to or crossing the transmission line.
- Sketches of any ‘non-standard’ pole top arrangement showing alterations to “standard” arrangements shall be shown on transmission line layouts.
- Grid marks.

- A virtual span table on each sheet tabulating the virtual spans of the tension lengths on that sheet in the following format.

Virtual Spans

POLE NUMBERS	VIRTUAL SPAN (m)
49A - 53	120
53 - 56	106.7
56 - 56C	Bay Length
56C - 65	99

11.3.2 Profiles

Final transmission line profile shall be prepared on AO-size Drawing Sheets with suitable horizontal and vertical scales to adequately show the required details.

The profiles shall be based on detailed route survey and shall be in archival quality plastic film or polyester drawing sheets.

11.3.2.1 Required information

Each profile will clearly indicate the following information:

1) Distance in metres along the centre line of the transmission line of poles, roads, other services, features, mid-span levels and obstructions.

2) AHD level of all these points and offset 8 metres left or right of centre line relative to an adopted datum.

3) Deflection angles left or right of the poles.

4) Numbering or coding of poles and pole top arrangements.

5) Height of poles and crossarm heights / post type insulator conductor support heights.

6) Conductor profile at 70^0 C and where the transmission line crosses under other services a 0^0 C conductor profile.

7) Height of obstructions, ancillary features, other services (communications, electricity distribution, etc) above the ground surface.

8) Span lengths.

9) Heading and reference to survey field notes used to generate the profile.

10) Where the transmission line crosses other services, a separate profile shall be drawn between the two poles supporting the crossing span of the other service. The point of intersection with the transmission line will be indicated showing the relative level of each transmission line or other service. These separate profiles shall be based on the combination of loading and ambient

conditions that cause the relative separation of the two circuits to be at a minimum. These conditions shall be indicated adjacent to the relevant profiles.

11.3.3 Requirements for design alterations to transmission lines

No alteration to the profile is required for poles replaced with identical poles within 1 metre of the original pole position where the ground line level is ± 1 metre of the surveyed level.

Alterations are required to the data set for:

1) poles replaced with a pole of a different length to the designed pole.

2) poles replaced more than 1 metre from the original pole position

3) where the ground level has changed by more than 1 metre

4) where the ground line between the poles has been raised by more than 1 metre.

The original profile may be altered or a new partial profile drawn from a survey of the affected area provided a cross-reference is noted on the original profile and the part profile.

11.3.4 Approval of layouts and profiles

Completed layouts and profiles shall be approved in accordance with ARTC's Configuration Management Policy.

11.4 Alterations to drawings

The Contractor shall carry out alterations to design drawings that may be found necessary during construction.

12 Ownership of documents

The completed transmission line/cable layouts, profiles, field survey books, diagrams, coordinate listings of surveys, photographs and sketches will form part of the final documentation and will become the property of the Australian Rail Track Corporation. However, the Australian Rail Track Corporation's Maintenance Provider for the transmission line will be the custodian of all documents.

13 Maintenance of documents

It is the responsibility of the Maintenance Provider for the transmission line to maintain and update all documents to reflect the all changes resulting from alterations and maintenance activities.

13.1 Maintenance management information baseline

The following information shall be loaded into the Maintenance Providers Maintenance Management Information System.

This listing shall include for each pole:

- Pole Top Arrangement
- Date erected
- The maximum ground line-bending moment under worst case design conditions.
- Pole Base treatment
- Girths at ground line
- Pole timber species
- Pole length and stress rating

14 Appendix A

Code descriptions.

CODE	DESCRIPTION	CODE	DESCRIPTION
ANT	Antenna or aerial	NS	Natural surface
AWN	Awning	MH	Manhole
ATTCH	Attachment	OHWS	OHW structure
BEND	Cable bend	POLE	Pole ARTC transmission line
BOB	Bottom of bank	PLV	Power pole low voltage
BDY	Boundary lines	PM	Permanent mark
BLD	Building	PP	Peg pole (peg location)
BM	Bench Mark	P66	Power pole 66kV
CL	Centreline	P33	Power pole 33kV
CLP	Council pole	P11	Power pole 11kV
CB	Cable	P2	Power pole 2kV
CBJ	Cable joint	PIT	Pit
CBT	Cable trench	PIPE	Pipe (CI, EW, Concrete)
CG	Change of grade	PNTS	Points (rail)
CK	Creek	RL	Rail
CNR	Corner	RLTT	Rail tramway
CONT	Contact wire (OHW)	SIGN	Sign hording
CATY	Catenary wire (OHW)	SHRUB	Shrub
CR	Cable repair	SIG	Signal
DUCT	Conduit & duct	SIGBRG	Signal bridge
EB	Edge of bitumen	SSM	State Survey Mark
EST	Elevated steel troughing	STR	Structure
ET	Edge of track	RSN	Ramset nail in structure
ETR	Edge of trees	TCM	Track control mark

CODE	DESCRIPTION	CODE	DESCRIPTION
FCE	Fence	TRAV	Traverse station
GATE	Gate	TOB	Top of bank
GLT	Ground line troughing	TREE	Tree
GRATE	Grate (drainage)	UCT	Underground conc. troughing
GUY	Guy pole	VENT	Vent
HT	Height (miscellaneous)	X1	Crossarm (top)
INTN	Intresection of power lines	X2	Crossarm (second)
KB	Kerb	X3	Crossarm (other)
KL	Kerb line	XOVR	Crossover (rails)
LIGHT	Light on pole	ULX	Under line crossing
NRL	Negative rail		

15 Appendix B

Required Format For Survey Data

Fixed Record Format (Space Delimited)

XXXXX XXXXXXXXXXXX XXXXXXXXXXXX XXXXXXXXX XXXXXX XXXXXXXXXXXXX

5CHR	2X	12CHR	2X	12CHR	2X	9CHR	2X	6CHR	2X	25CHR
(numeric) (integer)		(numeric	3	decimal places	)			(alpha)		(alpha)

16 Appendix C

Example of Fixed Data Format

CIVIL Job SDR00164 Date 04/07/99

File

Job details 04/07/99 WESTMEAD - DETAIL SURVEY OF 638 11 kV

TRANSMISSION LINE ADJACENT TO SUB.

PNT	EASTING	NORTHING	RL	Code	Comments
2	308210.946	1250951.522	10.458	P11	ARTC Pole 7 H=11.36, H=12.91, H=14.62
3	308215.762	1250950.046	10.596	P11	ARTC Pole H=11.42, H=11.48
4	308148.844	1250956.223	10.836	FCE	Fence H=1.9
5	308138.680	1250950.072	10.905	FCE	Fence H=1.9
6	308132.995	1250949.558	10.944	FCE	Fence H=1.9
7	308121.542	1250962.167	10.732	FCE	Fence H=1.9
8	308114.953	1250969.461	10.364	FCE	Fence H=1.9
9	308097.919	1250987.683	10.595	FCE	Fence H=1.9
10	308096.652	1250990.346	10.732	OHWS	OHW Structure H=9.62
11	308109.837	1251008.080	10.710	OHWS	OHW Structure
12	308100.430	1250987.005	10.788	BLD	ARTC Electrical cabinet H=2025
13	308098.976	1250988.144	10.732	BLD	ARTC Electrical cabinet H=2.3
14	308105.934	1250980.862	10.863	TREE	Tree H=7.8
15	308117.480	1250973.760	10.821	OHWS	OHW Structure MS12+449 DN H=10.55
16	308131.129	1250991.896	10.879	OHWS	OHW Structure MS12=449 UP
17	308125.720	1250964.585	10.908	OHWS	OHW Structure MS12+ DN H=7.4
18	308116.521	1250970.658	10.794	PP	Peg pole
19	308123.432	1250963.512	10.808	PP	Peg pole
20	308153.863	1250940.673	10.797	OHWS	OHW Structure MS 12+400 DN H=10.75
21	308168.280	1250958.995	11.085	OHWS	OHW Structure MS12+400 UP

22	308190.551	1250924.854	10.584	BLD	Building H=7.00
23	308145.275	1250953.219	11.852	TREE	Tree H=5.4
24	308145.567	1250951.058	10.852	P11	ARTC Pole #2, Heights removed
25	308138.884	1250955.770	10.809	NS	Natural surface