Government of South Australia
Department for Infrastructure and Transport

Overhead Wiring System Requirements for the 25kV Electrified Train Network

Engineering Standard

Rail Commissioner

TP1-DOC-000390

Document Amendment Record

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1. Introduction

The Department for Infrastructure and Transport (DIT) owns the Adelaide Metropolitan Passenger Rail Network (AMPRN) currently operated and maintained under the Rail Accreditation of third party. These standard forms part of the engineering management system used to ensure safety and customer service levels are efficiently and effectively supported.

Public Transport Services (PTS) is progressively installing a 25kV traction power system to the train network with the ultimate aim of expansion to the entire system. Electrical Multiple Units (EMU's) will replace the current Diesel Multiple Units (DMU'S) allowing for a more efficient and environmentally sensitive method of providing public transport to the Adelaide metropolitan area.

It is essential for safety, consistency and efficiency that the systems being installed are constructed to a uniform standard.

2. Purpose

The purpose of this standard is to list the technical requirements applicable to the overhead wiring system used for the 25kV electrified train network.

3. Scope

This standard is applicable to all design, construction and maintenance activities related to the overhead wiring system for the 25kV electrified train network.

4. References

- AS/NZS 1170.0: 2002 Structural design actions, Part 0: General principles
- AS/NZS 1170.1: Structural design actions, Part 1: Permanent, imposed and other actions
- AS/NZS 1170.2: Structural design actions, Part 2: Wind actions
- AS 1275 Metric screw threads for fasteners
- AS/NZS1214 Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
- AS/NZS 1554.1 Structural steel welding, Part 1: Welding of steel structures
- AS/NZS 4065 Concrete utility services poles
- AS 4100 Steel structures
- AS/NZS 4507: 2006 Cables - Classification of characteristics when exposed to fire
- AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
- AS 5100.2: 2017 Bridge design, Part 2: Design loads
- AS IEC 60038: 2022 Standard voltages
- EN 50125-3: 2003 Railway applications- Environmental conditions for equipment, Part 3: Equipment for signalling and telecommunications
- EN 50149 Railway applications. Fixed installations. Electric traction. Copper and copper alloy grooved contact wires
- EN 50163 Railway applications. Supply voltages of traction systems
- EN 50317 Railway applications. Current collection systems. Requirements for and validation of measurements of the dynamic interaction between pantograph and overhead contact line
- EN 50367: 2020+ A1:2022 Railway applications. Fixed installations and rolling stock. Criteria to achieve technical compatibility between pantographs and overhead contact line
- ENA C(b)1 - 2006 Guidelines for design and maintenance of overhead distribution and transmission lines
- TP1-DOC-000389: Electrical and Mechanical Clearances for the 25kV Electrified Train Network
- AR-EL-STD-0102: Guidelines for the Provisions Related to Electrical Earthing and Bonding for the Adelaide Metro Electrified Rail Network

- 25kV electrified area signage specification G53-SPE- TR-319 (Knet: 7910515)
- LOR-GEN-1401: General Arrangement of Free Running Overbridge Auto-Tensioned Equipment (Knet No: 9410436)
- LOR-WIR-4006: 19/3.25 Aluminium alloy conductor – LSZH Insulated (Knet: 9614939)
- LOR-WIR-5002: 7/7/0.51mm Bronze flexible stranded conductor (Knet: 9614943)
- LOR-FIT-1404: Dropper clips for contact & catenary wire (Knet: 9359210)
- LOR-WIR-6001: 19/7/0.71 Copper flexible conductor (Knet: 9614945)
- LOR-TEC-1031: Erection tensions 11kN auto-tensioned equipment (Knet: 9552516)
- LOR-TEC-1032: Erection tensions for ancillary wires (Knet: 9552519)
- LOR-GEN-2001: General arrangement of boom attachments (Knet: 9410506)
- LOR-GEN-1910: General arrangement of support & registration for 250 SHS TTC structure (Knet: 9410496)
- M03375-04-L: Pantograph Adelaide A-City EMU
- DIT range of OHW system drawings

5. Acronyms

ACRONYM	FULL NAME
AMPRN	Adelaide Metropolitan Passenger Rail Network
DIT	Department for Infrastructure and Transport
DMU	Diesel Multiple Unit
PTSOM	PTS Operations and Maintenance
PTS	Public Transport Services
APC	Automatic Power Control (track inductor)
BT	Booster Transformer
BTRC	Booster Transformer Return Conductor Current
EMU	Electric Multiple Unit
EST	Emergency Supply Transformer
IO	Insulated Overlap
MPC	Mid Point Connection
NS	Neutral Section
OHW	Overhead Wiring
OHWS	Overhead Wiring System
OPGW	Optical Power Ground Wire
RC	Return Conductor
SI	Section Insulator
TPS	Traction Power System
TSC	Track Sectioning Cabin
r.m.s.	Root Mean Square
XLPE	Cross-Linked Polyethylene
PVC	Polyvinyl Chloride
BWA	Balance Weight Anchor
OOR	Out of Running

6. Performance Requirements

The overhead wiring system shall meet the following performance requirements:

- Have an overall design life of at least 50 years.
- Contribute to the achievement of an overall availability target of 99.883%. The availability target being the number of trains which are delayed by less than 3 minutes as a percentage of the number of trains running for a defined period.

- Be designed to accommodate electrical multiple units (EMU) line speeds of up to 130 km/h. This shall include two EMU sets coupled together with both pantographs raised.

7. Design Requirements

Any new OHW or modification to the existing OHW should be made using components and assemblies from the DIT system design range. If a suitable arrangement does not exist in the system design range or an improved system is available then alternatives may be utilized with the approval of the Unit Manager Overhead Engineering.

7.1. General

The overhead wiring system (OHWS) design shall:

- Allow for the reconfiguration of the electrical feeding arrangement to isolate faulted electrical sections or sections requiring maintenance access during scheduled outages
- Meet the requirements for signal sighting for ground, mast and gantry signals under all conditions, including, but not limited to, possible glare at dawn and dusk, within the limits of the overhead wiring system design
- Provide coordination of load/fault current return paths and earthing & bonding parts of the signalling system to ensure the safety and reliability of both systems
- Coordinate the location of insulated overlaps with signalling positions
- Ensure the interaction between pantograph and contact wire does not exceed the maximum limit of arcing defined in EN 50317
- Ensure all mechanical and electrical clearances comply with TPI-DOC-000389
- Ensure dynamic response of the overhead wiring system and pantograph achieves even wear on the contact wire
- Ensure insulated overlaps or section insulators are not positioned within 50m of station platforms and the departure sides of signals and 200m from the approach side of signals.
- Comply with the requirements of AS4680
- All traction overhead conductors shall operate between -5°C to a maximum temperature of 80°C

OHWS shall consist of the following standard wiring arrangements with auto-tensioning devices:

- A simple catenary system on mainlines and sidings; and
- A simple catenary system or a single contact system as appropriate to other lines / depots.

OHWS shall use the following traction power distribution arrangements:

- Booster transformer return conductor current (BTRC) system or
- Simplified rail return system or
- Another PTS approved alternative power distribution arrangement

7.2. Structural Requirements

The OHWS on all single and multiple tracks shall be supported on either:

- Hinged cantilever assemblies attached to OHWS structures; or
- Span wire “pull off type” registrations

Where necessary, i.e. at turnouts, multi-track areas, or where there is no room for masts between tracks or between a track and the corridor boundary, the traction overhead equipment shall be supported and registered from portal structures or two track cantilever structures.

Where required portal structures to support cantilevers may be used at marginal platforms

OHWS designed over tracks within Adelaide station shall meet all performance requirements when subjected to the exhaust fumes and heat generated by the DMU's under all operating conditions.

7.3. Traction Power Switching Stations

The design shall comprise neutral sections (NS), insulated overlaps (IO) and section insulators (SI) complete with surge arresters, cables attachment and support arrangements and provisions for attachment of conduits to overhead wiring system masts, to enable the connection of traction power and return current cables.

The traction power system (TPS) shall provide a means to detect and clear faults on the OHWS via circuit breakers at feeder stations, track sectioning cabins and track coupling units.

7.4. Climatic Conditions

Adelaide is a coastal city with a Mediterranean climate consisting of mild, wet winters and hot, dry summers. The winter has a fairly reliable rainfall and average daily maximum temperature of 15-16ºC. Rainfall in summer is unreliable, light and infrequent and the average daily maximum temperature is 29-30ºC.

All areas shall be designated as Polluted/Corrosive Areas.

The overhead wiring system shall be designed to the following climatic conditions:

Minimum ambient shade temperature: -5ºC
Maximum ambient shade temperature: 55ºC
Yearly average temperature: 19ºC

Minimum ambient humidity: 0%
Maximum ambient humidity: 100%
Average ambient humidity: 55%

Intensity of solar radiation: 1.1kW/m²

Isokeraunic level: 18 days/year

Altitude: <1000m above sea level

Minimum salt / Corrosion level
(Medium pollution): 4C2 (as per table 4 of EN50125-3: 2003)

Maximum seismic rating: 0.2g

7.5. Wind Loading

Wind loading on the OHWS and support structures shall be determined in accordance with AS/NZS 1170.0:2002 and AS/NZS 1170.2.

For wind loading, the OHWS shall be considered importance level 1 in accordance with table F1 of AS/NZS 1170.0:2002.

For wind loading, the OHWS support structures shall be considered importance level 2 in accordance with table F1 of AS/NZS 1170.0: 2002.

Wind loading for the OHWS and OHWS support structures shall consider a design working life of 50 years.

The annual probability of exceedance for ultimate limit states shall be read from AS/NZS 1170.0:2002 table 3.3. For the design working life of 50 years, this gives 1/100 (i.e. V100 = 100 year return wind) for importance level 1 structure types and 1/500 (i.e. V500 = 500 year return wind) for importance level 2 structures.

Regional wind speeds (based on a 3 second gust) for wind loading shall be read from AS/NZS 1170.2:2002 table 3.1 where the Adelaide Metropolitan Passenger Rail Network is a region A. Therefore, the ultimate wind loading shall be 41m/s for the OHWS and 45m/s for OHWS support structures.

For operational wind calculations (blow off), the ultimate wind loading shall be based on the wind speed at which train operations will cease from AS 5100.2 : 2017, which is 40 m/s. This value shall be multiplied by a risk factor of 0.83 to take account of among other things, the likelihood of a train passing any given span during high wind conditions).

Regional wind speeds shall be modified in accordance with AS 1170.2 for design factors such as wind direction, terrain/height, shielding and topographical multipliers

7.6. System Voltage

Voltages shall comply with EN 50163: Railway applications, with the exception of Umax2.

The system voltage shall be:

- Lowest non-permanent voltage (Umin2): - 17.5kV*
- Lowest permanent voltage (Umin1): - 19kV
- Nominal voltage (Un): 25kV
- Highest permanent voltage (Umax1): 27.5kV
- Highest non-permanent voltage (Umax2): 30kV*
  * In accordance with AS IEC 60038: 2022 Table II and subject to confirmation with the rollingstock contractor

7.7. Short Circuit Levels

The indicative system short circuit levels are:

- Short circuit current rating: 6.7kA r.m.s.
- Short circuit current duration: 3 seconds
- Maximum track feeder current rating: 400A r.m.s.
- Maximum track feeder current duration: continuous

7.8. Dimension

The following pantograph dimensions shall be used:

- Overhorn: 1761mm +/- 10mm
- Carbon strip: 1050mm
- Height: horn tip to top of carbon strip (new): 230mm +/- 10mm
- Refer to M03375-04-L

7.9. Vertical Operating Range

The design shall accommodate a pantograph vertical operating range of 3500mm.

7.10. Vertical Operating Force

A static upthrust force of 70N ± 20N shall be used in accordance with EN 50367: 2020+ A1:2022.

7.11. Track Design Tolerances

The following track tolerances shall be used for OHWS design purposes

TOLERANCE TYPES	TOLERANCE VALUES
Gauge	
Nominal	1600mm
Max-Min Tangent Track	+/- 15mm
Max-Min Curved Track	+/- 15mm
Cant	
Max	130mm
Tolerance	+/- 15mm
Track position	
Horizontal alignment	+/- 30mm
Vertical alignment	+/- 20mm

7.12. Gauge Standardisation

Provision shall be made in the design for a change to standard gauge. Changes to the track centreline of up to 82.5 mm shall be factored into the cantilever adjustment. Wherever practicable, this will be undertaken retaining the existing sleeper location and the track centreline will be moved 82.5mm towards the cess.

Where this is not possible, tracks will be slewed and one rail relocated.

7.13. Traction Overhead Conductors

Erection tensions for overhead wires are tabled on drawings LOR-TEC-1031 and LOR-TEC-1032.

The proposed over tensioning parameters for overload and period of application for catenary wire is noted on LOR-TEC-1031.

Where separate electric supply services crossing over the PTS 25 kV railway system, the following shall apply:

- Crossing angle shall be 90° to 45° as this minimises electromagnetic coupling and also reduces the chance of an inter-system breakdown during a lightning strike.
- Clearance of the overhead conductors to the top of the railway structures shall be in accordance with ENA C(b)1-2006.

7.14. Contact Wire

LOCATION OF CONTACT WIRE	WIRE HEIGHT
Open route (nominal at support)	5200mm
Open route (minimum)	4700mm
Open route (absolute minimum)	4600mm
Station platforms (nominal)	5200mm
Station platforms (absolute minimum)	4700mm
Yards & sidings (minimum)	5700mm
Level crossings (minimum)	5700mm

7.14.1. Contact Wire Height

The absolute minimum contact wire height, at any point in a span, under the worst operating conditions shall be 4600mm
The contact wire height measured from the high rail level shall be:

Note: Nominal means the design contact wire height which is to be achieved where possible.

Only where there are constraints shall this be reduced with the approval of the Unit Manager Overhead Engineering.

7.14.2. Contact Wire Pre-SAG

The nominal height of the contact wire at mid-span shall be designed such that it is lower than at the supports to improve the current collection quality.

7.14.3. Gradient of Contact Wire

The height of the contact wire above track level shall be the same at each support.

Where a variation in height is necessary, due to a level crossing or overbridge, the height change shall be achieved with as low a gradient as practical.

The desirable grading for contact wire in relation to rail level shall be 1 in 500.

The contact wire grading must not exceed 1 in 3 times the train speed in kilometres/hour with a maximum grading of 1 in 200.

Where spans at a constant grade meet spans at another constant grade, there shall be a transitional grade for single span at 0.5 the sum of the grades where practical, refer LOR-GEN-1401.

Where there is a reverse in grade a level span shall be installed between the grade changes where practical.

7.14.4. Stagger

The maximum allowable contact wire deviation from the superelevated track centreline at contact wire height at any point in the span shall be 330mm at 5200mm contact wire height and under the worst operating conditions.

The contact wire stagger for each location shall be determined by the following considerations:

- The maximum allowable contact wire deviation shall consider the static position of contact wire, blow off, the effect of stagger change due to temperature, deflection of mast due to wind load, rotation of foundation, and construction tolerance.
- The stagger shall be in accordance with drawing LOR-GEN-1910.
- Generally, the stagger sweep on all the lines shall be as high as possible and shall not be less than 3mm per metre, particularly over large radius track.
- The contact wire stagger shall normally be in increments of 10mm.
- On tangent track, the nominal stagger shall be 230mm.
- On curved track, the nominal stagger shall be 300mm.

7.14.5. Splices

The contact wire shall be continuous. Splicing or jointing of the conductors is not permitted between terminations or between cut-in insulations.

If a contact wire splice is required for staging purposes, it shall be installed in the out of running (OOR) section.

7.14.6. Wire Tension

The contact wire shall be tensioned at 11kN (nominally) to provide a constant tension over the full conductor temperature range. Where spring tensioners are used they shall be set at 11kN (nominally). Where spring tensioners are used in Adelaide Yard they shall be set at 9.81kN. Spring tensioners are the preferred tensioning device.

7.14.7. Tension Length

A tension length is the length of catenary/contact wire between anchor points.

The tension length of catenary/contact wire shall be 1600m (nominally)

The half tension length of catenary/contact wire shall be 800m (nominally)

The maximum number of spans and support structures in a tension length of catenary/contact wire shall be based on 7% tension loss.

7.14.8. Span Length

The span length is directly impacted by the maximum displacement of the contact wire in the span length, which also requires consideration of the:

- blow-off (contact wire displacement at mid-span due to wind on the contact wire)
- track alignment (versine)
- stagger effect (i.e. the effect of equal or unequal staggers at supports)
- mast deflection due to wind loading
- temperature effect (i.e. the effect of stagger change due to temperature variation)
- erection tolerance
- effect of increasing design span lengths by 2m if necessary to suit local conditions as found during construction
- local infrastructure e.g. level crossings, overbridges, stations and viaduct
- wire height

The span length shall be within the range of 55m to 65m.

7.14.9. Wear

The contact wire shall have a permissible cross sectional wear area of 33.33%, as measured by the contact wire thickness.

7.14.10. Safety **Factor**

The contact wire (33.33% worn) shall have a tensile strength safety factor of = 2.0.

7.14.11. Material Specification

The contact wire shall be:

- solid, hard drawn copper, refer to EN50149
- nominal cross section 107mm².

7.15. Catenary Wire

7.15.1. Encumbrance

The nominal encumbrance shall be 900mm.

7.15.2. Splices

Splices in the catenary wire shall be avoided where possible. The maximum number of catenary wire splices is one per tension length, excluding contenery splices.

7.15.3. Material Specification

The catenary wire shall be:

- solid, hard drawn copper 7/3.75mm
- nominal cross section 77.3mm²

7.16. Contenary Wire

Contenary wire is a length of contact wire spliced into the catenary wire to form a solid copper catenary.

Contenary wire shall be provided under bridges and buildings over the line where the catenary wire is less than 1000mm from an object at earth potential.

A contenary splice within a bridge span shall provide a minimum 1000mm clearance from the bridge.

The splice shall be 1500mm from a traction overhead support structure.

The minimum tensile strength factor of safety of the contenary wire shall be = 2.0
Refer to LOR-GEN-1401.

7.17. Aerial Earth wire

The aerial earth wire conductor shall be stranded aluminium or similar material.

The earth wire shall have a cross section area of 157.5mm².

Any other conductor wires performance characteristics shall match or exceed this conductor.

7.17.1. Tension

The earth wire shall be fixed termination. Note: The tension varies with temperature change.

7.18. Optical Power Ground Wire (OPGW)

An OPGW cable is an aerial, metallic & fibre optic cable supported off the traction overhead masts as primary cable bearer for signalling and communication.

OPGW installation design shall comply with the electrical and mechanical clearances with other traction overhead conductors.

The OHWS shall allow for the installation of OPGW cable higher than the OHWS conductors.

At selected masts, the OPGW cable shall be run down to a junction box.

7.19. Return Current (RC) Conductor

The RC conductor shall be stranded aluminium.

The RC conductor shall have a cross section area of 157.5mm².

Where the RC conductor requires insulation it shall be insulated with 1kV PVC sheath (AS 4507: 2006) with low smoke zero halogen used in confined spaces. Refer to LOR-WIR-4006.

At Adelaide Station the RC conductor shall be 240mm² copper with XLPE 3kV insulation.

7.19.1. Tension

The RC conductor shall be fixed termination. Note: The tension varies with temperature change.

7.20. Bond Wire

Bond wires which carry traction current or may carry fault current shall be minimum 157.5mm^2 aluminium or equivalent.

Bond wires which may carry fault current shall be minimum 157.5mm^2 aluminium or 50 mm^2 copper.

Insulation on bond wires shall be 1 kV PVC sheath (refer to AS 4507:2006) low smoke zero halogen insulation used in confined spaces. 25mm^2 copper cables may be used for potential equalising bonds.

7.21. Feeder Wire

Copper conductors shall be used as the 25 kV feeder for cross track feeding purposes.

The current and thermal rating of the feeder wires shall be not less than that for the simple catenary system.

Clearance requirements shall be in accordance with TPI-DOC-000389.

7.22. Dropper Wires

A dropper shall consist of a stranded 7/ 7/ 0.51mm - 10mm^2 – bronze conductor refer to LOR-WIR-5002 and two dropper clamps refer to LOR-FIT-1404, one of which is connected to the contact wire and the other to the catenary wire.

The tensile breaking load of the complete joint shall not be less than 90% of the ultimate tensile strength of the dropper wire.

7.23. Jumper Wires

Jumper wires shall consist of a stranded 19/7/0.71mm - 52.66mm^2 flexible annealed multi-strand copper conductor, refer to LOR-WIR-6001.

The maximum resistance at a compression joint between the flexible annealed copper strands and the electrical connection clamp or lug, and at the contact point between the clamp and the catenary or contact wire, shall be less than the resistance of the conductor of the same length.

The maximum temperature rise at the compression joint and at the contact surface shall not be higher than that of the conductor.

7.24. Potential Jumpers

Potential jumpers are designed to keep the electrical potential of two sections of the traction overhead equipment the same since floating sections are not permitted. They are not designed to carry current. Potential jumpers shall be provided at locations such as the outside of an insulated overlap span.

7.25. Current Jumpers

Current jumpers shall be used to connect two different contact and catenary wires of different tension lengths to ensure electrical continuity.

Current jumpers shall be provided inside an un-insulated overlap span or a turnout.

7.26. Feeding Jumpers

- Feeding jumpers shall be used to connect trackside isolators to catenary/contact wires.

- The connection to the contact wire shall be carried out at the out-of-running portions.

- Where this is not practical, the electrical connector must be designed such that the system dynamic performance is unaffected.

7.27. Electrical Connectors

The clamps for jumpers shall be full current carrying.

Where a jumper is required to be terminated on an isolator terminating plate and other similar applications, crimped type lugs shall be used.

7.28. Stranded Stainless Steel Wire

Stranded stainless steel wire shall be cold drawn grade 304 or grade 316.

Greased stainless steel wire shall be used to reduce the risk of crevice corrosion effects exacerbated by salt and fatigue loadings.

7.29. Mast

7.29.1. Mast Types

All new masts on the AMPRN shall be galvanised steel in accordance with AS4100.

Note: Concrete masts have been used on the AMPRN.

7.29.2. Mast Design Loadings

Permanent actions for use in designing OHWS structures shall be in accordance with AS/NZS 1170.1.The following OHWS equipment loadings shall be considered as permanent actions:

- static weight load
- radial load
- tension of conductors
- balanced weight stack load
- wind loading
- spring tensioner device load
- anti-climbing provisions shall be provided as required to equipment within public / high trespass areas.
- anti-climbing provisions shall be provided on easily climbed structures eg. MPC structures and OPGW drop down structures

- height shall allow for 200mm of vertical adjustment of cantilever equipment mounted off the mast.
- allowance for independent cantilever registration.
- ability to support auxiliary cables

Imposed actions for use in the design of traction overhead system structures shall be a concentrated load of 1.07 kN imposed by a maintenance load applied on each run of wire attached to the structure such that this load shall be assumed to be borne by the structure and not shared by adjacent structures. Imposed actions for use in the design of OHW support structures shall include wind loading.

The mast loading calculation shall be carried out under the following conditions:

- The wind speed for loading calculation for material strength of the overhead wiring mast under the maximum wind speed.
- Drag factors shall be applied in the calculations in order to allow for the effects on the wind loading of shape and size of each element.

7.29.3. Structural Deflection Limits

Lateral deflection of the overhead wiring structure shall be limited to 50mm at the contact wire height due to wind loading under the worst operating condition. This shall not include any permanent deflection.

The following deflection limits shall not be exceeded:

STRUCTURAL DEFLECTION	DEFLECTION LIMITS
Portals	
Maximum vertical deflection (mm)	span / 250
Maximum horizontal deflection (in and out of plane) (mm)	height /100
Cantilever Masts	
Maximum vertical deflection (mm)	length / 75 (+ve)
Maximum vertical deflection (mm)	length / 500 (-ve)
Maximum horizontal deflection (in and out of plane) (mm)	height /100
Drop Verticals	
Maximum vertical deflection (mm)	not applicable
Maximum horizontal deflection (in and out of plane) (mm)	height/75

7.30. Welding of Steel Masts

The design of welded joints and connections, and the fabrication of welded steel parts, shall conform to the requirements of AS 1554.1.

7.31. Cantilever

Galvanised steel tubes shall be used for the cantilever, registration tubes and steady arm.

All insulators to be used for the cantilever assemblies shall be of the solid core porcelain type or polymetric equivalent.

Where required, wind stays shall be fitted to the steady arm to counteract any reversal of radial load by wind and to avoid excessive movement of the steady arm. Wind stays shall be designed to minimise fatigue failure due to uplift of the registration arm.

The support and registration assemblies shall have a minimum safety factor of 2.5 under the worst operating conditions.

Design of the cantilevers shall allow ± 300mm adjustment range of catenary and contact wire across track. Note: the -300mm is achieved by cutting of the strut tube.

The bottom end of inclined or vertical tubes shall be left open, or other provisions shall be made if fittings are attached, to ensure that any moisture that does enter the tubes will not accumulate.

7.32. Fasteners

The design of all components shall be such that, when completely assembled within the traction overhead equipment, all bolt heads and nuts are readily accessible by means of ordinary open-ended or ring spanners during maintenance, inspection and repair.

This shall include the method of torqueing and type of tools to be used to avoid static friction effects by gradual torqueing and possible galvanizing damage due to the indiscriminate use of impact wrenches.

Copper alloy fastenings shall be the only fastener type used for current carrying clamps on copper conductors.

Non copper conductors shall have suitable clamps designed to minimize dissimilar metal corrosion. In current carrying clamps the clearance between the holes and through bolts shall not exceed 1mm.

7.33. Tensioning Equipment

The automatic tensioning shall be achieved by balance weight anchor (BWA) giving a mechanical advantage of 3.0 and an efficiency of not less than 97% over the operating range or spring tensioner. A spring tensioner is the preferred mechanism.

The balance weight anchors shall be equipped with a guide tube to ensure that they will not move sideways and infringe the structural gauge.

The balance weight assembly rope shall be a flexible stranded stainless steel wire that shall not kink or twist as it goes through the pulley under tension and the balance weight assembly rope shall not become loose under any operating conditions.

Where BWA are employed at both ends of a tension length, the catenary shall be anchored (midpoint anchor) approximately half way between the BWAs.

The midpoint anchor arrangement shall withstand the full tension load of the catenary wire plus 50% tension load of the contact wire under wire breakage conditions.

7.34. Automatic Power Control (APC) Magnets

The APC magnets shall be located to trip and reclose EMU circuit breakers before entering and after leaving the Neutral Sections.

The APC magnets shall be mounted on the sleepers using 'Vortok' rail clips or equivalent at a height which enables the EMU detection equipment to operate the EMU circuit breaker.

The APC magnets shall be adjustable in position, able to be removed readily for major track works and shall be supplied complete with a flux density tester.

A total of 4 APC magnets shall be supplied and fitted per Neutral section per main track.

7.35. Isolators and Electrical Sectioning Equipment

Isolator switches shall be non-load break rotary side break type switches.

Isolator switches shall be manually operated.

Section insulators shall be suitable for passage of pantographs operating at the applicable line speed.

Neutral section insulators shall be suitable for passage of pantographs operating at the applicable line speed.

8. Mast Foundations

Mast foundations shall be designed to accommodate the structural requirements detailed in clause 7.2.

8.1. Bolted Base

Holding down bolts shall be positioned such that a mast can be installed with a clearance fit.

The base plate of bolted masts shall be grouted.

The mast foundations for bolted masts / portals shall have galvanized cast-in holding down bolts.

9. Drilling

All the OHWS equipment shall be clamped to the traction overhead system structures such as drop verticals and masts.

No drilling of prestressed concrete masts shall be permitted.

Where drilling of steel masts are required appropriate protection of the cut metal shall be made in accordance with galvanised coating requirements.

10. Drop Verticals

Drop verticals shall be installed on portal or two-track cantilever beams to support traction overhead equipment.

Drop verticals shall be single or have the ability to mount twin cantilevers via a twin drop vertical arrangement.

11. HV Cables

HV cables from booster transformers (BT) and the emergency supply transformers (EST) to the traction overhead shall be 300mm² XLPE insulated.

12. Signage

Signage shall be installed in accordance with the 25kV Electrified Area Signage Specification G53-SPE-TR-319.

13. Bibliography

- LOR-GEN-2001: General arrangement of boom attachments (Knet: 9410506)