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Standard governance

**Owner:** Lead Electrical Engineer, Asset Standards Authority  
**Authoriser:** Chief Engineer, Asset Standards Authority  
**Approver:** Executive Director, Asset Standards Authority on behalf of the ASA Configuration Control Board

**Document history**

<table>
<thead>
<tr>
<th>Version</th>
<th>Summary of changes</th>
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<td>1.0</td>
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Preface

The Asset Standards Authority (ASA) is a key strategic branch of Transport for NSW (TfNSW). As the network design and standards authority for NSW Transport Assets, as specified in the ASA Charter, the ASA identifies, selects, develops, publishes, maintains and controls a suite of requirements documents on behalf of TfNSW, the asset owner.

The ASA deploys TfNSW requirements for asset and safety assurance by creating and managing TfNSW’s governance models, documents and processes. To achieve this, the ASA focuses on four primary tasks:

- publishing and managing TfNSW’s process and requirements documents including TfNSW plans, standards, manuals and guides
- deploying TfNSW’s Authorised Engineering Organisation (AEO) framework
- continuously improving TfNSW’s Asset Management Framework
- collaborating with the Transport cluster and industry through open engagement

The AEO framework authorises engineering organisations to supply and provide asset related products and services to TfNSW. It works to assure the safety, quality and fitness for purpose of those products and services over the asset’s whole-of-life. AEOs are expected to demonstrate how they have applied the requirements of ASA documents, including TfNSW plans, standards and guides, when delivering assets and related services for TfNSW.

Compliance with ASA requirements by itself is not sufficient to ensure satisfactory outcomes for NSW Transport Assets. The ASA expects that professional judgement be used by competent personnel when using ASA requirements to produce those outcomes.

About this document

This document sets out the requirements for design and construction of 1500 V dc overhead wiring for new installations, and for the major rehabilitation of existing infrastructure.

This standard supersedes the RailCorp standard EP 08 00 00 01 SP Overhead Wiring Standards for the Electrification of New Routes, version 3.1.

The changes to previous content include:

- updates to reflect organisation changes and resulting changes in responsibilities
- incorporation of technical notes TN 008: 2013 and TN 052: 2014, and clarification to content
- conversion of the standard to ASA numbering, format and style

This standard is a first issue.
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1. **Introduction**

Overhead wiring (OHW) is used to transmit power from traction substations to electric trains. OHW generally consists of catenary and contact wires. The contact wire provides a mechanically continuous path for train pantographs and the catenary wire is used to support the contact wire. The traction current to the trains is carried by both the catenary and contact wires.

2. **Purpose**

The purpose of this document is set out the requirements for the design and construction of 1500 V dc OHW.

2.1. **Scope**

This document sets out the requirements for design and construction of 1500 V dc overhead wiring for new installations, and for major rehabilitation of existing infrastructure.

This document describes 1500 V dc OHW where maximum rolling stock outline is 4.42 m high.

This document sets out the interface requirements between OHW and civil structures, such as bridges and OHW structures; however it does not cover the design and construction requirements of these civil assets.

2.2. **Application**

This standard applies to the 1500 V dc OHW in the TfNSW metropolitan heavy rail network.

This standard is applicable to all new OHW installations and major rehabilitation of existing OHW.

A different set of requirements apply to the adjustment of existing OHW when the track under existing OHW is moved. These requirements are described in Appendix B.

3. **Reference documents**

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

**Australian standards**

AS 1154.3 Insulator and conductor fittings for overhead lines Part 3: Performance and general requirements for helical fittings

AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

**Transport for NSW standards**

EP 00 00 00 13 SP Electric Power Equipment – Design Ranges of Ambient Conditions
EP 08 00 00 10 SP Overhead Wiring Layouts – Requirements and Symbology
EP 08 00 00 19 SP Performance Specification for Overhead Wiring Post Insulator Units
EP 08 00 00 20 SP Performance Specification for Overhead Wiring String Insulator Set
EP 08 00 00 24 SP Contact Wire
EP 12 10 00 21 SP Low Voltage Installations Earthing
EP 12 20 00 01 SP Bonding of Overhead Wiring Structures to Rail
ESC 210 Track Geometry and Stability
ESC 215 Transit Space
ESC 250 Turnouts and Special Trackwork
ESC 310 Underbridges
SPG 0706 Installation of Trackside Equipment
SPG 1210 Signalling Signs and Instruction Plates
T HR CI 12040 ST Overhead Wiring Structures and Signal Gantries
T HR CI 12160 ST Boundary Fences
T HR EL 08001 ST Safety Screens and Barriers for 1500 V OHW Equipment
T HR EL 08002 ST Relative Positions of Signals and Open Overlaps
T HR EL 08003 ST Level Crossings – OHW Requirements
T HR EL 08004 ST Overhead Wiring Fittings and Materials
T HR EL 08005 ST Labels for OHW Structures
T HR EL 08009 ST Designations of Overhead Wiring Conductor Systems
T HR EL 08010 ST Overhead Wiring Conductor System Selection
T HR EL 08011 ST Overhead Wiring Maintenance Standard
T HR EL 10005 ST Requirements for Electric Aerials Crossing RailCorp Infrastructure
T HR EL 12002 GU Electrolysis from Stray DC Current
T HR RS 00850 ST RSU Appendix E – Rolling Stock 1500 V dc Overhead Power Supply Interface Requirements
T MU MD 00006 ST Engineering Drawings and CAD Requirements
TN 061:2016 Change authorisation process for proposed electrical operating diagrams
TfNSW drawings

CV 0131343 Standard Pantograph Profiles – Suburban / Interurban and Locomotive Rolling Stock

EL 0001110 General – Railways Overhead Wiring – Twin Contact – Short Bay Overlap – Arrangement

EL 0002017 Railways Overhead Wiring – Contact Splice

EL 0002963 Railway Overhead Wiring – Bonding Arrangement for Isolated Masts

EL 0003384 to EL 0003394 Railways Overhead Wiring – Mark 2 Cantilever – Twin Catenary Twin Contact – Standard Arrangement Sheet 1-11

EL 0003440 Railways Overhead Wiring – Mark 2 Cantilever – Twin Catenary Twin Contact – Data Sheet

EL 0003445 Railways Overhead Wiring – Mark 2 Cantilever – Twin Catenary Twin Contact – Jumpered Overlap Arrangement Sheet 1

EL 0003482 Railways Overhead Wiring – Catenary to Contact Feeder – Spacing Chart for Single Cont. "Heavy Current" Lines

EL 0003512 Railways Overhead Wiring – Mark 2 Cantilever – Multi Track Regulated System – Fixed – Mid Point Arrangement Sheet 1

EL 0004637 Railways Overhead Wiring – Overlap Jumpering & Additional In Span Feeder Arrangement Sheet 1

EL 0004638 Railways Overhead Wiring – Overlap Jumpering & Additional In Span Feeder Arrangement Sheet 2

EL 0004851 Railways Overhead Wiring – Spark Gap Label

EL 0006026 Railway Overhead Wiring – Supports for Auxiliary Feeder Sheet 1

EL 0006027 Railway Overhead Wiring – Supports for Auxiliary Feeder Sheet 2

EL 0006173 to EL 0006183 Railways Overhead Wiring – Mark 2 Cantilever – Single Catenary / Single Contact – Standard Arrangement Sheet 1-11

EL 0006282 to EL 0006284 Railway Overhead Wiring – Mark 2 Cantilever – T/W = 550 m – Mid Point Anchor Arrangement Sheet 1-3

EL 0006416 to EL 0006418 Railways Overhead Wiring – Mark 2 Single Contact Cantilever Construction – Jumpered Overlap arrangement Sheet 1-3

EL 0006421 to EL 0006424 Railways Overhead Wiring – Mark 2 Cantilever Construction – Pantograph Security Description Sheet 1-4

EL 0006542 Railways Overhead Wiring – Mark 2 Cantilever – Twin Catenary Twin Contact – Jumpered Overlap Arrangement Sheet 2
EL 0006632 Railways Overhead Wiring – Mark 2 Cantilever – Twin Catenary Twin Contact – Jumpered Overlap Arrangement Sheet 3

EL 0006697 to EL 0006699 Railways Overhead Wiring – Regulated 270mm² HDCu 30kN Caty – 2 x (137mm² HDCu 12.5kN Cont) – Cantilever Construction – Jumpered Overlap Arrangement Sheet 1-3

EL 0007802 Railways Overhead Wiring – Catenary to Contact Feeder – Spacing Chart for Single Caty. Twin Cont. Systems

EL 0007855 Railways Overhead Wiring – Jack Arch Bridges – Typical Bonding Arrangement

EL 0008074 to EL 0008076 Railways Overhead Wiring – Typical Airgap Feeding Arrangement – Wiring System 270mm² Catenary 2x137mm² Contact Sheet 1-3

EL 0009255 to EL 0009256 Railways Overhead Wiring – Waterfall to Port Kembla – Cantilever Construction – Mid Point Anchor Arrangement Sheet 1-2

EL 0009386 Railways Overhead Wiring – 270 mm Caty & 2x137 mm Cont – Regulated Tension – Data Sheet

EL 0009447 Railways Overhead Wiring – Single Catenary Twin Contact – Regulated Tension System – Dropper Spacing Tabulation

EL 0011619 Turramurra – North Shore Line – 21.289km – Railways Overhead Wiring – Feeding Location at MH21+289 – Feeding Arrangement

EL 0011739 Railways Overhead Wiring – Catenary to Contact Feeder – Typical Spacing Chart for Twin Caty. Twin Cont. Systems

EL 0011875 Railways Overhead Wiring – Bonding of Mast to Rail Arrangement Sheet 3

EL 0011878 Railways Overhead Wiring – Cable Feeding - Arrangement

EL 0011957 Railways Overhead Wiring – Tension Regulator Weight

EL 0012047 Railways Overhead Wiring – Mark 2 Cantilever – Multi Track Regulated System – Fixed Mid-Point Arrangement Sheet 2

EL 0012318 Railway Overhead Wiring – Overline Bridges – Catenary Roller Support – Clamp Assembly for Angles

EL 0013060 Railways Overhead Wiring – Dropper Spacing Chart for Regulated Tension System

EL 0018535 Railways Overhead Wiring – Catenary Stop – Assembly

EL 0018769 Railways Overhead Wiring – Liverpool to Glenlee – Constant Tension – Crossed Contacts Sliding Knuckle

EL 0024221 Railways Overhead Wiring – Catenary to Contact Feeder – 91/1.12 HD Copper Horizontal Loop – Arrangement
EL 0026361 Sydenham to Marrickville – Up & Dn Bankstown Line 5.95km (Approx.) – Railways Overhead Wiring – Switched Overlap at Location B5+942 – Switching arrangement – As Built

EL 0026992 General – Railways Overhead Wiring – Contact Wire Wear Strip - Arrangement

EL 0027000 General – Railways Overhead Wiring – Twin Contact Sliding Knuckle - Arrangement

EL 0027472 General – Railways Overhead Wiring – Catenary Feeding Loop – Arrangement

EL 0030508 General – Railways Overhead Wiring – Type 6 Section Insulator – Support – Arrangement – For Single Catenary

EL 0052290 Railways Overhead Wiring – Type 6 S.I. (Switched) in Compound OHW – Arrangement

EL 0057425 General – Railways Overhead Wiring – 1500V Isol / Rail Connecting Sw – Mast Mount – Arrangement – Left Hand Version

EL 0065499 Yennora – Old South Line 27+986km – Railways Overhead Wiring – Yennora Substation at G27+986 – Feeding Arrangement and Trackside Negative Bus


EL 0150615 Railways Overhead Wiring – Equipotential Mat for Switch Arrangement

EL 0159278 Central to Redfern – Central Flyover Tracks – 0.4km Approx. – Railways Overhead Wiring – Insulated Knuckle at SW0+378 – Installation Details - Proposal

EL 0161611 Goulburn St to Redfern – All Tracks – Railways Overhead Wiring – Stage "G" OHW Upgrade – Tension Length Diagram – Proposal

EL 0166574 Eveleigh – Millenium Train Servicing Facility – Railways Overhead Wiring – Skid – Termination Arrangement

EL 0166884 General – Railways Overhead Wiring – Type 6 Section Insulator – Body - Arrangement

EL 0166885 General – Railways Overhead Wiring – Fixed Anchor on Free Standing Mast - Arrangement


EL 0215038 General – Railways Overhead Wiring – Moving Anchor – Twin Catenary / Twin Contact – Standard Arrangement

EL 0215130 Railways Overhead Wiring – Mark 2 Cantilever – Twin Mast Regulator Assembly – Standard Arrangement

EL 0232899 General – Railways Overhead Wiring – Short Dropper – Single Contact - Arrangement

EL 0232901 General – Railways Overhead Wiring – Short Dropper – Twin Contact – Arrangement

EL 0232991 Strathfield Junction – Main West Line – 11.6km Approx. – Railways Overhead Wiring – Location MS 11+647 – Switching Arrangement – For Construction


EL 0237888 to EL 0237889 Strathfield – Main West Line – 11.976km (Approx.) – Railways Overhead Wiring – Location MS 11+976 – Switching Arrangement Sheet 1-2


EL 0282942 to EL 0282945 North Sydney – North Shore Line 5.00km Approx. – Railways Overhead Wiring – 7 Switch Bank at Location NS4+986 – Switch Arrangement Sheet 1-4

EL 0287236 General – Railways Overhead Wiring – Cable to Aerial Termination on Post Insul. – Arrangement – For 3 or 4 Cables

EL 0450662 General – Railways Overhead Wiring – Guide Rod Support Bracket on Mast – Arrangement

EL 0455574 General – Railways Overhead Wiring – Switched Overlap on PP Masts – Switching Arrangement

EL 0474288 General – Railways Overhead Wiring – 2x165mm² Catenary / 2x137mm² Contact – Spacing Chart / Data Sheet

EL 0474340 General – Railways Overhead Wiring – Standard Dropper – Twin Contact – Arrangement

EL 0475858 General – Railways Overhead Wiring – Type 1 & 2 Single Contact Pull-off – Standard Arrangement

EL 0475859 General – Railways Overhead Wiring – Type 3 Single Contact Pull-off – Standard Arrangement

EL 0475865 General – Railways Overhead Wiring – Type 1 & 2 Twin Contact Pull-off – Standard Arrangement

EL 0475866 General – Railways Overhead Wiring – Type 3 Twin Contact Pull-off – Standard Arrangement

EL 0475906 General – Railways Overhead Wiring – Cable to Aerial Termination on Post Insl. - Arrangement

EL 0491331 General – Railways Overhead Wiring – 1500V Switch Operator Platform – Arrangement

EL 0583866 General – Railways Overhead Wiring – Connection to Rail with Steel Bonding Cable – Arrangement

Other reference documents

EDI004 OHW Standard Arrangements for New Electrification

EDI005 OHW Fittings for New Electrification

EDI006 OHW Data for New Electrification

EDI007 OHW Computer Program Register

PR-D-78000 Electrical Network Safety Rules
4. **Terms and definitions**

The following terms and definitions apply in this document:

- **AEO** Authorised Engineering Organisation
- **ASA** Asset Standards Authority
- **RailCorp** the NSW Government's asset holding entity for the metropolitan heavy rail network assets; RailCorp infrastructure includes rail infrastructure associated with the metropolitan heavy rail network and excludes rail infrastructure that belong to the Sydney metro and light rail networks.
- **OHW** overhead wiring
- **TfNSW** Transport for New South Wales

5. **Modification to existing OHW**

Where existing overhead wiring is to be modified, the design and construction of the modification shall be such that the resultant OHW configuration shall comply with this document. Where it is not practical to do so, the designer shall list all noncompliances and the proposed design approach to mitigate the risks associated with each of the listed noncompliances. Acceptance of the mitigation measures by the relevant authority of the maintenance AEO is required prior to the commencement of detailed design. A concession is not required for the noncompliances when the associated mitigation measures are accepted by the relevant authority of the maintenance AEO. In establishing the noncompliance list, the aspects to be included shall include, but not limited to, the following:

- relative positions of signals and open overlaps
- pantograph security
- electrical and mechanical clearances
- proximity of OHW to existing or proposed signals
- clearance of OHW and OHW structures to high voltage and low voltage aerial lines, and other overhead lines
- contact wire gradient
- OHW layouts and symbology
- bonding of overhead wiring structures
- safety screens and barriers
- services erected above overhead wiring
See Appendix B for the requirements that are applicable to modifications, which consist only of adjustment of existing OHW to suit the track movement under existing OHW.

6. **OHW design documentation**

Before any OHW can be built, a complete and signed off OHW design documentation shall be available for the constructors to build from.

The project may also require one or more staging designs to be produced that lead up to the final design, to suit construction requirements. These would normally be done in consultation with the construction staff.

The design drawings shall have sufficient and clear details.

All calculations shall be checked and recorded. Refer to EDI007 *OHW Computer Program Register* for programs that may be used for design calculations. Design AEOs are responsible for the correctness of the application and the outputs of the programs.

All calculation records shall be provided to the maintenance AEO as part of the asset handover.

6.1. **OHW design drawing set**

A typical OHW design requires the types of design drawings described in Section 6.1.1 to Section 6.1.8.

OHW design drawings shall comply with T MU MD 00006 ST *Engineering Drawings and CAD Requirements*.

Refer to EDI004 *OHW Standard Arrangements for New Electrification*, EDI005 *OHW Fittings for New Electrification* and EDI006 *OHW Data for New Electrification* for examples, reference drawings and data.

6.1.1. **Proposed electrical sectioning diagram**

The proposed electrical sectioning diagram shall be developed and approved in accordance with TN 061:2016 *Change authorisation process for proposed electrical operating diagrams*.

The proposed electrical sectioning diagram shall be signed off by key stakeholders, at the concept design stage, so that subsequent fundamental changes are avoided or at least minimised with better control.
6.1.2. **Tension length diagram**

For each new project a proposed tension length diagram should be prepared, and this is expected at the concept design stage of the project.

The diagram shows a number of things for each OHW run, including:

- proposed location of all moving, fixed and fixed mid-point anchors
- OHW conductor system details for every run (catenary and contact size, tension and standard heights)
- all conductor tension lengths (from moving to fixed anchor or fixed mid-point)
- ideally the tension loss percentage amount can be shown at the moving anchor for each tension length to confirm suitability of the proposed conductor run length
- all instances and extent of auxiliary feeders, including configuration information such as conductor size, standard tension at temperature, and so on

A tension length diagram example is shown on EL 0161611. For complex OHW projects with multiple tracks, adopting a different colour scheme for each run can aid with subsequent construction of the OHW if the same corresponding colour is used on other products including the OHW layouts, cross sections and so on. This helps in understanding the threading of the wire runs where several OHW runs come together and disperse.

6.1.3. **OHW layouts**

OHW layouts are a fundamental map into the rest of the OHW design.

OHW layouts shall be developed on CAD in accordance with EP 08 00 00 10 SP *Overhead Wiring Layouts – Requirements and Symbology*.

6.1.4. **OHW profiles**

Profiles shall be drawn whenever electrical clearances are reduced, to confirm that the design will attain suitable electrical clearances to buildings and other obstructions.

They should be drawn at a scale of 1:50 - vertically and 1:500 - horizontally and placed on separate drawings, unless there is sufficient space on the corresponding OHW layout without overcrowding the layout drawing.

The clearance information shall be used by construction staff when the wire is run, to measure and confirm that the critical clearances have not been infringed. These clearances shall be documented for hand-over to the asset owner.
6.1.5. **OHW cross-sections**

The cross-section drawings are typically drawn at a scale of 1:50 or 1:100 for showing detail, and are required in the following situations:

- whenever the standard cantilever coding cannot fully describe the proposed support and registration arrangement, this additional drawing detail is required so that it can be built
- where a special relationship exists between two or more support and registration arrangements at a location, such as relative stagger clearances between catenaries, and the cross-section drawing shows how this is to be achieved (and it confirms the design will work)
- sometimes where over-run protection is required

6.1.6. **Non-standard anchor arrangements**

A non-standard anchor arrangement shall include the standard arrangement drawing number reference and the details of changes to it.

6.1.7. **Switching and feeding arrangements**

Each instance of switching and feeding to the OHW shall have a drawing showing how this is to be achieved, unless a standard arrangement exists that shows exactly how to switch and feed at a particular location.

These drawings would typically include an electrical schematic diagram to help understand the electrical requirements at a glance.

6.1.8. **Bonding arrangements**

Bonding arrangement drawings shall be developed to show how the bonding policy is to be implemented in identified risk areas, including stations, air-space developments, overline bridges (if OHW is attached or horizontal safety screens are installed), viaducts, tunnels, and so on.

The bonding aims to address electrical protection (traction return), electrolysis corrosion and safety issues.

See Section 6.2.9 for bonding schedules requirements.

6.2. **Other OHW design information**

The documents described in Section 6.2.1 to Section 6.2.11 are typically required to fully document the design and allow it to be constructed.
6.2.1. Support and registration information

CCalcs and Pull-Off Calcs are required to be given to construction staff in complete wire runs, so that they can use the information (in conjunction with any relevant cross-section drawings) to construct the various support and registration arrangements to hold the OHW up.

TCalc’s are used for constructing certain tunnel cantilever arrangements.

Refer to RailCorp computer programs 'CCALC.exe', 'PO-Calc.xlt' and 'TCalc.xlt' (user manual is available for CCALC).

6.2.2. Dropper calculations

Dropper calculations shall be done for every bay in the OHW run, and passed onto construction staff.

Refer to RailCorp computer program 'RegDrop.exe'.

6.2.3. MinCont calculations

For fixed-anchored OHW, the minimum contact wire height in a bay at the highest design conductor temperature may be calculated by using RailCorp computer program 'MinCont.xlt'.

6.2.4. Loading diagrams

The loading diagrams document the proposed maximum loads to be applied to a new OHW structure, which along with any other relevant configuration information such as structure height above rail, number of tracks spanned, and so on, can then be used to determine the structure’s steel size and shape during its subsequent design.

Refer to RailCorp computer program 'Load-Dgm.xlt' (user manual is available).

6.2.5. Drop vertical length and position tables

RailCorp computer program DV_Position.xlt may be used to determine and document drop vertical lengths and positions for all drop verticals on an OHW structure (user manual is available).

6.2.6. Overlap design details

Preference should be given to designing a short bay overlap as shown in drawing EL 0001110.

In conjunction with the above arrangement drawing, use RailCorp computer program 'Overlap.xlt' to design suitable staggers and conductor heights, which are then to be documented on the relevant OHW layout drawing (user manual is available).
6.2.7. Non-standard support and registration construction schedules

Construction schedules, using spreadsheets, showing complete construction details, may need to be developed to allow construction staff to build all non-standard support and registration arrangements. This would normally also require reference to corresponding OHW cross-section drawings or other standard arrangement drawings.

6.2.8. Temperature and tension charts

When a design calls up an OHW conductor system that is not listed in T HR EL 08009 ST Designations of Overhead Wiring Conductor Systems, a set of temperature and tension charts shall be developed for both unloaded and loaded catenary situation. This may instead take the form of temperature and tension tables for the expected design temperature range.

6.2.9. Bonding schedules

A schedule shall be developed that identifies the OHW structures that are to be bonded, including specific location (for example, down leg of portal).

This information shall be shown on the OHW layout drawing, or a separate drawing referenced on the layout.

This information is provided to the signalling section for inclusion on the track insulation plan for the area, and they make the physical bond connection to track.

6.2.10. Pantograph gauge clearance checks

As part of the OHW design, clearance checks may need to be done to confirm that certain objects do not collide with the train’s pantograph such as pull-offs from station awnings, drop verticals located close to track, and so on. This information should be documented as part of the design.

Refer to RailCorp 'PanGauge.xlt' spreadsheet program which can be used to confirm suitable clearances to surrounding objects.

6.2.11. Survey data

Survey is normally required for certain aspects of the OHW design, including:

- survey of overline bridges and tunnels, to determine clearances when developing appropriate support and registration arrangements
- survey of as-built OHW structures, for subsequent processing by CCcalc
The information picked up by survey is in the form of distances and reduced levels (RL’s), and typically includes:

- design track position and superelevation
- reference nail in mast to design centreline of track (horizontal and vertical)
- track centreline to bottom of drop vertical (horizontal and vertical)
- reference nail to under-side of portal bridge
- height to overline bridge beams and so on from design rail level
- other information as detailed by OHW designer

7. General aspects of OHW system

The requirements for general aspects of OHW system is provided in Table 1.

<table>
<thead>
<tr>
<th>General aspects</th>
<th>Requirement</th>
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<tbody>
<tr>
<td>Safe working clearances</td>
<td>Refer to electrical system safe operation standards and PR-D-78000 Electrical Network Safety Rules for safe working clearances.</td>
</tr>
<tr>
<td>Standard OHW configuration</td>
<td>The standard OHW configuration is a regulated system 2 with a contact height of 5.0 m. Refer to T HR EL 08009 ST.</td>
</tr>
<tr>
<td>Train speed</td>
<td>The OHW shall have a design speed of not less than the minimum design speed for other systems, for example, track, signalling.</td>
</tr>
<tr>
<td>Pantograph configuration (Number of pans)</td>
<td>Refer to T HR EL 08010 ST Overhead Wiring Conductor System Selection for acceptable pantograph configurations on various OHW Systems.</td>
</tr>
<tr>
<td>Pantograph pressure – static</td>
<td>80 N to 130 N. Refer to T HR RS 00850 ST RSU Appendix E – Rolling stock 1500 V dc Overhead Power Supply Interface Requirements.</td>
</tr>
<tr>
<td>Additional pantograph pressure at speed</td>
<td>&lt; 60 N additional uplift force (at any speed of the train up to160 km/h and subject to any non-train generated winds up to 100 km/h). Refer to T HR RS 00850 ST.</td>
</tr>
<tr>
<td>Pantograph movement – dynamic lateral</td>
<td>381 mm at 5.2 m contact height, comprising:</td>
</tr>
<tr>
<td></td>
<td>• 80 mm lateral bogie movement</td>
</tr>
<tr>
<td></td>
<td>• 2° body roll</td>
</tr>
<tr>
<td></td>
<td>• 50 mm lateral track deviation from design*</td>
</tr>
<tr>
<td></td>
<td>• 25 mm deviation of superelevation from design*</td>
</tr>
<tr>
<td></td>
<td>(*specified in ESC 210 Track Geometry and Stability)</td>
</tr>
<tr>
<td>Pantograph clearances to OHW equipment and structures</td>
<td>Use RailCorp computer program 'PanGauge.xlt' to ensure suitable clearances from 'raised and oscillated' envelope and 'electrical clearance' envelope, as appropriate (user manual is available).</td>
</tr>
</tbody>
</table>
### General aspects

<table>
<thead>
<tr>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety factors on materials</td>
</tr>
<tr>
<td>Provision for portable rail connections</td>
</tr>
<tr>
<td>Electrolysis mitigation</td>
</tr>
<tr>
<td>Rail level - definition</td>
</tr>
<tr>
<td>Mean rail level - definition</td>
</tr>
</tbody>
</table>

### 7.1. Electrical aspects

The requirements for the electrical aspects are provided in Table 2.

**Table 2 – General electrical aspects requirements**

<table>
<thead>
<tr>
<th>Electrical aspects</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical insulation</td>
<td>The principle of grading insulation shall apply to the OHW insulators. Catenary and contact terminations shall have the greatest insulation level, and the insulation level of the catenary suspension shall be greater than or equal to that of the contact registration.</td>
</tr>
<tr>
<td>Insulators</td>
<td>Refer to EP 08 00 00 19 SP Performance Specification for Overhead Wiring Post Insulator Units and EP 08 00 00 20 SP Performance Specification for Overhead Wiring String Insulator Set.</td>
</tr>
<tr>
<td>Orientation of disc insulators for termination</td>
<td>Porcelain disc insulators shall be installed with clevis on the live side, except in special circumstances (with approval from the Lead Electrical Engineer, ASA). This orientation minimises the effect of electrolytic corrosion.</td>
</tr>
<tr>
<td>Orientation of disc insulators for catenary suspension</td>
<td>Porcelain disc insulators shall be installed with tongues on the live side (ideally the clevis should be on the live side to reduce electrolytic corrosion, but the greater requirement for this insulator is that the insulator skirt should not collect water).</td>
</tr>
<tr>
<td>Orientation of disc insulators for contact registration</td>
<td>Porcelain disc insulators shall be installed with clevis on the live side.</td>
</tr>
</tbody>
</table>
Electrical potentials

Except for overhead wiring adjacent to skid arrangements at the entrance of maintenance centres, neutral (floating) sections of wire are not permitted. Sections of OHW should be at live wire potential or structure support potential.

Electrical loading

All electrical sections shall be capable of transmitting the full maximum load current and short duration fault current.

Insulation level of auxiliary feeders

To be the same as for catenary suspension and catenary termination.

New OHW under existing HV aerial crossings

Refer to T HR EL 10005 ST Requirements for Electric Aerials Crossing RailCorp Infrastructure for requirements.

Electrical connections

All bolted, crimped or preformed wrap on fittings shall be capable of conducting the sustained normal maximum current capacity of the conductor and short duration fault current of the system without any detrimental effects.

### 7.2. Materials

Refer to T HR EL 08004 ST for materials requirements.

### 7.3. General corrosion protection

Refer to T HR EL 08004 ST for general corrosion protection requirements.

### 7.4. Testing OHW

Tests that are required to be performed on OHW when commissioning OHW, prior to being placed in service, are provided in Table 3.

#### Table 3 – Tests on OHW

<table>
<thead>
<tr>
<th>Tests</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical continuity</td>
<td>A heavy current (50 A), low voltage test shall be performed that ensures that there are no electrical discontinuities or high resistance joints from the beginning to the end of each electrical section, and back through the rails.</td>
</tr>
<tr>
<td>Electrical insulation (2 kV)</td>
<td>With feeder cables, surge arresters, rail connections and earths disconnected, a 2 kV test voltage shall be applied to the OHW for one minute and the insulation resistance recorded. Resistance value shall be greater than 100 kΩ divided by the length of the overhead wiring (in km) being tested.</td>
</tr>
<tr>
<td>High potential test (6 kV)</td>
<td>With feeder cables, surge arresters, rail connections and earths disconnected, 6 kV dc shall be applied to the OHW for five minutes. The leakage current shall be less than 1 mA per km of single track OHW. This test is applicable for overhead wiring construction over new routes only.</td>
</tr>
</tbody>
</table>
8. OHW conductors

This section outlines the requirements for catenary, contact, droppers, in-span feeders, contact full splices, sliding knuckles, pennant insulators, catenary splices and feeder or potential jumpers used in the OHW of the TfNSW metropolitan heavy rail network.

The requirements for OHW conductor and associated fittings are provided in Table 4.

Table 4 – Requirements for OHW conductors and associated fittings

<table>
<thead>
<tr>
<th>OHW conductor aspects</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catenary and contact</td>
<td>The OHW shall be of the straight chord design between suspension and</td>
</tr>
<tr>
<td>alignment</td>
<td>registration points with the catenary wire located vertically above the</td>
</tr>
<tr>
<td></td>
<td>contact wire.</td>
</tr>
<tr>
<td>Stagger direction</td>
<td>In double track areas, at any location, the stagger on the up and down</td>
</tr>
<tr>
<td></td>
<td>tracks should generally be in the same direction.</td>
</tr>
<tr>
<td>Catenary arrangement</td>
<td>The catenary wire shall be of simple catenary construction.</td>
</tr>
<tr>
<td>Contact profile</td>
<td>Regulated OHW in main lines shall have the contact wire presagged (bay</td>
</tr>
<tr>
<td></td>
<td>length/1000). Fixed-anchored OHW and OHW on crossovers and sidings should</td>
</tr>
<tr>
<td></td>
<td>have a flat contact wire profile at the design temperature.</td>
</tr>
<tr>
<td>Contact wire grading</td>
<td>Shall not to be less than 1: 500.</td>
</tr>
<tr>
<td></td>
<td>For train speeds &lt;80 km/h the gradient may be increased up to 1: 300.</td>
</tr>
<tr>
<td>Contact stagger</td>
<td>The contact wire is staggered to:</td>
</tr>
<tr>
<td></td>
<td>• ensure pantograph security (around curved track)</td>
</tr>
<tr>
<td></td>
<td>• provide sweep on the pantograph carbon strips to provide more uniform</td>
</tr>
<tr>
<td></td>
<td>wear</td>
</tr>
<tr>
<td>Typical contact stagger</td>
<td>Refer to data sheets EL 0009386, EL 0003440, EL 0474288, EL 0006423 and</td>
</tr>
<tr>
<td>values</td>
<td>EL 0006424 for typical stagger values.</td>
</tr>
<tr>
<td></td>
<td>Typical stagger values are:</td>
</tr>
<tr>
<td></td>
<td>• 250 mm alternately either side of track centreline on tangent track</td>
</tr>
<tr>
<td></td>
<td>• 250 mm towards the outside of large curves &gt;800 m radius</td>
</tr>
<tr>
<td></td>
<td>• 300 mm towards the outside of tracks &lt;800 m radius</td>
</tr>
<tr>
<td>OHW conductor aspects</td>
<td>Requirement</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Contact stagger variations</td>
<td>Variation from the standard contact staggers are used to achieve a lower risk outcome. For example, setting up appropriate contact staggers through a platform to avoid placing live parts of support and registration arrangements close to the edge of platforms. Contact stagger variations shall be documented as part of the design process.</td>
</tr>
<tr>
<td>Contact stagger in transitions</td>
<td>At curve transitions, the contact wire should be staggered using structure spacing as for the smallest adjacent curve.</td>
</tr>
<tr>
<td>Crossovers and turnouts</td>
<td>Structure location and spacing shall ensure pantograph security throughout the turnout or crossover. Particular consideration shall be made on the difference in wire sags at and near wire junctions.</td>
</tr>
<tr>
<td>Pantograph security</td>
<td>To be assured under cumulative effect of:</td>
</tr>
<tr>
<td></td>
<td>• wind</td>
</tr>
<tr>
<td></td>
<td>• dynamic lateral pantograph movement</td>
</tr>
<tr>
<td></td>
<td>• cantilever and pull-off arm swing</td>
</tr>
<tr>
<td></td>
<td>Special care shall be taken to assure pantograph security in:</td>
</tr>
<tr>
<td></td>
<td>• track geometry transitions</td>
</tr>
<tr>
<td></td>
<td>• junctions of fixed-anchored and regulated wires</td>
</tr>
<tr>
<td>Pantograph security drawings</td>
<td>EL 0006421 and EL 0006422</td>
</tr>
<tr>
<td>Maximum mid-bay stagger with blowout for regulated OHW</td>
<td>The maximum mid-bay stagger with blowout with 130 km/h wind (static) for open route, and 0 km/h in tunnels, shall be:</td>
</tr>
<tr>
<td></td>
<td>• 350 mm for straight track and curved track down to 800 m radius</td>
</tr>
<tr>
<td></td>
<td>• 300 mm for curved track with radius &lt;800 m</td>
</tr>
<tr>
<td>Maximum contact displacement anywhere in a bay</td>
<td>The maximum contact displacement anywhere in a bay, with 130 km/h wind (static) for open route, and 0 km/h in tunnels, shall be:</td>
</tr>
<tr>
<td></td>
<td>• 381 mm for normal bays</td>
</tr>
<tr>
<td></td>
<td>• 450 mm for twin contact for overlap bays</td>
</tr>
<tr>
<td></td>
<td>• 381 mm for single contact for overlap bays</td>
</tr>
<tr>
<td></td>
<td>RailCorp computer program is available to calculate this.</td>
</tr>
<tr>
<td></td>
<td>For twin contact systems, the displacement is measured between the superelevated centreline and the mean centreline of the contact wires.</td>
</tr>
<tr>
<td>OHW run length - definition</td>
<td>The maximum length of OHW conductor from one termination to where it is again terminated. Where OHW is tensioned by a tension regulator device at both ends with a fixed midpoint arrangement in between, the OHW run length is the distance between the regulators.</td>
</tr>
<tr>
<td>OHW tension length - definition</td>
<td>The length of OHW conductor from the fixed anchor to the tension regulator. A midpoint arrangement is considered to be a fixed anchor.</td>
</tr>
<tr>
<td>Use of midpoint arrangements</td>
<td>If OHW is tensioned by a tension regulator at each end, it shall have a midpoint arrangement in between to prevent the OHW catenary and contact wires from drifting.</td>
</tr>
<tr>
<td>Maximum tension length</td>
<td>The maximum tension length shall not exceed 1000 m.</td>
</tr>
<tr>
<td>OHW conductor aspects</td>
<td>Requirement</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Allowable tension change (for regulated OHW)</td>
<td>±10% from nominal, comprising of 7% maximum change due to cantilever movement at the limits of the design conductor temperature range, and 3% maximum due to friction in the tension regulator system.</td>
</tr>
<tr>
<td>Maximum conductor temperature at any point</td>
<td>The design operating conductor temperature at any point along a catenary wire, a contact wire, or an auxiliary feeder wire shall not exceed 80 °C.</td>
</tr>
<tr>
<td>Conductor temperature range for regulated OHW</td>
<td>Under the ambient conditions set out in EP 00 00 00 13 SP Electric Power Equipment – Design Ranges of Ambient Conditions and the specified operating conditions, the average conductor temperature over a tension length of 1000 m shall be within the following temperature ranges:</td>
</tr>
<tr>
<td></td>
<td>-5 °C to 60 °C for open route and for tunnels less than 200 m in length</td>
</tr>
<tr>
<td></td>
<td>5 °C to 60 °C for tunnels longer than 200 m and located at an altitude below 850 m</td>
</tr>
<tr>
<td></td>
<td>0 °C to 60 °C for longer than 200 m and located at an altitude at or above 850 m</td>
</tr>
<tr>
<td></td>
<td>A higher maximum average conductor temperature is permissible for a tension length shorter than 1000 m, provided that all the following conditions are satisfied:</td>
</tr>
<tr>
<td></td>
<td>• the longitudinal wire movements at all cantilever supports and registration locations of the tension length are within the limits specified for cantilevers in Section 9.2</td>
</tr>
<tr>
<td></td>
<td>• the longitudinal wire movements at all suspension supports of the tension length have been assessed by the design AEO to be within the design functional limits of each of the suspension arrangements</td>
</tr>
<tr>
<td></td>
<td>• the calculated tension loss due to cantilever movement at the limits of the design conductor temperature range shall not be more than 7%</td>
</tr>
<tr>
<td></td>
<td>• the weight stack of the weight tensioner arrangement shall move freely for the entire range of design conductor temperatures</td>
</tr>
<tr>
<td></td>
<td>• the maximum average conductor temperature for the tension length shall be shown on the relevant OHW layout drawings in a conspicuous manner</td>
</tr>
<tr>
<td></td>
<td>• appropriate control measures are included in the design to ensure that the OHW comply with the requirements of this standard after allowance for wire creep and construction tolerances</td>
</tr>
<tr>
<td></td>
<td>• additional control measures, for example, the installation of appropriate signage on support structures, specified by the maintainer shall be implemented</td>
</tr>
<tr>
<td>Fixed-anchored OHW design</td>
<td>Special care shall be given to the design of fixed-anchored OHW systems with regard to the changing nature of both the catenary and contact wire tensions with temperature. Some aspects where care has to be exercised are given in T HR EL 08010 ST.</td>
</tr>
</tbody>
</table>
**OHW conductor aspects** | **Requirement**
---|---
Fixed-anchored OHW conductors under cold conditions (with higher tensions) | In general the following aspects shall be considered:
- mechanical loading on OHW structures
- catenary sags and thus clearances from objects located above, for example under overline bridges
- sagging into running, for example contact wire from anchor

Fixed-anchored OHW conductors under hot conditions (with lower tensions) | In general the following aspects shall be considered:
- blowout under windy conditions (affecting pantograph security)
- low contact wire heights
- pantograph interface performance at speed
- reduced mechanical or electrical clearances to OHW equipment of different electrical section, and so on
- adverse condition (see Section 9)
- conductor annealing
Refer to T HR EL 08010 ST for requirements that limit the maximum conductor temperatures for fixed-anchored OHW.

Auxiliary feeder sag | Sagged the same as the adjacent OHW loaded catenary at its design temperature.

Auxiliary feeder – maximum conductor temperature | There shall be adequate clearances between the auxiliary feeder conductor and the contact wire, train pantographs and other obstructions, such as OHW structures and other conductors, at the maximum allowable operating temperature for the auxiliary feeder conductor.

Auxiliary feeder connection to adjacent catenary | Auxiliary feeders shall be connected to adjacent catenary using auxiliary feeder jumpers (AFJ’s) at regular intervals as determined by a load flow study.

Maximum bay length | 67 m (larger bays subject to applying maximum blowout conditions, for example in overlaps).

Dead spans | To avoid potentially hazardous ‘traps’, as far as practicable, dead spans shall not be placed under live catenaries, and live spans shall not be placed over dead spans or equipment.

Design conductor height reference | All OHW heights shall be designed to final design rail level.

Catenary splice | Use helical in-line wrap-on in accordance with AS 1154.3 *Insulator and conductor fittings for overhead lines Part 3: Performance and general requirements for helical fittings.*

## 8.1. Conductor heights

The requirements for OHW conductor heights are provided in Table 5.

**Table 5 – Requirements for OHW conductor heights**

<table>
<thead>
<tr>
<th>Conductor height aspects</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height reference point</td>
<td>The heights nominated in this section are measured to the mean rail level as defined in Section 7.</td>
</tr>
</tbody>
</table>
8.2. Clearances

The clearance requirements for OHW conductors and associated fittings are provided in Table 6.

<table>
<thead>
<tr>
<th>Clearance aspects</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum electrical clearance to earth or another conductor (section)</td>
<td>150 mm – under adverse conditions (maximum 130 km/h dynamic wind) or a man on a ladder (+/- 200N radial load).</td>
</tr>
<tr>
<td>Minimum clearance between 2 parallel wires in open overlaps</td>
<td>250 mm but may be reduced to 150 mm absolute minimum under the worst case, for example at mid-bay in open overlaps.</td>
</tr>
<tr>
<td>Live span crossing above contact wire</td>
<td>300 mm minimum (may be reduced if a fender is installed on a contact wire below the span). This figure allows adequate clearance with pantograph uplift.</td>
</tr>
</tbody>
</table>
| Insulator skirt clearance above contact level (for example in open overlap) | If <5 m from a catenary support structure:  
• 300 mm minimum for porcelain insulators  
• 200 mm minimum for composite insulators  
If >5 m from a catenary support structure, it is subject to analysis. |
| Fitting clearance | All live OHW fittings and insulators to clear 'raised and oscillated' positions on pantograph gauge by 50 mm horizontal and 20 mm vertical, and all 'earth' potential OHW fittings to clear the electrical clearance on top of the 'raised and oscillated' position on the pantograph gauge. |
| Segregation of OHW between tracks | Where possible, all tracks are to be independently registered, unless a value engineering study reveals that segregation is not required. |
## Clearance aspects

<table>
<thead>
<tr>
<th>Clearance aspects</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crossovers and turnouts</strong></td>
<td>Where it is reasonably practicable to do so:</td>
</tr>
<tr>
<td></td>
<td>• crossover wires should be anchored so that they are associated only with two adjacent tracks</td>
</tr>
<tr>
<td></td>
<td>• wiring for crossover should be independent of main line OHW</td>
</tr>
<tr>
<td></td>
<td>Anchor pennants shall be clear of pantograph running under worst sag conditions. Particular care shall be taken for anchor pennants of fixed anchored overhead wiring.</td>
</tr>
<tr>
<td><strong>Pantograph gauge</strong></td>
<td>Maximum worn envelope of pantograph is shown in CV 0131343.</td>
</tr>
<tr>
<td></td>
<td>Refer also to RailCorp 'PanGauge.xlt' spreadsheet program which can be used to confirm suitable clearances to surrounding objects.</td>
</tr>
<tr>
<td><strong>Static clearance - definition</strong></td>
<td>Static clearance is the minimum distance required between the live parts of OHW equipment (under any permissible conditions of maintenance and when not subject to uplift from a pantograph) and a structure or the earthed parts of the OHW equipment.</td>
</tr>
<tr>
<td><strong>Normal static clearance</strong></td>
<td>150 mm minimum.</td>
</tr>
<tr>
<td><strong>Reduced static clearance</strong></td>
<td>120 mm minimum. Reduced clearance only for non-conducting material, for example tunnel brickwork.</td>
</tr>
<tr>
<td><strong>Special reduced static clearance</strong></td>
<td>100 mm minimum. Special reduced clearance only for non-conducting material, for example tunnel brickwork.</td>
</tr>
<tr>
<td><strong>Passing clearance - definition</strong></td>
<td>Passing clearance is the minimum distance required between live parts of OHW equipment and any earthed or rail vehicle, or between pantograph and any earthed material, under any permissible conditions of operation and maintenance of vehicles, track and OHW equipment.</td>
</tr>
<tr>
<td><strong>Normal passing clearance</strong></td>
<td>200 mm minimum.</td>
</tr>
<tr>
<td><strong>Reduced passing clearance</strong></td>
<td>150 mm minimum. Reduced clearance only for non-conducting material, for example tunnel brickwork.</td>
</tr>
<tr>
<td><strong>Special reduced passing clearance</strong></td>
<td>100 mm minimum. Special reduced clearance only for non-conducting material, for example tunnel brickwork.</td>
</tr>
<tr>
<td><strong>Clearance of OHW unattached under a bridge</strong></td>
<td>450 mm minimum (comprises 300 mm dynamic pantograph uplift + 150 mm electrical clearance).</td>
</tr>
<tr>
<td><strong>Reduced vertical clearances from catenary to overline bridge</strong></td>
<td>Every effort should be made to achieve the above clearance figure of 450 mm. However if this cannot be readily achieved, a cost-benefit analysis should be carried out to justify using the reduced clearances listed below, which is then subject to acceptance by the relevant authority of the design AEO.</td>
</tr>
<tr>
<td>Clearance aspects</td>
<td>Requirement</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Reduced vertical clearance to 'earthed' metalwork from catenary to overline bridge for regulated OHW | Based on 150 mm minimum static clearance and allowance for dynamic considerations, the minimum clearance is:  
- 150 mm where the distance from catenary support is not more than 5 m  
- 200 mm where the distance from catenary support is between 5 m and 15 m  
- 250 mm where the distance from catenary support is between 15 m and 20 m  
- 300 mm where the distance from catenary support is between 20 m and 25 m  
- 400 mm where the distance from catenary support is between 25 m and 30 m  
- 450 mm where the distance from catenary support is between 30 m and 35 m |

| Reduced vertical clearance to 'earthed' metalwork from catenary to overline bridge for fixed-anchored OHW at minimum design temperature | Based on 150 mm minimum static clearance and allowance for dynamic considerations, the minimum clearance is:  
- 150 mm where the distance from catenary support is not more than 5 m  
- 200 mm where the distance from catenary support is between 5 m and 20 m  
- 250 mm where the distance from catenary support is between 20 m and 25 m  
- 300 mm where the distance from catenary support is between 25 m and 35 m |

| Reduced vertical clearance to non-conductive 'earthed' material (for example non-reinforced concrete or brickwork) from catenary to overline bridge for regulated OHW | Based on 150 mm minimum static clearance and allowance for dynamic considerations, the minimum clearance is:  
- 150 mm where the distance from catenary support is not more than 15 m  
- 200 mm where the distance from catenary support is between 15 m and 20 m  
- 250 mm where the distance from catenary support is between 20 m and 25 m  
- 350 mm where the distance from catenary support is between 25 m and 30 m  
- 400 mm where the distance from catenary support is between 30 m and 35 m |

| Reduced vertical clearance to non-conductive 'earthed' material (for example non-reinforced concrete or brickwork) from catenary to overline bridge for fixed-anchored OHW at minimum design temperature | Based on 150 mm minimum static clearance and allowance for dynamic considerations, the minimum clearance is:  
- 150 mm where the distance from catenary support is not more than 20 m  
- 200 mm where the distance from catenary support is between 20 m and 25 m  
- 250 mm where the distance from catenary support is between 25 m and 35 m |

| Structures                                                                 | No part of OHW electrical support structures shall impede on the structure gauge, for example, drop vertical position. Refer to ESC 215 *Transit Space.* |
Clearance aspects | Requirement
--- | ---
Catenaries crossing | 100 mm recommended (crossing catenaries shall have adequate physical clearance to avoid touching under all temperature and normal operating wind conditions.) 50 mm absolute minimum wire centre to wire centre. Catenaries shall both be in the same electrical section.
Contacts crossing at turnouts | Splices, dropper clips, registration clamps and feeder clamps shall not infringe on pantograph movement at the forking-in points. (The forking-in point is the point where a pantograph of a train meets the overhead wiring of the adjacent track.)

8.3. Construction tolerances

The construction tolerance levels are provided in Table 7.

Table 7 – Construction tolerances

<table>
<thead>
<tr>
<th>OHW conductor construction aspects</th>
<th>Tolerance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catenary height</td>
<td>+/- 50 mm</td>
</tr>
<tr>
<td>Contact height</td>
<td>+/- 50 mm</td>
</tr>
<tr>
<td>Contact stagger</td>
<td>+/- 50 mm</td>
</tr>
<tr>
<td>System depth at support</td>
<td>+/- 50 mm</td>
</tr>
<tr>
<td>Contact wire pre-sag between registrations</td>
<td>+/- 25 mm</td>
</tr>
<tr>
<td>Catenary vertical alignment with contact wire at supports</td>
<td>+/- 25 mm</td>
</tr>
<tr>
<td>Dropper length</td>
<td>+/- 5 mm</td>
</tr>
<tr>
<td>Dropper position with respect to design position</td>
<td>+/- 25 mm</td>
</tr>
</tbody>
</table>

8.4. Approved overhead wiring conductor systems

The approved OHW conductor systems for new installations are listed in Table 8.

Table 8 – Approved OHW conductor systems for new installations

<table>
<thead>
<tr>
<th>OHW system ID*</th>
<th>OHW system details (catenary / contact) (mm²)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>270 / 2x137</td>
<td>OHW on main lines including tunnels and areas where train speeds exceed 80 km/h but are less than 160 km/h.</td>
</tr>
<tr>
<td>12</td>
<td>2x270 / 2x137</td>
<td>OHW on main lines and areas where train speeds exceed 80 km/h but are less than 160 km/h, and where System 2 does not have adequate current carrying capacity.**</td>
</tr>
</tbody>
</table>
### 8.5. Auxiliary feeders

The requirements for auxiliary feeders are provided in Table 9.

**Table 9 – Requirements for auxiliary feeders**

<table>
<thead>
<tr>
<th>Auxiliary feeders aspects</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate system to auxiliary feeders</td>
<td>Preference should be given to the use of OHW System 12 or System 15 as an alternative to installing an auxiliary feeder adjacent to the support structure, for safety reasons.</td>
</tr>
</tbody>
</table>
8.6. **Droppers**

The general requirements for droppers are provided in Table 10.

**Table 10 – General requirements for droppers**

<table>
<thead>
<tr>
<th>Aspects of dropper arrangements</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installation in OHW bays</td>
<td>Droppers shall be provided for all overhead wiring bays, including overlap bays and anchor bays. Dropper spacing shall be in accordance with the requirements specified in Section 8.6.1 to Section 8.6.4.</td>
</tr>
<tr>
<td>Wire creep corrections</td>
<td>Initial strain creep from both the catenary and contact wires shall be negated or reduced before droppers and other fittings are permanently attached. Wire creep is normally removed by over-tensioning the wire for a period of time.</td>
</tr>
<tr>
<td>At crossovers</td>
<td>Droppers immediately adjacent to the crossover point on the crossover wire shall not be tied off to facilitate resetting of the junction after conductor creep, and so on has upset the optimum running profile.</td>
</tr>
<tr>
<td>Dropper arrangements</td>
<td>Refer to EL 0106184 for the range of dropper arrangements and their applications.</td>
</tr>
</tbody>
</table>

8.6.1. **Twin contacts – with standard 150 mm contact spacing**

The requirements for droppers used for OHW with twin contacts with a contact spacing of 150 mm are provided in Table 11.

**Table 11 – Requirements for droppers for twin contacts with 150 mm spacing**

<table>
<thead>
<tr>
<th>Aspects of droppers for twin contact with 150 mm spacing</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where used</td>
<td>Standard contact separation on open route is 150 mm. Reduced contact separation of 50 mm is used with insulation bar dropper arrangement when catenary to contact distance is reduced below the minimum length of the standard dropper.</td>
</tr>
<tr>
<td>Minimum dropper length on open route</td>
<td>450 mm</td>
</tr>
<tr>
<td>Aspects of droppers for twin contact with 150 mm spacing</td>
<td>Requirement</td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Standard dropper arrangement</td>
<td>EL 0254113 (single droppers)</td>
</tr>
<tr>
<td>Short dropper arrangement</td>
<td>Use insulation bar arrangement (below) and reduce contact spacing to 50 mm.</td>
</tr>
<tr>
<td>Dropper spacing in bay</td>
<td>To EL 0009447</td>
</tr>
<tr>
<td>Policy on left or right contact dropper</td>
<td>The left contact wire (with back to Sydney) is the first wire to be supported in the bay (heading into the bay away from Sydney). This is dropper #1.</td>
</tr>
<tr>
<td>Dropper length</td>
<td>May be calculated using the latest version of the RailCorp computer program ‘REGDROP’.</td>
</tr>
</tbody>
</table>

### 8.6.2. Twin contact – with reduced 50 mm contact spacing

Insulation bar droppers allow the twin contact wires that are being supported to pivot, inherently forcing both wires to run on a pantograph, in turn causing them to wear evenly, which is a benefit of this arrangement.

The insulation bar arrangements should not be used in the open, if possible because of their inherent increased maintenance requirements (plastic parts eventually deteriorate in sunlight).

The insulation bar droppers are suited in tunnel areas that are not exposed to the sunlight.

The insulation bar arrangements are generally used where catenary to contact distance is reduced below the minimum length of the standard dropper, for example, at low overline bridges. They are also used throughout tunnels.

> The insulation bar droppers can only be used where the contact separation in the whole bay is a constant 50 mm. The contact separation has to reduce from 150 mm to 50 mm in the bays adjacent to the bay with insulation bar droppers.

The minimum short dropper length is 95 mm. Refer to EL 0232901.

The minimum standard dropper length is 374 mm. Refer to EL 0474340.

For standard dropper arrangement, refer to EL 0474340.

The dropper spacing in a bay shall comply with EL 0009447 for system 2, System 12 and System 15. The dropper spacing for System 28 may be determined by using the latest version of the appropriate RailCorp computer program.

The dropper length may be calculated using the latest version of RailCorp computer program ‘REGDROP’.
8.6.3. Single contact

The requirements for droppers used for OHW with single contact are provided in Table 12.

<table>
<thead>
<tr>
<th>Aspects of single contact dropper</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard dropper arrangement</td>
<td>EL 0254113</td>
</tr>
<tr>
<td>Minimum dropper length on open route</td>
<td>450 mm</td>
</tr>
<tr>
<td>Minimum short dropper</td>
<td>70 mm (270 mm² catenary) / 73 mm (165 mm² catenary)</td>
</tr>
<tr>
<td>Short dropper arrangement</td>
<td>EL 0232899</td>
</tr>
<tr>
<td>Dropper spacing in bay</td>
<td>EL 0013060</td>
</tr>
<tr>
<td>Dropper length</td>
<td>May be calculated using RailCorp computer program 'REGDROP'</td>
</tr>
</tbody>
</table>

8.6.4. Overlap droppers

Overlap droppers are standard droppers that are used in the actual overlap bay of an overlap. These bays have about half the bay with the catenary supporting the contact wire and for the remainder of the bay the catenary is unloaded as the contact wire rises under its natural weight out-of-running.

The overlap bay has standard droppers installed for the entire bay. Individual dropper lengths set the contact wire out-of-running profile.

Refer to dropper arrangement requirements in Section 8.6.1, Section 8.6.2 and Section 8.6.3.

The dropper spacing shall be the same as standard droppers.

The length of droppers may be calculated using the latest version of the appropriate RailCorp computer program.

8.7. In-span feeders

The requirements for in-span feeders are provided in Table 13.

<table>
<thead>
<tr>
<th>In-span feeders aspects</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard arrangement</td>
<td>EL 0024221</td>
</tr>
<tr>
<td>Number of in-span feeders per bay</td>
<td>EL 0003482, EL 0007802 and EL 0011739</td>
</tr>
<tr>
<td>In-span feeders at feeder locations</td>
<td>EL 0027472</td>
</tr>
</tbody>
</table>
8.8. **Contact full splices**

The contact full splice is intended to be used for maintenance of contact wires in accordance with T HR EL 08011 ST *Overhead Wiring Maintenance Standards*.

The arrangements and fittings for splicing contact wires shall be type approved. The currently type approved splice fittings for 'in-running' contact wires include fitting 462/8. Refer to EL 0002017.

The contact full splice shall not be used for splicing 'in-running' contact wires for the following:

- new overhead wiring installations
- where an entire contact wire run is replaced

The contact full splice may be used for 'in running' contact wires for:

- modifications to existing wire runs if the use of the contact full splice is justified by life cycle costing
- construction staging works where the temporary wire run, containing contact full splices, is replaced within a year

Then the number of contact full splices in a wire run between any two adjacent support structures shall not be more than three in accordance with T HR EL 08011 ST.

8.9. **Knuckles**

Fixed knuckled contact or catenary wires are not permitted in a regulated OHW system, unless the arrangement is within 50 m of the fixed anchor points of both wire runs. Where the fixed anchor points are on the same side of the fixed knuckle arrangement, this distance may be increased to 100 m.

Sliding knuckles shall be in accordance with EL 0018769 (fitting 46/1).

Where contact wires cross above twin contact wires, a sliding knuckle shall be installed on each of the in-running twin contact wires in accordance with EL 0027000.
Insulated knuckles are generally only used, where the OHW is regulated, in a diamond crossover situation to suit electrical sectioning requirements. Limitations on position are as detailed in fixed knuckles above.

An example is given in EL 0159278.

8.10. **Contact wear strips**

Contact wear strip arrangement shall be in accordance with EL 0026992 (fitting 49/1).

A contact wear strip is essentially an additional length of tin-bearing contact wire, specially shaped at its ends and installed next to the main contact wire using clamps that acts as a sacrificial component – the wear strip wears instead of the tensioned contact wire. This can prevent any future wear on the main contact wire. A contact wear strip can be installed on new wire where it is anticipated that significant wear will occur.

8.11. **Feeder and potential jumpers**

Feeder jumpers (FJ) are used to carry the load current from one wire run to another. They connect from catenary to catenary and include in-span feeders connecting to the associated contact wires, to help distribute the electrical load.

At least two FJs should be installed in overlap bays and turnouts (for redundancy).

Wherever it is practical to do so, the feeder jumpers should be installed at or near the extreme ends so as to minimise the OHW electrical resistance and make good use of the available OHW copper conductors. This aims to minimise ongoing electrical losses in the OHW when passing heavy train currents.

Refer to EL 0004637-8 for feeder jumper arrangements.

Potential Jumpers are designed to keep the electrical potential of two sections of OHW the same (since floating sections are not permitted), but they are not designed to carry current.

Auxiliary feeder jumpers (AFJ) are required to regularly connect the auxiliary feeder to the catenary of the OHW that is being electrically strengthened by the auxiliary feeder. The size of the AFJ is the same as the catenary wire.

The spacing of the AFJs shall be calculated by the load flow study that determined that auxiliary feeders were required in the first place. This spacing may vary depending on distance from substation, and should not exceed 300 m.
9. **OHW support and registration arrangements**

The general requirements for OHW support and registration arrangements are provided in Table 14.

**Table 14 – General requirements for OHW support and registration**

<table>
<thead>
<tr>
<th>Aspects of OHW support and registration arrangements</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent registration</td>
<td>The OHW conductors for all tracks shall be independently registered, unless a value engineering study determines that segregation is not required.</td>
</tr>
<tr>
<td>Stray feeding</td>
<td>Where independent registration is not used (for example, span wires in yards) measures shall be provided to prevent stray current flowing through steelwork, and so on in the registration arrangements (components not designed to carry dc current).</td>
</tr>
<tr>
<td>Support and registration insulators</td>
<td>String insulator sets shall be in accordance with EP 08 00 00 20 SP. Post type insulators shall be in accordance with EP 08 00 00 19 SP.</td>
</tr>
<tr>
<td>Contact registration</td>
<td>The contact shall be registered by pull-off arms as used in the standard cantilever arrangements. The heel of the particular pull-off arms used shall clear the pantograph gauge 'raised and oscillated' envelope by 50 mm horizontal and 20 mm vertical. As a guide, the minimum distance from superelevated centre-line of track to the heel of pull-off arm is 1350 mm (based on current pantograph gauge).</td>
</tr>
<tr>
<td>Pull-off arms at platforms</td>
<td>Ideally at station platforms the pull-off arm should be located so that the heel is located on the remote side of the track from the platform (for example between tracks). Stagger variations can often achieve this outcome, and it is permissible to have a negative (compressive) radial load on the arm, up to -300 N per arm, at a station, to help achieve this outcome. (It may be possible to accept higher compressive loads, subject to approval by the Lead Electrical Engineer, ASA). If this absolutely cannot be achieved, pull-off arms are only permitted above a platform if the arms are registered from a drop vertical which is located as close as practical to the platform edge, to limit exposure of the electrical hazard. Pull-off arms from a Type 1A or 2A cantilever 'negative boom' are not permitted on the platform side.</td>
</tr>
</tbody>
</table>
### Aspects of OHW support and registration arrangements

<table>
<thead>
<tr>
<th>Requirement</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Adverse condition (radial load - wind load)</strong></td>
<td></td>
</tr>
<tr>
<td>Adverse condition is a check that there is sufficient radial load on the contact wire to hold a pull-off arm in place when registered by a span, as wind blows against the radial load. The risk is that a pull-off arm that is not held up correctly under all likely conditions may droop down into the path of a train pantograph and subsequently damage both the OHW and train. See Figure 1. The condition is only necessary for pull-off arms held by span wires. If the arm is supported by a rigid horizontal post arrangement, then this condition does not apply. (See Figure 1). This is generally why Types 1 and 2 cantilevers and pull-off arrangements include a solid support for the pull-off arm, and Type 3 (where Adverse condition is &gt;250 N) uses the cheaper span arrangement. If adverse condition is &gt;250 N (radial load is greater than wind load by more than 250 N), it is acceptable to use a span arrangement to register the pull-off arm. The 250 N load is necessary in order to keep the heel of the pull-off arm from slumping into the path of a pantograph. If adverse condition is &lt; 250 N, a rigid connection to the pull-off arm is required, for example 189/- channel from mast or 403/- telescopic tube from drop vertical. These arrangements hold the heel of the pull-off arm rigidly in place.</td>
<td></td>
</tr>
</tbody>
</table>

| **Adverse condition for regulated contact wire**                             |   |
| The adverse condition on a regulated contact wire is defined as:             |   |
| Adverse = Radial load - dynamic wind load @ 130 km/h                       |   |
| Refer to EL 0006442 for definitions of static and dynamic wind loads.      |   |

| **Adverse condition for fixed-anchored contact wire**                       |   |
| The adverse condition on a fixed-anchored contact wire is generally defined as: |   |
| Adverse = the lesser of:                                                    |   |
| (a) radial load @ 40°C - static wind load @ 80 km/h                        |   |
| (b) radial load @ 0°C - dynamic wind load @ 130 km/h                      |   |
9.1. Construction tolerances

The construction tolerances are provided in Table 15.

Table 15 – Construction tolerances for support and registration arrangements

<table>
<thead>
<tr>
<th>Construction aspect</th>
<th>Tolerance level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catenary support positions from theoretical along-track positions</td>
<td>+/- 50 mm (having due regard to conductor temperature and distance from fixed anchor)</td>
</tr>
<tr>
<td>Pull-off arm heel height</td>
<td>+/- 25 mm (the heel height shall not go below contact level – zero heel height)</td>
</tr>
<tr>
<td>Reference nail to drop vertical horizontal</td>
<td>+/- 25 mm</td>
</tr>
<tr>
<td>Reference nail to contact vertical</td>
<td>+/- 50 mm</td>
</tr>
<tr>
<td>Reference nail to contact horizontal</td>
<td>+/- 50 mm</td>
</tr>
<tr>
<td>Reference nail to catenary vertical</td>
<td>+/- 50 mm</td>
</tr>
<tr>
<td>Reference nail to catenary horizontal</td>
<td>+/- 50 mm</td>
</tr>
<tr>
<td>Reference nail to cantilever mast bracket vertical</td>
<td>+/- 10 mm</td>
</tr>
<tr>
<td>Horizontal booms and tie-rod chains</td>
<td>+/- 20 mm per metre of length</td>
</tr>
</tbody>
</table>
9.2. Cantilevers

The requirements for cantilevers are provided in Table 16.

<table>
<thead>
<tr>
<th>Cantilever aspects</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Style</td>
<td>Mark 2 cantilevers</td>
</tr>
<tr>
<td>Main line open route OHW standard arrangement</td>
<td>EL 0194773 - EL 0194783</td>
</tr>
<tr>
<td>Heavy current OHW standard arrangements</td>
<td>EL 0003384 – EL 0003394</td>
</tr>
<tr>
<td>Siding OHW standard arrangement</td>
<td>EL 0006173 – EL 0006183</td>
</tr>
<tr>
<td>Allowable longitudinal wire movement</td>
<td>0.7 m maximum from position at design temperature; 1.0 m maximum total movement through the entire design temperature range.</td>
</tr>
<tr>
<td>Means of calculation</td>
<td>The latest version of computer program 'CCalc' shall be used to generate all necessary construction information for the installation of new cantilevers.</td>
</tr>
<tr>
<td>Calculation storage policy</td>
<td>CCalc's shall be generated and stored in computer files in run lengths, that is, all cantilevers supporting OHW in a particular run length shall be included sequentially in the same file. The filename shall appear on the layout at the start and end of the OHW run. The CCalc input files shall be stored at the offices of the maintainers of the OHW equipment.</td>
</tr>
<tr>
<td>Wire run naming convention</td>
<td>Refer to EP 08 00 00 10 SP.</td>
</tr>
<tr>
<td>CCALC instruction manual</td>
<td>Document 'CCALC – Program for Calculating Mark-2 Overhead Wiring Cantilevers on the H.P.3000 Computer' describes how to code and gather information necessary to calculate cantilevers. It also guides the user in interpreting the output details.</td>
</tr>
<tr>
<td>Cantilever movement restriction at portal knee-braces</td>
<td>Cantilevers should be free to move with conductor temperature changes and not be impeded by portal knee-braces (particularly at the tie-rod chain). 'Wide knee-braces' may need to be installed if cantilever movement is excessive.</td>
</tr>
<tr>
<td>Pull-off arm selection with non-standard stagger</td>
<td>Cantilever standard arrangements show which pull-off arms to use when using non-standard stagers. Arm selection is also influenced by proximity to adjacent tracks (heel of arm needs to clear pantograph gauge), for example at crossovers. As a guide, the minimum distance from superelevated centre-line of track to the heel of pull-off arm is 1350 mm (based on current pantograph gauge).</td>
</tr>
</tbody>
</table>
9.3. Overline bridge arrangement

The requirements for OHW support and registration arrangements at overline bridges (OLB) are provided in Table 17.

Table 17 – Requirements for support and registration arrangements at OLB

<table>
<thead>
<tr>
<th>Aspects of OHW support and registration at OLB</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attachment of OHW to OLB</td>
<td>Preference should be given to overhead wiring that is not attached to overline bridges, as this eliminates the possibility of stray or fault current damaging the bridge steel work. Both the bridge height and its width (along the track) influence whether OHW can pass unattached under a bridge (the preferred outcome), or whether the OHW needs to be attached (undesirable). As a guide, if the under-side of bridge is &gt;8 m above track, then generally the OHW should be capable of being installed from standard OHW masts or portals, independent of the bridge, and therefore not attached to the bridge. For bridges lower than 8 m, an OHW concept design is required to establish that the bridge height and width can allow the OHW to pass through unattached beneath the bridge, which is the preferred outcome (due to electrolysis corrosion considerations and ongoing maintenance). Alternatively, OHW may only be attached to the bridge if the OHW concept design can demonstrate that there are no other options because the bridge is too low, too wide, or both (an undesirable outcome). In this case the concept design shall identify how the OHW should be supported and registered under the bridge, and how minimum electrical clearances are to be met.</td>
</tr>
<tr>
<td>Inadequate bridge clearance</td>
<td>OHW design for cases of reduced clearance to track shall comply with Section 8.1.</td>
</tr>
<tr>
<td>Typical standard arrangement</td>
<td>There are no standard arrangements – refer to past practice on drawings.</td>
</tr>
<tr>
<td>Location of rollers</td>
<td>Where catenary rollers are used, the catenary low point should be designed to occur near the roller on an overline bridge. The resulting catenary weight span or uplift span on the roller can be up to 15 m, subject to a structural strength check on any structure or fitting supporting the rollers. Larger weight spans can cause conductor fatigue in time and should be avoided. Refer to fitting 385/42 (EL 0012318) for the roller assembly and a typical mounting arrangement.</td>
</tr>
<tr>
<td>Fixed anchor at bridge</td>
<td>If an OLB is chosen as a fixed anchor location the strength of the bridge and L-iron arrangement shall be investigated and confirmed for this additional loading.</td>
</tr>
</tbody>
</table>
### Aspects of OHW support and registration at OLB

<table>
<thead>
<tr>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Midpoint arrangement at bridge</strong> If an OLB is chosen as a midpoint arrangement, the strength of the bridge shall be investigated and confirmed for this additional loading. The fixing attachment to the catenary should allow the catenary to slide through in case of a catenary breakage.</td>
</tr>
<tr>
<td><strong>Out-of-balance loading of fixed anchor arrangement on OLB</strong> +/- 2 kN maximum in catenary.</td>
</tr>
<tr>
<td><strong>Bonding of bridge attachments</strong> All OHW attachment points to an OLB shall be bonded to rail through spark gap, unless special arrangements (such as double insulation, and so on) are put in place to prevent stray current and safety issues. Refer to EL 0007855.</td>
</tr>
<tr>
<td><strong>Safety screens on overline bridges</strong> Refer to T HR EL 08001 ST Safety Screens and Barriers for 1500 V OHW Equipment, for requirements.</td>
</tr>
</tbody>
</table>
| **Insulated stop beams** To be used where OHW is unattached (and therefore uncontrolled) under a bridge, and where the required electrical clearance of the OHW to the bridge may be infringed (See Section 8.2). For example:  
  - pantograph uplift  
  - tension regulator jams in cold weather  
  - fixed-anchored OHW in cold weather  
  Refer to fittings 41/21 to 41/25 (EL 0018535) or approved alternate arrangements. |
| **Attachment to pre-stressed or post-stressed concrete bridges** If possible, do not attach OHW to these bridges to avoid corrosion problems with the reinforcing rods of the bridge structure. Otherwise special insulated anchor bolts or insulating plates and ferrules shall be designed and installed that effectively prevent stray traction currents into the steel reinforcing. |

### 9.4. Pull-off arrangements

Pull-off arrangements may only be used on main lines in low speed areas, and provided independent registration is achieved.

Pull-off arrangements, where used in yards and sidings, shall be limited to the registration of a maximum of two adjacent tracks (to achieve some degree of independent registration).

Refer to the following drawings for typical arrangements:

- EL 0475865 (twin contact with type 1 and type 2 loads)
- EL 0475866 (twin contact with type 3 load)
- EL 0475858 (single contact type 1 and type 2 loads)
- EL 0475859 (single contact with type 3 load)
9.5. **Push-off arrangements**

Arrangements with the contact registration in compression under static load are not preferred.

9.6. **Polygon arrangements**

Polygon (headspan) support systems shall not be used.

10. **Support structures**

10.1. **General requirements**

The general requirements applicable to OHW interface with support structures are provided in Section 10.1.1 to Section 10.1.12.

Refer to T HR CI 12040 ST Overhead Wiring Structures and Signal Gantries for civil requirements of OHW structures.

10.1.1. **Minimum clearance**

The minimum clearance from OHW support structures to adjacent main line and crossing loop tracks shall be 3.0 m from track centre to closest face of structure. Refer to ESC 215.

The minimum clearance from OHW support structures to adjacent siding tracks shall be 2.5 m plus curve superelevation effects, measured from track centre to closest face of structure. Refer to ESC 215.

The minimum clearance from OHW support structures on platforms to adjacent tracks shall be 4.3 m from track centre to closest face of structure or plinth. Refer to ESC 215.

10.1.2. **Reference nail**

A reference nail shall be installed on the face of mast and portal legs, located adjacent to serviced tracks.

This nail is an important reference point for measuring vertically to various OHW cantilever fittings. The nail also serves to define the 'design' track position (both horizontally and vertically).

The nominal location of reference nail shall be at 300 mm above design rail level (1300 mm above design rail level in the case of a platform or structures in cuttings).

10.1.3. **OHW structure loading**

The OHW structure shall be determined by appropriately qualified structural engineers, given, details such as minimum structure height, static and dynamic weight, radial and wind loads of the conductors and any anchor loads installed on the structure.
RailCorp computer spreadsheet 'Load-Dgm.xlt' may be used to document the various OHW loads on the new proposed OHW structure (user manual is available).

Wind loading on structure due to OHW shall be determined using dynamic wind load with 130 km/h wind in open route and 0 km/h in tunnels.

Structure deflection due to dynamic wind load shall be a maximum of 50 mm at contact wire height.

The weight loading on structure due to OHW shall be determined using the dynamic weight loads. The dynamic weight load on structure due to OHW is the greater of the following:

- OHW weight load +50%
- OHW weight load +1068 N (allowance for the weight of a person)

Lateral loading on structure due to OHW is determined from the sum of radial loads and wind loads on each OHW conductor.

10.1.4. Foundations

Foundations shall be designed for strength and ability to resist rotation in the soils along the route.

10.1.5. Standard structures sizes

Refer to T HR CI 12040 ST for standard structure sizes.

10.1.6. Minimum height of structure

The minimum height of the structure shall be determined by the OHW designer. This includes allowances for catenary height, insulator string length and other mechanical clearances. The structure height is typically 7.5 m or 8.0 m from rail level.

10.1.7. Protective coating

OHW structures shall be galvanized in accordance with AS/NZS 4680 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.

10.1.8. Signal sighting

Structures shall not obstruct signals. Placement of structures with respect to signals shall comply with signal sighting requirements in accordance with SPG 0706 Installation of Trackside Equipment.
10.1.9. Structure spacing

Wherever possible, structures should be spaced according to the relevant structure spacing chart, for example, data sheet drawings EL 0003440, EL 0006423, EL 0006424, EL 0009386 and EL 0474288.

The structure spacing shall be shown on the OHW layout drawing.

10.1.10. Proximity to other infrastructure

Structures should be positioned at least 3 m from closest edge of culverts. Refer to ESC 310 Underbridges for civil requirements for culverts.

Structures on either side of a road level crossing should be evenly spaced to the road crossing, with a minimum of 5 m distance from the structure to the edge of road. It is desirable to maximise the distance from the structure to the edge of road to avoid vehicular damage.

Structures should not be installed in line with a catch point, to prevent possible damage to the structure in case of a derailment. Refer to ESC 250 Turnouts and Special Trackwork for further information.

Structures should not be located beneath HV aerial crossings. Refer to T HR EL 10005 ST for more information.

Structures should be installed such that no part of the continuous fencing is closer than 2 m to the structure. If this cannot be achieved, either insulating panels should be installed in the lineside fencing where the structure is located near the lineside fencing, or a suitable insulating barrier installed. Refer to T HR CI 12160 ST Boundary Fences and EP 12 10 00 21 SP Low Voltage Installations Earthing for more information.

Structures shall not be installed within 2 m of platform lighting columns. Refer to EP 12 10 00 21 SP for more information.

Structures should not be installed within a 2 m minimum clearance to metallic troughing. Where this clearance cannot be obtained, either two (electrical) isolating breaks should be installed in the troughing (one on each side of the structure), or a suitable insulating barrier installed. Refer to EP 12 10 00 21 SP for more information.

Refer to EP 12 10 00 21 SP for requirements at locations where the structures are close to station awning.

10.1.11. Structure location number

Following construction, each support structure shall be permanently labelled with its structure location number in accordance with T HR EL 08005 ST Labels for OHW Structures.
10.1.12. Bonding arrangements

Steel OHW structures at prescribed locations shall be bonded to rail by spark gap. Refer to EP 12 20 00 01 SP Bonding of Overhead Wiring Structures to Rail.

Where a cable feeding arrangement is installed on an OHW structure at a substation or sectioning hut, the steel structure shall be connected to the substation earth. Refer to EL 0011878.

Bonding arrangement with copper bonding cable shall be in accordance with EL 0011875. This should be used in locations where theft of the bonding cable is unlikely.

Bonding arrangement with steel bonding cable shall be in accordance with EL 0583866 to reduce copper theft.

EL 0002963 shows an arrangement for bonding isolated masts. The use of this arrangement is subject to an approved earthing and bonding design.

The particular rail to be bonded to the mast (that is, near or far rail of a track) shall be in accordance with the relevant track insulation plan.

10.2. Steel masts

Mast installation on station platforms should be avoided. Preference is given to portal structures which enable the structure leg to be placed well away from passenger entry and exit areas.

Unloaded masts should be nominally raked away from the track by 17 mm horizontally in 2000 mm vertical. 'Positive' rake is rake that leans away from the track being serviced. This is done to counteract the deflection on the mast when it is loaded.

Where the mast is located between tracks and back-to-back cantilever arrangements installed on the mast, the mast should be vertical (rake = 0 mm).

10.3. Steel portals

Wide knee-braces are used where cantilevers are installed within the knee-brace of a portal and the wire movement on the cantilever would cause the cantilever to foul the standard knee-brace. The clearance of the cantilever to the knee-brace shall be checked by the OHW designer.

Bolted splices and batten plates on portal bridges should be designed to be clear of the positions of drop verticals.
10.4. **Drop verticals**

The drop vertical length shall be calculated by the OHW designer to be long enough to allow the cantilever pull-off arrangement to be installed on the drop vertical and provide an additional 50 mm minimum for possible future adjustment.

However, the drop vertical shall not be so long as to foul the structure gauge. Refer to ESC 215 *Transit Space*.

RailCorp computer program 'DV_Position.xlt' may be used to determine and document drop vertical lengths and positions for all drop verticals on an OHW structure (user manual is available).

The minimum clearance to adjacent track shall be 1.55 m from adjacent track super centre-line to drop vertical face or any protruding bolts. Refer to ESC 215.

10.4.1. **Wood poles**

Wood poles shall not be used as permanent structures in new construction. Wood poles may be used as temporary structure for OHW support or registration only.

11. **Anchor arrangements**

Terminations and guys shall not be positioned on platforms.

Guy foundations shall be designed to resist uplift, horizontal and rotational displacement.

11.1. **Weight tensioner arrangement**

Weight tensioner arrangement requirements are provided in Table 18.

<table>
<thead>
<tr>
<th>Weight tensioner arrangement aspects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements</td>
</tr>
<tr>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Standard arrangement – main line OHW</td>
</tr>
<tr>
<td>EL 0237849</td>
</tr>
<tr>
<td>EL 0215130 (Twin masts arrangement to accommodate structure gauge clearance requirements).</td>
</tr>
<tr>
<td>Standard arrangement – alternative (heavy current) main line OHW</td>
</tr>
<tr>
<td>EL 0215038</td>
</tr>
<tr>
<td>Standard arrangement – siding OHW</td>
</tr>
<tr>
<td>EL 0237851 (for 270 / 193 OHW system), and EL 0023685 (for 165 / 193 OHW system).</td>
</tr>
<tr>
<td>EL 0237851 may also be used as non-preferred standard arrangement for 165 /193 OHW system, for example, where shallow weight stacks are required.</td>
</tr>
<tr>
<td>Weights</td>
</tr>
<tr>
<td>25 kg galvanised circular cast iron to EL 0011957.</td>
</tr>
</tbody>
</table>
Weight tensioner arrangement aspects | Requirements
--- | ---
**Weight guide** | Weight guides shall be installed as soon as the wire is tensioned. Refer to EL 0450662. The weight guide shall be installed so that it is not more than 10 mm out-of-plumb between its support brackets.

**Weight travel** | Tension regulators shall be free-moving for the conductor temperature range specified in Section 8. Weight assemblies shall not chaffe heavily on weight guides.

**Pre-tensioning the conductors** | Catenary and contact wires shall be held for two hours minimum at 50% above their final installed tension. The tension shall then be reduced to below the normal value and tensioned up to the correct value.

**Set-up** | RailCorp spreadsheet program 'WeightSet.xls' may be used to determine the optimum set up for each weight tension regulator. The designer shall complete the 'design' portion of the main table and hand over to the constructor for subsequent entries in the 'construction' portion. The main table shall be updated to show the as-built information and provided to the maintainer.

### 11.2. Gas tensioner

Gas tensioners shall not be used.

### 11.3. Spring tensioner

Spring tensioners shall not be used.

### 11.4. Fixed anchor

Arrangement drawings for OHW fixed anchor are provided in Table 19.

**Table 19 – Fixed anchor arrangement drawings**

<table>
<thead>
<tr>
<th>OHW type</th>
<th>Fixed anchor arrangement drawing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main line OHW</td>
<td>EL 0237850</td>
</tr>
<tr>
<td>Siding OHW</td>
<td>EL 0237852</td>
</tr>
<tr>
<td>Alternate (heavy current) main line OHW</td>
<td>EL 0215037</td>
</tr>
</tbody>
</table>

EL 0166885 is an alternate arrangement with free standing anchor mast (FSAM).

### 11.5. Midpoint anchor

Refer to EL 0009255 and EL 0009256 for midpoint anchor arrangement for main line OHW.

Refer to EL 0006282, EL 0006283 and EL 0006284 for midpoint anchor arrangement for siding OHW.
Refer to EL 0003512 and EL 0012047 for arrangement of midpoint anchor on multi-track portals.

The designer shall specify the virtual span applicable to the catenary bridle when used in the midpoint anchor arrangement.

12. **Overlap arrangements**

The requirements for overlap arrangements are provided in Table 20.

**Table 20 – Requirements for overlap arrangements**

<table>
<thead>
<tr>
<th>Overlap arrangements aspects</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductor spacing</td>
<td>The horizontal separation between the closest conductors of different wire run in the overlap bay should be 200 mm minimum, but may be reduced to 150 mm absolute minimum with approval by the relevant authority of the design AEO.</td>
</tr>
<tr>
<td>Location in relation to signals</td>
<td>Refer to T HR EL 08002 ST Relative Positions of Signals and Open Overlaps.</td>
</tr>
<tr>
<td>Single bay overlap</td>
<td>In order to minimise OHW equipment and conductors, preference should be given to designing an overlap over a single bay. Ideally use the short bay overlap design as shown in EL 0001110. In conjunction with the above arrangement drawing, use RailCorp computer program ‘Overlap.xlt’ to design suitable stagger and conductor heights, which are then to be documented on the relevant OHW layout drawing.</td>
</tr>
<tr>
<td>Main line OHW arrangement (non-preferred)</td>
<td>EL 0006697, EL 0006698 and EL 0006699</td>
</tr>
<tr>
<td>Main line heavy current OHW arrangement (non-preferred)</td>
<td>EL 0003445, EL 0006542 and EL 0006632</td>
</tr>
<tr>
<td>Siding OHW (non-preferred)</td>
<td>EL 0006416, EL 0006417 and EL 0006418</td>
</tr>
<tr>
<td>Scissors effect at overlap</td>
<td>50 mm maximum, but should design for 0 mm if this is possible.</td>
</tr>
<tr>
<td>Anchor pennants</td>
<td>Anchor pennants shall be clear of pantograph running under worst sag conditions. Particular care shall be taken for anchor pennants of fixed anchored overhead wiring in an overlap between regulated and fixed anchored wires.</td>
</tr>
</tbody>
</table>

13. **Section insulators**

The requirements for section insulators (SI) are provided in Table 21.
Table 21 – Requirements for section insulators

<table>
<thead>
<tr>
<th>Section insulators aspects</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard type</td>
<td>Section insulators shall be type approved. 'Type 6 S.I.' (manufactured by Galland) in accordance with EL 0166884 is the currently type approved product. Refer to EL 0030508 for simple catenary OHW systems. Refer to EL 0052290 for compound catenary OHW system.</td>
</tr>
<tr>
<td>SI location</td>
<td>It is preferred not to install section insulators in main line OHW.</td>
</tr>
<tr>
<td>Electric vehicle maintenance centres</td>
<td>Where a section insulator is installed between two electrical sections which may have significant voltage difference, measures shall be taken to control the risk of damage to the contact wire or the section insulator runners caused by bridging of the two sections by a stationary train pantograph at the section insulator.</td>
</tr>
<tr>
<td>Maximum operating speeds for Type 6 SI</td>
<td>Forward direction – 120 km/h. Reverse direction – 80 km/h (with auxiliary arcing horns installed).</td>
</tr>
<tr>
<td>Installation</td>
<td>SI’s are to be installed and inspected in accordance with the Type 6 Section Insulator Installation and Inspection Manual.</td>
</tr>
</tbody>
</table>

14. Switches

The requirements for switches are provided in Table 22.

Table 22 – Requirements for OHW switches

<table>
<thead>
<tr>
<th>Switch arrangement aspects</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous current rating</td>
<td>Sectioning switches for overhead wiring shall be rated at 3000 A.</td>
</tr>
<tr>
<td>Use of insulated cables</td>
<td>Screened insulated cables shall be used to connect a switch to overhead wiring over a track that is not adjacent to the switch. Bare aerial conductors from the termination of the insulated cables to the switch shall be kept as far away as practical, and not within 1.5 m of the centre of a track not associated with that electrical section. Where practical, insulated cables shall be used to cross OHW conductors over the same track, but of a different electrical section of the feeder. See Figure 2.</td>
</tr>
</tbody>
</table>
Switch arrangement aspects | Requirements
--- | ---
Standard switches | Refer to the following drawings for details of the standard switches:
| EL 0057425 – isolating and rail connecting switch (left hand)
| EL 0077250 - isolating and rail connecting switch (right hand)
| EL 0077251 – 2 pole isolating switch (left hand)
| EL 0077252 - 2 pole isolating switch (right hand)
| EL 0282734 – 2 position switch (left hand)
| EL 0282735 – 2 position switch (right hand)
| EL 0282806 – rail connecting switch (left hand)
| EL 0282807 – rail connecting switch (right hand)

Switch operators platform | Platform shall be directly bonded to the operating handle to provide a safe equipotential situation for the switch operator. Refer to EL 0491331 (preferred) or EL 0150615 (alternate).

Typical switch arrangement drawings | • EL 0455574
• EL 0232991
• EL 0237888
• EL 0237889
• EL 0026361
• EL 0282942 to EL 0282945

15. Feeding arrangements

The feeding arrangements requirements are provided in Table 23.

Table 23 – Requirements for feeding arrangements

| Feeding arrangements aspects | Requirements |
--- | ---
Conductor | OHW shall be fed from substations or sectioning huts with a minimum of two 400 mm² screened XLPE cables. The cables should be terminated onto a copper plate located adjacent to the track associated with the feeder. A minimum of two 270 mm² bare aerial conductors shall connect between the copper plate and the OHW conductors. For cable to aerial termination arrangements, refer to EL 0475906 (fitting 468/51 – twin cables) and EL 0287236 (fitting 468/55 – 3 or 4 cables).

Connection to catenary | Feeding from a substation or sectioning hut onto a catenary in tension is not allowed. The feeder wire shall be connected to the catenary either at a feeder loop formed in the catenary or at a 'tail' at a pennant insulator. (Refer to EL 0027472).
Feeding arrangements aspects | Requirements
---|---
Bare aerial feeders | Care shall be exercised with aerial feeder wires crossing near OHW of a different electrical section, to ensure the required electrical clearance (see Section 8.2) is maintained under extreme conditions (wind, wire movement, temperature, and so on).
Care shall also be exercised to ensure that bare aerial feeder wires are kept clear of an adjacent track not associated with that electrical section. A minimum distance of 1.5 m is required in this situation.
See Figure 2.
Allowance for conductor movement | Feeding arrangements shall be designed to ensure that feeders do not 'clash' and are not 'pulled', under the full range of conductor movement as a result of temperature changes, wind and electromagnetic forces.
Examples | EL 0065499 and EL 0011619
Typical feeding arrangements at overlaps | EL0008074 to EL0008076
Feeding loop arrangement | EL 0027472

Figure 2 - OHW feeding arrangement

## 16. Surge arresters

Surge arresters shall be installed on OHW at cable to aerial feeder junction locations.

Refer to EL 0475906 and EL 0287236 (arrangement fitting 468/51 and 468/55) for more information.
17. **Over-run protection**

Over-run protection is provided as a means of preventing damage to equipment if pantographs traverse into unwired sections of track. They generally allow the pantograph to extend to full travel without damaging the OHW, for example, skids at car sheds.

Refer to EL 0166574 for more information on skid arrangement at car shed.

18. **Signs**

Signs are required at strategic locations to warn or convey information about the OHW.

Typical signs are provided in Table 24.

<table>
<thead>
<tr>
<th>Locations</th>
<th>Signs requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level crossings</td>
<td>Refer to T HR EL 08003 ST for requirements of level crossing signs.</td>
</tr>
<tr>
<td>Goods yards and sidings</td>
<td>‘Danger – Beware of Overhead Wires’ positioned to be seen by persons approaching the hazard.</td>
</tr>
<tr>
<td>OHW structure identification</td>
<td>Refer to T HR EL 08005 ST.</td>
</tr>
<tr>
<td>Switch identification</td>
<td>Label to show designation in accordance with the operating diagram.</td>
</tr>
<tr>
<td>Switch position identification</td>
<td>Labels to designate the positions of the switch, for example, 'Closed' (red), 'Open' (green), 'To Rail' (blue).</td>
</tr>
<tr>
<td>Electric train stop boards</td>
<td>Provided by signals discipline. Refer to SPG 1210 Signalling Signs and Instruction Plates.</td>
</tr>
<tr>
<td>Feeder mast spark gap sign</td>
<td>Refer to EL 0004851 (fitting 330/31) for details of sign. This sign is installed on a feeder mast to warn that a spark gap should not be installed (Refer to cable feeding arrangement in EL 0011878).</td>
</tr>
</tbody>
</table>

19. **Data set associated with overhead wiring**

The data set specified in Section 19.1 to Section 19.5 shall be maintained for all OHW installations. This data shall be the property of TfNSW and shall be kept up-to-date by the AEO responsible for maintaining the overhead wiring.

19.1. **Electrified track kilometrage**

Electrified track kilometrage is the total length of tracks for which OHW is installed. Measurements for the purpose of electrified track kilometrage are defined in Table 25.
Table 25 – Electrified track kilometrage

<table>
<thead>
<tr>
<th>Track</th>
<th>Measurement for electrified track kilometrage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main line</td>
<td>From Sydney-end of the Sydney-end overlap to the Sydney-end of the country-end overlap for each wire run</td>
</tr>
<tr>
<td>Crossover</td>
<td>From toe of Sydney-end points to toe of country-end points</td>
</tr>
<tr>
<td>Sidings (loops)</td>
<td>From toe of Sydney-end points to toe of country-end points</td>
</tr>
<tr>
<td>Sidings (dead end)</td>
<td>From toe of points to the buffer stop</td>
</tr>
</tbody>
</table>

19.2. Overhead wiring design documentation

See Section 6.1 for a list of typical OHW design products, all of which need to be kept up-to-date by the maintenance AEO.

19.3. Design data for construction

See Section 6.2 for various construction data, such as CCALCs, Dropper Calcs, and so on. This should also be kept readily available for reference.

19.4. Field measurements and test data

The records of the results of tests stipulated in Section 7.4 shall be maintained.

19.5. Concessions

The records for all concessions applicable to the overhead wiring installation shall be maintained.
Appendix A  Derivation of minimum contact height for regulated overhead wiring

The minimum contact height for regulated OHW is derived from the information provided in Table 26.

Table 26 – Derivation of minimum contact wire height

<table>
<thead>
<tr>
<th>Component</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rolling stock static height</td>
<td>4.42 m</td>
</tr>
<tr>
<td>Electrical clearance</td>
<td>0.15 m</td>
</tr>
<tr>
<td>Absolute minimum contact height</td>
<td>4.57 m</td>
</tr>
<tr>
<td>Allowance for overhead wiring dynamics</td>
<td>0.05 m</td>
</tr>
<tr>
<td>Allowance for vehicle bounce (Refer to ESC 215)</td>
<td>0.05 m</td>
</tr>
<tr>
<td>Track vertical tolerance (Refer to ESC 210 for allowable tolerances of rail levels in restricted height areas)</td>
<td>0.03 m</td>
</tr>
<tr>
<td>Overhead wiring construction tolerance (see Section 8.3)</td>
<td>0.05 m</td>
</tr>
<tr>
<td>Minimum design contact height</td>
<td>4.75 m</td>
</tr>
</tbody>
</table>

The design contact height at support locations may need to be increased to take into consideration the effects of:

- Pre-sag (see Section 8), with a 67 m bay, the effect of pre-sag is that the contact wire height at mid-bay is lowered by 0.07 m when compared with a flat contact wire profile.
- Variation in catenary tension (see Section 8), for the regulated OHW conductor systems nominated in Section 8.4, a 10% reduction in catenary tension in a 67 m bay increases the sag of the catenary wire in the bay by 0.11 m.
- Where the location is not in restricted height areas, the track vertical tolerance should be increased to 0.05 m. The minimum design contact height should then be increased by 0.02 m accordingly.

The standard contact height for a conductor system (see Section 8.1) is usually higher than that derived above to allow for:

- track maintenance
- future upgrades, such as larger rolling stock, possible ac electrification, or changes in infrastructure configurations

The standard contact height should be used in the design of new electrification or major overhaul of existing infrastructure, unless measures are in place to control maintenance activities, possible upgrades and the tolerances set out above.
Appendix B  Adjustment of existing OHW when the track under existing OHW is moved

OHW and track design both reference the track control mark (often referred to as the ramset nail) normally installed in OHW structures. From a movement perspective, the OHW normally does not move, as it is attached to fixed structures; however, the track over time can move out of alignment. Periodically, the track can be either put back to its original design geometry, put to new design geometry, or a combination of the two.

The purpose of this appendix is to define when the OHW is required to be redesigned and the requirements when track is moved under existing OHW.

Example scenarios are those associated with track upgrading, track reconditioning, track resurfacing, ballast cleaning, tamping and turnout renewals.

Adjustment of the track is normally to either:

- move the track in accordance to the existing design geometry
- move the track to a new design geometry

The OHW adjustment design approach when the track is to be maintained or moved to the existing design geometry is to allow for design outside of the parameters in this standard but within the maintenance triggers of T HR EL 08011 ST.

The OHW adjustment design approach when the track is to be moved to a new track design is to apply the parameters as specified in this standard.

B.1. Maintain the track in accordance to the existing design geometry

Where track is to be maintained in accordance with the existing design geometry then OHW redesign should not normally be required. OHW designers will be required to confirm that the OHW surveyed will be suitable for train running. This should be documented in a noncompliance report.
The fundamental 'in running' design parameter limits that apply with reference to Figure 3 are provided in Table 27 and Table 28.

**Table 27 - Design parameter limits**

<table>
<thead>
<tr>
<th>Design parameter</th>
<th>Applicable limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact wire stagger</td>
<td>Maximum 430 mm design. This allows for track construction tolerance and diversification factors. Maximum 460 mm construction (that is, on site measurement).</td>
</tr>
<tr>
<td>Contact wire displacement</td>
<td>Due to mid bay stagger and conductor blowout anywhere in the bay - maximum 430 mm for design and 460 mm for construction to superelevated track centreline.</td>
</tr>
<tr>
<td>Contact wire height</td>
<td>Fixed-anchored and regulated tension contact wire height above track - Maximum 5.8 m and minimum 4.75 m for open route, 4.65 m for low bridges.</td>
</tr>
<tr>
<td>Horizontal distance to pull-off arm heel</td>
<td>Horizontal distance between heel of pull-off arm and superelevated track centreline - minimum of 1250 mm.</td>
</tr>
<tr>
<td>Pull-off arm heel height</td>
<td>Can only be positive (that is, at or above contact wire level).</td>
</tr>
<tr>
<td>Drop vertical clearance</td>
<td>Horizontal distance from drop vertical face to superelevated track centreline – minimum of 1500 mm.</td>
</tr>
</tbody>
</table>
### Table 28 – Maximum contact gradient

<table>
<thead>
<tr>
<th>Maximum train speed (km/h)</th>
<th>Maximum contact wire gradient</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>1:40</td>
</tr>
<tr>
<td>60</td>
<td>1:50</td>
</tr>
<tr>
<td>100</td>
<td>1:167</td>
</tr>
<tr>
<td>120</td>
<td>1:250</td>
</tr>
<tr>
<td>160</td>
<td>1:300</td>
</tr>
</tbody>
</table>

When OHW adjustments are considered necessary, that is beyond the parameters in Table 27 and Table 28 then a re-design is required in accordance with the requirements for new OHW.

If OHW adjustments when applying this standard result in adjustments to too many locations, or adjustments go beyond the initial area of work, an options report can be submitted to the design authority for OHW design delivery and design assurance of the relevant AEO for consideration. The scoping of the options report should be discussed with the design authority for OHW design delivery and design assurance of the relevant AEO prior to preparation and will nominally address the following as a minimum:

- when the OHW was first installed and type of OHW, as this determines the design parameters used
- pantograph security including site specific circumstances that may affect the design limit conditions, for example, presence of structures, shielding OHW from winds and so on
- existing asset condition, whether life expired or relatively new, including availability of spares
- original design of line section, related to cascading effect from bay to bay (for example, Liverpool to Glenlee, contact staggered but not catenary on tangent track)
- the number and magnitude of existing noncompliances with respect to electrification standards within the scope of the project
- cost differential for options to be considered
- availability of track possessions

#### B.2. Move the track to new design geometry

Where track is to be moved to a new design geometry the requirements for new OHW apply.

Where a crossover is being replaced in a different location to existing without changing the design of the mainline, the crossover should be designed to the requirements for new OHW, while the mainline is assessed under Section B.1.

When OHW adjustments are considered necessary then a re-design to the requirements for new OHW is required.
Where there are minor changes only to the existing design track geometry and application of the requirements for new OHW is considered excessive, the design authority for OHW design delivery and design assurance of the relevant AEO can be consulted for a design approach on a case by case basis. All decisions resulting from this consultation should be documented on the project file.

The designer should prepare a noncompliance report and design proposal options as the first stage in this consultation. Typical list of factors to be addressed include (but not limited to):

- standards applicable when the OHW was first installed, such as structure spacing
- scale of adjustment available in existing equipment
- manufacturing and spares availability
- condition of existing equipment
- utilisation of current standard arrangements (to benefit from latest technology and safety consideration)
- reduction of maintenance tasks and inspection requirements
- ease of construction or adjustment
- costs
- safety in design

**B.3. Documenting adjustments to OHW**

In assessing whether a re-design is necessary, the following documentation should be produced:

a. **NCR – noncompliance report**

   This is used to compare survey of existing OHW to existing track and existing OHW to new track design without any OHW changes. This should assist in determining if OHW adjustments are required. This includes providing layout plans to a scale of 1:200 for areas with a junction, crossover or turnout.

b. **OHW adjustment spreadsheet**

   If OHW adjustments are required, a table format is required to be submitted for design review and subsequent construction of OHW adjustments, including a handover sheet showing design and installed values of critical parameters. The parameter limits used should be reflected in the handover sheet, to verify that these limits are not exceeded by construction tolerances, and reference the TCM for each structure location.
c. OHW design documentation

If the original OHW design is altered, such as height of OHW to mean rail level, suspension or cantilever type, standard stagger, all applicable design documentation, such as layout, cross section, bridge arrangement, CCalc's to be altered and produced as required shall document the change. These shall be submitted for approval or acceptance as the OHW design proposal.

d. Overline bridges

Where overline bridges are encountered and OHW adjustment is necessary, a profile drawing shall be submitted with a scale of 1:50 vertical and 1:500 horizontal to demonstrate the clearances to bridges. Bay lengths, structure location numbers, track profile and reduced levels (RL) shall be shown for the underside of bridge, mean track level, catenary and contact wires with critical clearances clearly shown.

e. Drop verticals

Where drop verticals are required to be adjusted or installed a ‘Drop Vertical Length and Position Table’ produced using the tool DV_position.xlt should be forwarded as part of the design proposal.

f. Overlaps

Where OHW adjustments are required in overlaps then the Overlap Security tool Overlaps.xlt should be utilised and results provided as part of the design proposal.

g. Tunnels

Where tunnels are encountered or other areas with restricted clearances not covered in the above sections, a pantograph gauge analysis using the tool Panguage.xlt should be forwarded as part of the design proposal.

For accessing these tools, contact your AEO representative.

B.4. As-built design

‘As built’ design shall be submitted following completion of the site works and either:

- reference the new proposed layout or cross section on the existing drawings

or

- incorporate the changed design onto existing drawings (preferred) and cancel or supersede the ‘for construction’ design drawings produced for the works

The approach will be as determined by the design authority for OHW design delivery and design assurance of the relevant AEO, and accepted by the relevant authority of the maintenance AEO.
As-built drawings shall be produced and submitted for acceptance and approval shall be supplied in Microstation format and pdf.

Survey of as-built OHW shall be based on ISG co-ordinate system, or MGA as relevant, and reduced levels (RL's) to Australian Height Datum (AHD)