Important Warning

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Preface

The Asset Standards Authority (ASA) develops, controls, maintains, and publishes standards and documentation for transport assets for New South Wales, using expertise from the engineering functions of the ASA and industry.

ASA publications include the network and asset standards for NSW rail assets. ASA publications include RailCorp engineering standards that were previously managed by RailCorp until July 2013.

This standard supersedes RailCorp standard EP 08 00 00 13 SP *Overhead Wiring Fittings and Materials*, Version 3.0.

The changes to previous content include:

- updates to reflect organisation changes and resulting changes in responsibilities
- minor amendments and clarification to content
- conversion of the standard to ASA numbering, format and style
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1. **Scope and application**

This document specifies the requirements for new fittings and materials that are to be used in the RailCorp 1500 V dc Overhead Wiring (electrical traction) System.

Existing non-complying fittings may remain in service and must only be used for the replacement of damaged fittings of the same type, unless explicitly prohibited.

2. **References**

See references listed in each section.

3. **Terms and definitions**

- **AEO** Authorised Engineering Organization
- **ASA** Asset Standards Authority
- **NSW Rail Assets** Refer to the ASA Charter for the definition of NSW Rail Assets
- **TfNSW** Transport for New South Wales

4. **General**

4.1 **Work health and safety**

Fittings shall be designed, and materials shall be selected so that risks of injury to persons involved in manufacture, fabrication, storage, handling, installation, maintenance and disposal are reduced to as low as reasonable practicable (ALARP). Possible potential hazards may include:

- excessive weight
- sharp edges and burrs
- toxic emissions during manufacture
- hazardous substances, e.g. lubricants, coating, dusts

4.2 **Vibration and cyclic loading**

Fittings shall be designed to maintain their integrity when subjected to conditions of vibration and cyclic loading that might reasonably be expected in service.
4.3 Tools

Fittings shall be designed so nuts/bolts can be tensioned using long wall sockets (approximately 85 mm deep) and ratchet wrenches where possible. Allowance must be made for clearance for the head of the ratchet.

If the design and/or application does not allow for the use of long wall socket and ratchet wrenches, standard ring or flat spanners may be used.

4.4 Maintainability

Fittings shall be designed to facilitate the convenient and safe replacement of components in service. Factors that shall be taken into consideration may include providing adequate rigging points and the ease of attachment and removal of components e.g. split pins.

4.5 Safety factors

The design of new overhead wiring fittings must include safety factors as specified in Sections 5 and 6.

4.6 Metallurgical compatibility

Dissimilar metals shall not be connected together unless test results indicate that the electrolytic action between them will not result in corrosion of the metals.

4.7 Inventory minimisation

Where practicable, the design of overhead wiring fittings should facilitate the minimisation of inventory for the overhead wiring system.

Prior to designing a new overhead wiring fitting, the Designer should check for the existence of similar fittings. The feasibility of modifying existing fittings to suit both existing and new requirements should be considered.

4.8 Quality assurance

4.8.1 Quality system of suppliers

4.8.1.1 Accreditation

Overhead wiring fittings shall be sourced from suppliers that are certified to the latest edition of AS/NZS ISO 9001.

Details of the provisions in the quality system that demonstrate compliance of the product with relevant Transport, Australian and international standards and specifications shall be provided to, and accepted by, the Authorised Engineering Organization (AEO) procuring the material.
4.8.1.2 Type tests

Type tests are required for all new fittings prior to their introduction to the overhead wiring systems, unless it can be shown that the fitting is substantially similar to an existing fitting.

Tests shall be performed by a National Association of Testing Authorities Australia (or ASA approved equivalent) registered test facility in accordance with the specifications provided in the design and approved by the Lead Electrical Engineer, ASA.

4.8.1.3 Batch conformance

The manufacturer or supplier shall provide details in their quality system that demonstrate batch conformance for the product. Where inspection and tests are required, Test Certificates issued by a National Association of Testing Authorities Australia (or ASA approved equivalent) registered test facility shall be supplied with the delivery of the batch.

4.8.2 Acceptance inspection and tests

The organisation receiving the material shall check that appropriate compliance and test certificates are provided by the supplier. The material received shall also be subjected to appropriate inspection and testing within the organisation to ensure that the material is fit for installation. Within Sydney Trains, this requirement is satisfied through Logistics Procedure LOG-711-PR-001 “Inspection, Testing and Traceability”. Under this procedure, overhead wiring materials are assigned inspection codes in accordance with the criticality of the material. The inspection and testing requirements for each inspection category are listed in Table 1.

<table>
<thead>
<tr>
<th>Inspection code</th>
<th>Inspected by</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>Receiving Officer</td>
<td>Check delivery docket / transport slip against order. Visual inspection for any damage.</td>
</tr>
<tr>
<td>2R</td>
<td>Receiving Officer</td>
<td>Check delivery docket / transport slip against order. Check that Part A of Material Certificate of Conformance (Form LOG-711-FM-005) has been completed by supplier. Visual inspection for any damage</td>
</tr>
<tr>
<td>3X</td>
<td>Materials Inspector authorised by the Senior Materials Engineer, Electrical Design</td>
<td>Check dimensions and tolerances, surface finish, packaging and general quality of workmanship. Check that Part A of Material Certificate of Conformance has been completed by supplier</td>
</tr>
<tr>
<td>4E</td>
<td>Senior Materials Engineer, Electrical Design</td>
<td>Check dimensions and tolerances, surface finish, packaging and general quality of workmanship. Check that Part A of Material Certificate of Conformance has been completed by supplier. Check that the material meets design intent. Conduct suitable tests on samples if required from inspection of the material or records of past performance.</td>
</tr>
</tbody>
</table>
### Inspection code | Inspected by | Description
--- | --- | ---
5E | Senior Materials Engineer, Electrical Design | All checks for 4E, plus:
Examine test certificates to confirm that all test requirements are complete and satisfactory
Conduct engineering tests as stipulated in Transport standards and drawings.

4T | Receiving Officer | Check delivery docket / transport slip against order.
Check that timber inspector certificate from Forests NSW or ASA approved equivalent is provided.

For external organisations, this requirement may be satisfied by having materials supplied by the Logistics section of Sydney Trains. This is the preferred materials supply arrangements by ASA.

If an external organisation decides not to have materials supplied through Sydney Trains Logistics, details of their material inspection and testing system, including procedures, instructions, and the persons involved shall be submitted to ASA. Approval of the system by the Lead Electrical Engineer, ASA is required prior to the release for construction of any overhead wiring materials.

#### 4.8.3 Performance of suppliers

The performance of suppliers with respect to the quality of materials shall be monitored and recorded. The acceptance inspection and testing requirements may be adjusted as a result of the past performance of the supplier.

#### 4.9 Packaging and delivery

Goods delivered shall be suitably packaged in accordance with relevant Transport standards and specifications, and comply with the relevant requirements of AS 2400.

Packets that may require manual handling shall be appropriately packaged to minimise the risk of personal injury or damage to material due to manual handling.

Where special arrangements, such as the provision of cranes, are required to take delivery of goods, the supplier shall advise the receiving organisation of the requirements and with sufficient time to allow for such arrangements to be made.

### 5. Material based rules

#### 5.1 Copper and high copper alloys

Refer to AS 2738:2000 for the definition of copper and high copper alloys.

#### 5.1.1 Reference standards

AS 1565:1996 Copper and copper alloys – Ingots and castings
AS 1566:1997 Copper and copper alloys – Rolled flat products
AS/NZS 1567:1997 Copper and copper alloys – Wrought rods, bars and sections
AS/NZS 1568:1998 Copper and copper alloys – Forging stock and forgings
AS 1572:1998 Copper and copper alloys – Seamless tubes for engineering purpose
AS/NZS 1573:1995 Copper and copper alloys – Wire for engineering purposes
AS/NZS 1574:1996 Copper and copper alloys – Wire for electrical purposes
AS 1746:1991 Conductors – Bare overhead – Hard-drawn copper
AS 2738:2000 Copper and copper alloys – Compositions and designations of refinery products, wrought products, ingots and castings

5.1.2 Approved alloys and applications

For fabricating, the approved alloy designation is C11000 (Electrolytic tough pitch copper) in accordance with AS 2738:2000.

Cable terminating plates AS 1566:1997, Designation C11000.
For stranded copper conductors refer to Section 6.1.
For contact wires refer to Section 6.2.

5.1.3 Prohibited applications

Castings of copper or high copper alloys shall not be used in applications requiring line tension.

5.1.4 Safety factor

Unless otherwise specified in Section 6, the safety factor shall not be less than three.

5.1.5 Surface finish

Fabrications and castings shall be clean, smooth and free from sharp edges.

Electrical contact surfaces shall have a minimum surface finish of Ra 3, 2 in accordance with AS ISO 1302:2005.

Machining is required to achieve this surface finish for sandcast components.
Machining is not required for investment cast components.
5.1.6 Tolerances
In accordance with the relevant Australian standards unless otherwise specified on the relevant drawing.

5.1.7 Acceptance criteria
Copper/copper alloys must comply with the relevant Australian standards with the exception that the only marking required on copper castings (AS 1565:1996, clause 9.2) is the fitting number, or the identification as required by the details shown on the fitting drawing.

5.2 Brass and gunmetal castings
Refer to AS 2738:2000 for the definition of brass.

For the purpose of this document gunmetal is copper alloy C92610A in accordance with AS 1565:1996.

5.2.1 Reference standards
AS 1154.1:2009 Insulator and conductor fittings for overhead power lines – Part 1: Performance, material, general requirements and dimensions
AS 1565:1996 Copper and copper alloys – Ingots and castings
AS 1568:1998 Copper and copper alloys – Forging stock and forgings
AS 2738:2000 Copper and copper alloys – Compositions and designations of refinery products, wrought products, ingots and castings

5.2.2 Approved alloys and applications
The approved alloys are Designations C85710 and C92610A to AS 1565:1996.

These alloys are approved for components in contact with copper conductors.

5.2.3 Prohibited applications
There are no prohibited applications for brass or gunmetal castings.

5.2.4 Safety factor
The safety factor shall not be less than four.

5.2.5 Surface finish
Electrical contact surfaces shall have a minimum surface finish of Ra 3.2 in accordance with AS ISO 1302:2005.

Machining is required to achieve this surface finish for sandcast components.
Finishing is not required for investment cast components.

5.2.6  **Tolerances**
In accordance with the relevant Australian standards unless otherwise specified on the relevant drawing.

5.2.7  **Design requirements**
The design for sandcast items shall consider minimum radii on all corners and adequate draw (taper) for cored holes to facilitate the casting process.

5.2.8  **Acceptance criteria**
Micro and gas porosity must be minimal and consistent with best casting practices.
All castings shall be free of visible shrinkage porosity.
Line tension castings must not be subject to remedial treatment to conceal shrinkage porosity.
Line tension fittings shall satisfy all relevant testing requirements of AS 1154.1:2009.

5.3  **Mild steel**
For the purpose of this document mild steel refers to the range of steel for which AS/NZS 3678:2011 and AS/NZS 3679:2010 are applicable.

5.3.1  **Reference standards**
AS 1111:2000 ISO metric hexagon bolts and screws
AS 1112:2000 ISO metric hexagon nuts
AS 1154.1:2009 Insulator and conductor fittings for overhead power lines – Part 1: Performance, material, general requirements and dimensions
AS 1237:2002 Plain washers for metric bolts, screws and nuts for general purposes
AS 1721:1985 General purpose metric screw threads
AS/NZS 3678:2011 Structural steel – Hot-rolled plates, floorplates and slabs
AS/NZS 3679.1:2010 Structural steel – Part1: Hot-rolled bars and sections
AS/NZS 3679.2:2010 Structural steel – Part 2: Welded I sections
AS 4100:1998 Steel structures
AS/NZS 4680:2006 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
AS/NZS 4792:2006 Hot-dip galvanised (zinc) coatings on ferrous hollow sections, applied by a continuous or a specialized process
5.3.2 Approved grades and applications

Mild steel shall be of minimum grade 250 to AS/NZS 3678:2011 and of minimum grade 300 to AS/NZS 3679.1:2010 as applicable. Approved applications include:

- brackets
- chains
- turnbuckles
- pull off arms
- connecting pins
- U bolts

Material for mild steel fasteners shall be to the relevant Australian Standard referred to in Section 5.3.1.

5.3.3 Prohibited applications

Punched holes are not permitted in mild steel sections due to high stresses created around the punched holes.

5.3.4 Safety factor

The safety factor shall not be less than three.

5.3.5 Welding

Seal welding must be used if two sections are to be welded together.

Holes must not be drilled through two sections that are lapped as the interface within the hole will not be sealed or have a continuous coating of galvanizing and would create a point where corrosion can occur.

5.3.6 Surface finish

- remove sharp edges and burrs
- remove slag and scale from welds by chipping, wire brushing and grit blasting prior to galvanizing
- galvanized in accordance with AS/NZS 4680:2006 or AS/NZS 4792:2006 as appropriate

5.3.7 Tolerances

In accordance with the relevant Australian standards.
5.3.8 Design requirements
The minimum edge distances specified in AS 4100:1998 are not applicable to overhead wiring fittings. Refer to AS 1154.1:2009 for applicable requirements.

5.3.9 Acceptance criteria
In accordance with the relevant Australian standards.

5.4 Cast iron
For the purpose of this document cast iron refers to castings from the range of iron alloys for which AS 1830:2007 and AS 1831:2007 are applicable.

5.4.1 Reference standards
AS 1214:1983 Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
AS 1830:2007 Grey cast iron
AS 1831:2007 Ductile cast iron
AS/NZS 4680:2006 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles

5.4.2 Approved alloys and applications
Tension Regulator Weights AS 1830:2007, Designation ISO 185/JL/150

5.4.3 Prohibited applications
Cast iron shall not be used for current carrying components.

5.4.4 Safety factor
The safety factor shall not be less than four.

5.4.5 Surface finish
Surfaces shall be free from burrs and sharp edges before galvanizing.
Galvanized in accordance with AS/NZS 4680:2006.

5.4.6 Tolerance
In accordance with the relevant Australian standards.

5.4.7 Acceptance criteria
In accordance with the relevant Australian standards.
5.5 Stainless steel fabrications and bolts

Stainless steel refers to steel that contains a high percentage (8 to 25%) of chromium.

5.5.1 Reference standards

- AS 2837:1986 Wrought alloy steels – Stainless steel bars and semi-finished products
- ASTM A276-13a Standard Specification for Stainless Steel Bars and Shapes

5.5.2 Approved alloys and applications

Applications:

- Connecting pins See Section 6.6.2
- Welded components, e.g. bridge attachment bolt ASTM A276-13a Type 321
- Shaft, e.g. tension regulator pulley shafts ASTM A276-13a Type 431
- Bolts See Section 6.5.2
- U-Bolts See Section 6.5.2

5.5.3 Prohibited applications

Stainless steel must not be used to conduct 1500 V dc. The use of stainless steel for live equipment is only permitted in cases where there is a low resistance parallel path, e.g. U-bolt type feeder clamps, or where the component is insulated so that no current can flow.

5.5.4 Safety factor

The safety factor shall not be less than three.

5.5.5 Heat treatment

If components are hot formed, then they must be heat treated in accordance with the relevant Australian and ASTM standards.

5.5.6 Surface finish

Fabricated components shall have all burrs and sharp edges removed. Where tolerances more stringent than those specified in the relevant Australian standards are required, more accurate manufacturing methods, such as smooth grinding or polishing must be used.

5.5.7 Tolerances

In accordance with the relevant Australian or international standards.

- Tolerance for smooth ground finish: + 0, - 0.08 mm.
- Tolerance for polish finish: + 0, - 0.062 mm.
5.5.8 Acceptance criteria
Refer to Sections 6.5.2 and 6.6.2.

5.6 Stainless steel castings
Refer to Section 5.5 for the definition of stainless steel.

5.6.1 Reference standards
AS 2074:2003 Cast steels.

5.6.2 Approved alloys and applications
Grade H5A alloy shall be used for all investment cast austenitic (300 series) stainless steel fittings.
Exception: Type 431 stainless steel shall be used for contact wire wedges.

5.6.3 Prohibited applications
Grade H5B alloy shall not be used due to problems with grain boundary carbides.
Stainless steel must not be used to conduct 1500 V dc. The use of stainless steel for live equipment is only permitted in cases where there is a low resistance parallel path, or where the component is insulated so that no current can flow.

5.6.4 Safety factor
The safety factor shall not be less than four.

5.6.5 Heat Treatment
Grade H5A items shall be heat treated in accordance with AS 2074:2003.

5.6.6 Surface treatment
Grade H5A items shall have all surfaces passivated with a suitable acid treatment.
Grade 431 items require no surface treatment.

5.6.7 Tolerances
The tolerances on angles shall be +/- 1 degree and dimensions shall be +/- 0.2 mm, unless otherwise specified.
5.6.8 Acceptance criteria

5.6.8.1 Type tests
Sample fittings shall be subjected to tensile and/or compressive loads to prove suitability for in service duty.

Samples shall be tested to destruction to verify that the safety factor requirements are met.

Accelerated weathering and ageing tests shall be carried out to prove that the fitting is suitable for the in service environment.

Sample fittings shall be subjected to a composition analysis.

5.6.8.2 Batch acceptance tests
A batch of material grade H5A fittings (i.e. from the same melt) is deemed acceptable when:

- samples of randomly selected fittings comply with physical dimensions on the drawing.
- a composition analysis, in accordance with AS 2074:2003, for samples from each melt meets specification

No hardness test is required for H5A material.

A batch of material Type 431 fittings (i.e. from the same melt) is deemed acceptable when:

- samples of randomly selected fittings comply with physical dimensions on the drawing
- one fitting randomly selected from each heat treatment batch satisfies the Brinell hardness test (300 – 350 Brinell)
- a composition analysis, in accordance with AS 2074:2003, for samples from each melt meets specification

For the hardness test and composition analysis, it is acceptable that the same fitting be used.

5.6.9 Batch identification
Depending on the physical constraints of suitable space, all stainless steel castings shall be marked to identify the manufacturer and manufacturer’s job or batch number. Markings shall be positioned to be visible when the component is assembled.

5.7 Aluminium

5.7.1 Reference standards
AS/NZS 1734:1997 Aluminium and aluminium alloys – Flat sheet, coiled sheet and plate

AS 2342:1992 Development, testing and implementation of information and safety symbols and symbolic signs
5.7.2 **Approved alloys and applications**

Marine grade aluminium alloys in accordance with AS/NZS 1734:1997 shall be used for warning signs and labels.

5.7.3 **Safety factor**

The use of a safety factor is not applicable to the applications currently approved.

5.7.4 **Surface finish**

Surfaces shall be clean, smooth and free from sharp edges.

5.8 **Polymeric materials**

5.8.1 **Approved materials and applications**

<table>
<thead>
<tr>
<th>Application</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulators</td>
<td>Refer to Section 6.4</td>
</tr>
<tr>
<td>Cantilever jib thrust washers</td>
<td>15% Glass filled Polytetrafluoroethylene (P.T.F.E)</td>
</tr>
<tr>
<td>Twin contact dropper link bar</td>
<td>Zytel 74G33W BK196</td>
</tr>
<tr>
<td>Insulating block for short dropper</td>
<td>Delrin acetal resin</td>
</tr>
<tr>
<td>Insulated dropper sleeve</td>
<td>Amidene AM90/1 R01 Black</td>
</tr>
<tr>
<td>Insulation for connections between conductors in compound system</td>
<td>Neoprene Compound C4 70 Duro to ASTM C864</td>
</tr>
<tr>
<td>Supplementary insulation for OHW fitting attachments to structures</td>
<td>Acetal copolymer (black) 'Sustarin C'</td>
</tr>
</tbody>
</table>

5.8.2 **Ultraviolet protection**

Polymeric materials shall be protected against degradation by ultra-violet radiation.

5.9 **Laminated timber**

Not for future use.

6. **Application based rules**

6.1 **Stranded Conductors**

6.1.1 **Referenced standards**


AS 1746:1991 Conductors – Bare overhead – Hard-drawn copper

AS 2738:2000 Copper and copper alloys – Compositions and designations of refinery products, wrought products, ingots and castings
6.1.2 Suitable materials

Unless otherwise specified, stranded conductors shall be made from alloy Designation C11000 – Electrolytic tough pitch (ETP) copper in accordance with AS 2738:2000 / AS 1746:1991. The wire shall be hard (H) drawn in accordance with AS/NZS 1574:1996.

Tin bearing copper alloy, consisting of ETP copper in accordance with AS 2738:2000 with an addition of 0.30% by weight of commercially pure tin, may be used where increased strength is required (note the reduced conductivity).

6.1.3 Safety factors

A safety factor of at least three (referenced to the Calculated Breaking Load) shall apply.

6.1.4 Prohibitions

Rope (Hauser) laid conductors shall not be used.

6.1.5 Tolerances

In accordance with AS 1746:1991.

6.1.6 Acceptance criteria

Each drum of wire shall be covered by a certificate of compliance in accordance with AS 1746:1991.

6.1.7 Approved applications

6.1.7.1 Catenary wire

<table>
<thead>
<tr>
<th>Material</th>
<th>C11000 ETP copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lay (Note 1)</td>
<td>Right hand</td>
</tr>
<tr>
<td>To Standard</td>
<td>AS 1746:1991</td>
</tr>
</tbody>
</table>

*Note 1: Existing left hand lay may remain in service. No further left hand lay conductors shall be installed.*
Table 4 – Catenary wires

<table>
<thead>
<tr>
<th>Nominal area (mm²)</th>
<th>Conductor Stranding – No. of Strands / strand diameter (mm)</th>
<th>Conductor Diameter (mm)</th>
<th>Mass (Kg/m)</th>
<th>Calculated Breaking Load (kN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>510</td>
<td>37/4.19</td>
<td>29.34</td>
<td>4.62</td>
<td>181.9</td>
</tr>
<tr>
<td>327</td>
<td>37/3.35</td>
<td>23.47</td>
<td>2.95</td>
<td>121.2</td>
</tr>
<tr>
<td>270</td>
<td>37/3.05</td>
<td>21.34</td>
<td>2.45</td>
<td>101.9</td>
</tr>
<tr>
<td>267 (Note 1)</td>
<td>61/0.093 in</td>
<td>21.26</td>
<td>2.42</td>
<td>103.9</td>
</tr>
<tr>
<td>179 (Note 2)</td>
<td>19/3.48</td>
<td>17.40</td>
<td>1.63</td>
<td>66.8</td>
</tr>
<tr>
<td>165</td>
<td>19/3.35</td>
<td>16.75</td>
<td>1.51</td>
<td>62.2</td>
</tr>
</tbody>
</table>

Note 1: 61/0.093in (0.4 square inch) wire may remain in service. No further 61/0.093in conductors shall be installed.

Note 2: Auxiliary catenary for existing overhead wiring system 27. Refer to EP 08 00 00 16 SP Designations of Overhead Wiring Conductor Systems

6.1.7.2 In span feeder wire

Material: C11000 ETP copper.

Stranding: 91/1.12mm.

Lay ratio: Maximum of 10 to 1.

6.1.7.3 Span Wire

Material: Tin bearing copper alloy.

Stranding: 37/1.75 mm.

6.2 Contact wire

For contact wire information, refer to EP 08 00 00 24 SP Contact Wire.

6.3 Splices and terminations for stranded conductors

6.3.1 Reference standards

AS 1154.1:2009 Insulator and conductor fittings for overhead power lines – Part 1: Performance, material, general requirements and dimensions

AS 1154.3:2009 Insulator and conductor fittings for overhead power lines – Part 3: Performance and general requirements for helical fittings
6.3.2 **Approved splices / terminations**

Splices and terminations for stranded conductors shall comply with AS 1154.1:2009.

Helical wrap-on fittings shall also comply with AS 1154.3:2009.

For span wire, a copper twisted jointing sleeve or U-bolt wire clips may be used because of space limitations.

6.3.3 **Acceptance criteria**

6.3.3.1 **Type tests**

Type tests shall be in accordance with AS 1154.1:2009 and AS 1154.3:2009 as applicable.

6.3.3.2 **Batch acceptance tests**

Batch acceptance tests shall be in accordance with AS 1154.1:2009 and AS 1154.3:2009 as applicable.

6.4 **1500V dc insulators**

For post insulators units refer to EP 08 00 00 19 SP *Performance Specification for Overhead Wiring Post Insulator Units*.

For string insulator units refer to EP 08 00 00 20 SP *Performance Specification for Overhead Wiring String Insulator Set*.

6.5 **Threaded fasteners**

6.5.1 **Reference standards**

AS 1111:2000 ISO metric hexagon bolts and screws

AS 1112:2000 ISO metric hexagon nuts

AS 1214:1983 Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)

AS 1237:2002 Plain washers for metric bolts, screws and nuts for general purposes

AS/NZS 1390:1997 Cup head bolts with ISO metric coarse pitch threads

AS 1442:2007 Carbon steels and carbon-manganese steels – Hot rolled bars and semi-finished products

AS/NZS 1554.6:2012 Structural steel welding – Part 6: Welding stainless steels for structural purposes

AS 1721:1985 General purpose metric screw threads

ASTM 276-13a Standard Specifications for Stainless Steel Bars and Shapes
### 6.5.2 Stainless steel threaded fasteners

#### 6.5.2.1 Bolts

Bolts shall be made from austenitic stainless steel.

Hot forged: ASTM A27613a Type 316 or Type 321.

The method of forging bolts shall be to preheat the component slowly to 800°C – 870°C. The forging temperature should not fall below 900°C.

For hot forged components, heat treat in accordance with the relevant Australian standards. The components may be re-heated to 600°C prior to thread cutting.

Cold formed: ASTM A276-13a 300 series.

#### 6.5.2.2 U-bolts

U-bolts shall be cold formed from ASTM A276-13a Type 304.

The minimum bending radius is 7.5mm for U-bolts of 10 mm diameter, and 13 mm for U-bolts of 12mm diameter.

#### 6.5.2.3 Nuts

Nuts shall be cold formed or machined from austenitic ASTM A276-13a 300 series stainless steel.

Nuts shall be double chamfered.

#### 6.5.2.4 Bridge attachment bolts

Bolts with welded heads or plates that are to be cast into bridges for overhead wiring support shall be made of ASTM 276-13a Type 321 stainless steel.

#### 6.5.2.5 Welding

Welding shall be in accordance with AS/NZS 1554.6:2012.

#### 6.5.2.6 Threads

Thread profiles and tolerances shall be in accordance with AS 1721:1985.

M10 and M12 stainless steel threads shall have a 1.25 mm pitch and the tolerance class shall be:

- 6H for internal threads
- 6g for external threads

Threads for U-bolts shall be cut.

Threads for bolts may be cut or rolled.
6.5.2.7 Safety factors
The safety factor shall not be less than three.

6.5.2.8 Tolerances
In accordance with the relevant Australian standards.

6.5.2.9 Tightening torque

Table 5 – Tightening torques for stainless steel threaded fasteners

<table>
<thead>
<tr>
<th>Bolt size (diameter)</th>
<th>Min torque (Nm)</th>
<th>Max torque (Nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M10</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>M12</td>
<td>55</td>
<td>60</td>
</tr>
</tbody>
</table>

6.5.2.10 Acceptance criteria
U-bolts shall be inspected for material and dimensions.

Bridge Attachments bolts with welded heads or plates require a certificate confirming that the material and the welding process are correct.

All other fasteners shall be accepted if they are in accordance with the relevant Australian standards.

6.5.3 Galvanized mild steel threaded fasteners

6.5.3.1 Material
Mild steel in accordance with AS 1442:2007, grade 1010 to grade 1015 shall be used for U-bolts. Material for other mild steel fasteners shall be in accordance with the relevant Australian standards.

6.5.3.2 Threads
Threads for bolts may be cut or rolled.

Threads for U-bolts shall be cut.

Thread profiles shall be in accordance with AS 1721:1985.

6.5.3.3 Safety factors
The safety factor shall not be less than three.

6.5.3.4 Surface finish
Mild steel fasteners shall be galvanized in accordance with AS 1214:1983.

6.5.3.5 Tolerances
In accordance with the relevant Australian standards.

6.5.3.6 Tightening torque
Galvanized mild steel fasteners shall be tightened using a standard wrench until the spring washer is fully compressed, followed by an additional one-third of a turn.

6.5.3.7 Design requirements
Galvanized steel spring washers shall be used with all galvanized mild steel bolts and set screws.

6.5.3.8 Acceptance criteria
Bolts and nuts shall be accepted if manufactured in accordance with the relevant Australian standards.

U-bolts must be checked for clean thread to ensure free nut running.

6.5.3.9 Prohibitions
Aluminium or copper nuts and bolts shall not be used.

Mild steel shall not be used for bolts of a diameter less than 12 mm.

6.6 Connecting pins

6.6.1 Reference standards
AS 1154.1:2009 Insulator and conductor fittings for overhead power lines – Part 1: Performance, material, general requirements and dimensions
AS 1214:1983 Hot-dip galvanized coatings on threaded fasteners (ISO metric coarse thread series)
AS 2837:1986 Wrought alloy steels – Stainless steel bars and semi-finished products
AS/NZS 3679.1:2010 Structural Steel – Part 1: Hot-rolled bars and sections
ASTM A276-13a Standard Specification for Stainless Steel Bars and Shapes

6.6.2 Stainless Steel
Stainless steel connecting pins shall be made from ASTM 276-13a Type 431.

6.6.2.1 Safety factors
The safety factor shall not be less than three.

6.6.2.2 Surface finish
Stainless steel connecting pins shall be smooth, clean and free from sharp edges and burrs.

6.6.2.3 Tolerances
In accordance with relevant standards and drawings.

6.6.2.4 Acceptance criteria
Pins must be free from burrs and sharp edges and drill holes must accept the relevant split pin.
6.6.3 **Galvanized mild steel**

Galvanized mild steel connecting pins shall be made from grade 300 mild steel in accordance with AS/NZS 3679.1:2010.

6.6.3.1 **Safety factors**

The safety factor shall not be less than three.

6.6.3.2 **Surface finish**

Surfaces shall be galvanized in accordance with AS 1214:1983.

6.6.3.3 **Tolerances**

In accordance with relevant standards and drawings.

6.6.3.4 **Acceptance criteria**

Pins must be free from burrs and sharp edges and drilled holes must accept the relevant split pin.

Pins are to be free of deep corrosion and forging fins.

7. **Fitting identification**

7.1 **Fitting numbers**

7.1.1 **Format**

The format of fitting numbers shall be a one, two, or three digit number optionally followed by a ‘/’ (forward slash) and a one or two digit sub-number.

Sub-numbers shall be used for series of similar or related components or fittings.

7.1.2 **Allocation**

Fitting numbers shall be allocated to all design components and assemblies.

Fitting numbers are obtained from the Principal Engineer Mains, Sydney Trains.

7.1.3 **Similar fittings**

When a range of very similar fittings is created, field staff may experience difficulty in correctly distinguishing between them. For this reason, the fittings shall be marked with the fitting number, sub-number or any other distinguishing feature. An example is the range of clamps that fit the various catenary conductors, which all look very similar. Correct selection is important as they may look the same but have different radii to fit the corresponding conductors. In this case each fitting is identified by the size of conductor which the fitting is designed to fit.
8. **Line tension components**

8.1 **Reference standards**

AS 1154.1:2009 Insulator and conductor fittings for overhead power lines – Part 1: Performance, material, general requirements and dimensions

8.2 **Coordination of hole sizes**

Where line tension components are connected with tongue, clevis and pin arrangements, the hole and pin sizes shall be in accordance with AS 1154.1:2009 and as follows:

<table>
<thead>
<tr>
<th></th>
<th>16 mm systems</th>
<th>19 mm systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal maximum working tension (kN)</td>
<td>23.3</td>
<td>53.3</td>
</tr>
<tr>
<td>Nominal pin/bolt diameter (mm)</td>
<td>16</td>
<td>19</td>
</tr>
<tr>
<td>Hole size for mild steel fabrications (mm)</td>
<td>17.5</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>For clevises – “holes to be drilled in line”</td>
<td>For clevises – “holes to be drilled in line”</td>
</tr>
<tr>
<td>Hole size for castings and forgings (mm)</td>
<td>17.5</td>
<td>21.5</td>
</tr>
<tr>
<td>Nominal tongue thickness (mm)</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>Tongue thickness for mild steel fabrications (mm)</td>
<td>16</td>
<td>20</td>
</tr>
<tr>
<td>Tongue thickness for castings and forgings (mm)</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Clevis opening for mild steel fabrications (mm)</td>
<td>17.5 min</td>
<td>22 min</td>
</tr>
<tr>
<td>Clevis opening for castings and forgings (mm)</td>
<td>18</td>
<td>22.5</td>
</tr>
</tbody>
</table>

Tolerances shall be in accordance with AS 1154.1:2009.

8.3 **Threaded components in tension**

Where threaded components are used at line tension for length adjustment, such as in turnbuckles and eyebolts, split pins shall be provided to prevent the components becoming disconnected, unless lock nuts are fitted.

8.4 **Fittings assembled in series with catenary and contact wires**

All tension fittings shall comply with the requirements of AS 1154.1:2009.
9. **Fitting drawings**

9.1 **Reference standards**

AS 1100.101:1992 Technical drawing – General principles

9.2 **Component drawings**

Component drawings shall show one or more related components. Several components may be shown on the same drawing where the components are similar.

Component drawings shall show:

- all necessary dimensions for manufacture of the component including tolerances to be applied
- all necessary information e.g. welding, machining, heat treatment, surface treatment, surface coating
- safe working loads
- fitting number for each individual fitting

9.3 **Assembly drawings**

Assembly drawings shall show one or more related assemblies. Assemblies shall consist only of components shown on component drawings and commercial items such as washers.

Assembly drawings shall show:

- functional dimensions only
- all necessary instructions for assembly e.g. bolt/nut tightening torque, cleaning, application of grease, lubricants etc
- only the essential hidden outlines
- outlines for the components associated with, but not part of the assembly shall be shown as type K lines in accordance with AS 1100.101:1992.