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Standard governance

**Owner:** Lead Rolling Stock Engineer, Asset Standards Authority

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Document history

<table>
<thead>
<tr>
<th>Version</th>
<th>Summary of changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>First issue – 27 June 2014</td>
</tr>
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</tr>
<tr>
<td>4.0</td>
<td>Fourth issue - Changes to content in this version include amendment of Section 15 and Section 19</td>
</tr>
</tbody>
</table>
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 provides the requirements for the conditions of operation, design, construction, components, materials, finishes and testing of electronic equipment supplied for passenger rolling stock.

Changes to content in this version include amendment of Section 15 and Section 19.
# Table of contents

1. Introduction .............................................................................................................................................. 6
2. Purpose .................................................................................................................................................... 6
   2.1. Scope ..................................................................................................................................................... 6
   2.2. Application ............................................................................................................................................. 6
3. Reference documents ............................................................................................................................. 7
4. Terms and definitions ............................................................................................................................. 8
5. Operating environment ........................................................................................................................... 8
6. General electric circuits and equipment requirements ....................................................................... 9
   6.1. General materials requirements ............................................................................................................ 9
7. Fire protection requirements ................................................................................................................ 10
8. Circuit diagrams .................................................................................................................................... 10
9. Circuits and earthing ............................................................................................................................. 10
   9.1. Alternating current circuit protection .................................................................................................... 11
   9.2. Direct current circuit protection ............................................................................................................ 11
   9.3. Earthing ................................................................................................................................................ 11
   9.4. Colour coding and marking of cables .................................................................................................. 12
10. Auxiliary contacts .................................................................................................................................. 12
11. Power contactors and arc control devices ......................................................................................... 12
12. Coils and windings of small inductances and transformers ............................................................ 13
13. Cable connectors and plug-in components ....................................................................................... 13
14. Calibrated devices .................................................................................................................................. 13
15. Low voltage, extra low voltage switches and push buttons .................................................................. 14
16. Circuit breakers ..................................................................................................................................... 14
   16.1. Circuit breakers on general purpose outlets .................................................................................... 14
17. Fuses ...................................................................................................................................................... 15
   17.1. Low voltage and extra low voltage fuses .......................................................................................... 15
   17.2. High voltage fuses ........................................................................................................................... 15
18. High voltage or heavy current resistors ............................................................................................. 15
19. Light current resistors .......................................................................................................................... 15
20. Capacitors .............................................................................................................................................. 15
21. Electrical measuring instruments ........................................................................................................ 16
   21.1. Instrument accuracy ........................................................................................................................ 16
1. **Introduction**

This document provides the minimum performance requirements and recommendations for the electric circuits, electric components and electro-pneumatic components for Transport for NSW (TfNSW) passenger rolling stock. This document covers the mechanical, electrical, and fire performance requirements of these items.

2. **Purpose**

This standard details the requirements that equipment manufacturers who wish to supply equipment for use on TfNSW passenger rolling stock need to meet.

This standard aims to ensure the reliability, availability, maintainability and safety of the electric circuits, electric equipment and electro-pneumatic equipment used in passenger rolling stock.

2.1. **Scope**

This standard covers the following electric circuits and electric and electro-pneumatic components for passenger rolling stock:

- traction and auxiliary power and control circuits and their components
- communication and auxiliary control circuits and their components
- electric components such as switches, push buttons, circuit breakers, and fuses
- electro-pneumatic and electro-magnetic devices such as magnetic valves and high speed circuit breakers

2.2. **Application**

This standard applies to new passenger rolling stock and the refurbishment or modifications of existing rolling stock assets. Pending a direction otherwise from the TfNSW contract administrator (or applicable equivalent), contracts and tenders for new or modified passenger rolling stock released before the standard effective date shall be exempt from the requirements of this standard.

This standard forms part of a suite of passenger rolling stock electrical standards and should be read in conjunction with those standards specifically including the following:

- T MU RS 00126 ST Electronic Equipment for Passenger Rolling Stock
- T MU RS 00164 ST Cable for Passenger Rolling Stock
- T HR RS 01701 ST Mounting and Installation of Electrical Equipment
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.

International standards

EN 50121-3-1 Railway applications - Electromagnetic compatibility - Part 3-1: Rolling stock - Train and complete vehicle

EN 50121-3-2 Railway applications - Electromagnetic compatibility - Part 3-2: Rolling stock - Apparatus

EN 50153 Railway applications – Rolling stock – Protective provisions relating to electrical hazards

EN 50163 Railway applications – Supply voltages of traction systems

IEC 60034-1 Rotating electrical machines – Part 1: Rating and performance

IEC 60051-1 Direct acting indicating analogue electrical measuring instruments and their accessories Part 1: Definitions and general requirements common to all parts

IEC 60077-1 Railway applications – Electric equipment for rolling stock - Part 1: General service conditions and general rules


IEC 60077-5 Railway applications – Electric equipment for rolling stock – Part 5: Electrotechnical components – Rules for HV fuses

IEC 60349-2 Electric traction – Rotating electrical machines for rail and road vehicles - Part 2: Electronic converter-fed alternating current motors

IEC TS 63064 Graphical symbols for diagrams – Guidance on design for standardization in

IEC 60617

Transport for NSW standards

T HR RS 01701 ST Mounting and Installation of Electrical Equipment

T HR RS 17010 ST Passenger Rolling Stock Fire Safety

T MU AM 01003 ST Development of Technical Maintenance Plans

T MU RS 00126 ST Electronic Equipment for Passenger Rolling Stock

T MU RS 00164 ST Cable for Passenger Rolling Stock
4. Terms and definitions

The following terms and definitions apply in this document:

**approval** process whereby an authorised person certifies that engineering outputs have been verified as meeting input specifications and requirements and that the engineering output has been completed in accordance with relevant regulations and standards, prior to progressing to the next stage

**ASA** Asset Standards Authority

**CAD** computer-aided design

**enclosure** a closed space in which equipment or terminal boxes are mounted

**heavy current** currents in excess of 30 A

**HRC** high rupture current

**light current** currents of 30 A or less

**power contact** a contact not covered by the definition of auxiliary contact

**TfNSW** Transport for NSW

**voltage classification** as described in Table 1 aligned with EN 50153 *Railway applications – Rolling stock – Protective provisions relating to electrical hazards*

<table>
<thead>
<tr>
<th>TfNSW definition</th>
<th>Band</th>
<th>Nominal voltage (Un) – V ac</th>
<th>Nominal voltage (Un) – V dc</th>
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<td>U ≤ 60</td>
</tr>
<tr>
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<td>25 &lt; U ≤ 50</td>
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</tr>
<tr>
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<td>III</td>
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<td>120 &lt; U ≤ 1500</td>
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<tr>
<td>High voltage</td>
<td>IV</td>
<td>U &gt; 1000</td>
<td>U &gt; 1500</td>
</tr>
</tbody>
</table>

5. Operating environment

All electrical equipment shall be suitable for use in the environmental conditions as defined in T MU RS 17001 ST *Environmental Conditions for Rolling Stock.*
6. General electric circuits and equipment requirements

The requirements specified in this section are paramount and are overriding on all clauses of this standard.

This document shall be read in conjunction with the following TfNSW standards:

- T MU RS 00164 ST Cable for Passenger Rolling Stock
- T HR RS 01701 ST Mounting and Installation of Electrical Equipment

All passenger rolling stock electrical circuits and equipment shall comply with the relevant sections of one or more of the following standards:

- EN 50121-3-1 Railway applications - Electromagnetic compatibility - Part 3-1: Rolling stock - Train and complete vehicle
- EN 50121-3-2 Railway applications - Electromagnetic compatibility - Part 3-2: Rolling stock - Apparatus
- EN 50153 Railway applications – Rolling stock – Protective provisions relating to electrical hazards
- EN 50163 Railway applications – Supply voltages of traction systems
- IEC 60034-1 Rotating electrical machines – Part 1: Rating and performance
- IEC 60077-1 Railway applications – Electric equipment for rolling stock - Part 1: General service conditions and general rules
- IEC 60349-2 Electric Traction - Rotating electrical machines for rail and road vehicles - Part 2: Electronic converter-fed alternating current motors
- IEC TS 63064 Graphical symbols for diagrams – Guidance on design for standardization in IEC 60617

All materials and equipment shall be suitable for use in the TfNSW rolling stock environment and remain suitable without attention for use in that environment for a minimum of six years of service, from placing in service unless otherwise specified in the contract specification. Variance to this period shall specifically be approved in writing by a concession to this standard.

6.1. General materials requirements

The supplier shall provide adequate evidence that the materials used will not cause any environmental damage.

All materials shall comply with the requirements of T MU RS 17002 ST Prohibited and Restricted Materials.
7. **Fire protection requirements**

All new equipment shall comply with T HR RS 17010 ST *Passenger Rolling Stock Fire Safety*.

8. **Circuit diagrams**

Major electrical systems and equipment shall be accompanied by technical manuals that include functional systems diagrams, as well as point to point systems diagrams and detailed descriptions of operation for the purpose of assessment, maintenance, fault-finding and future modification activities. In such cases, a technical maintenance plan shall also be provided, which complies with T MU AM 01003 ST *Development of Technical Maintenance Plans*. These documents, including all notes and symbols, shall all be in English.

Circuit diagrams shall be clear and easy to interpret and comply with IEC TS 63064 *Graphical symbols for diagrams – Guidance on design for standardization in IEC 60617*.

The interlocks, contacts and controlled equipment of any device shall be shown and clearly identifiable by reference to only one drawing.

A legend shall be available for all component symbols.

An electrical circuit diagrams package shall be supplied in an editable computer-aided design (CAD) and searchable PDF electronic format along with a bound hard copy.

An abbreviations table shall be available to define all abbreviations.

An index showing the drawing zone location of all numbered circuit links, wires and circuit components shall be available.

9. **Circuits and earthing**

Train batteries shall have switches installed in the positive side and shall be fused on the positive and negative sides.

Train batteries shall have switches installed in positive and negative rails.

Batteries shall be protected by high rupture current (HRC) fuses in both the positive and negative rail.

All dc and single-phase circuits shall have one pole of each device connected directly to the negative or neutral line with no switches, fuses or contacts.

The practice of de-energising devices by short-circuiting the operating coil is not permitted.

Use of economy resistors or separate pull-in and holding coils for contactor, solenoids or similar devices which have lower voltage ratings than the circuit is not acceptable.

Each circuit function shall be protected by an individual circuit breaker, which shall be clearly and unambiguously labelled.
Where regular switching by hand is anticipated, separate switches shall be provided.

Circuit breakers shall not be used where regular switching by hand is anticipated.

### 9.1. Alternating current circuit protection

Protection and isolation of alternating current (ac) circuits up to and including low voltage shall be by magnetic circuit breakers backed up by power source circuit breakers.

Sources of ac shall have the neutral earthed and a ganged circuit breaker in each phase.

Proof of adequate protection of the power source by this circuit breaker shall be provided; that is, both the machine characteristic and circuit breaker characteristic shall be consistent.

The loading of each phase of three-phase power sources shall be within 5% of each other.

### 9.2. Direct current circuit protection

Protection and isolation of direct current (dc) circuits up to and including low voltage shall be by magnetic circuit breakers backed up by power source fuses, with the exception of motor circuits where HRC fuses shall be used for motors rated at more than 1 kW.

### 9.3. Earthing

Protective earthing shall comply with EN 50153.

Separate insulated earthing bars shall be provided for the high, low and extra low voltage circuits on each car.

Each circuit shall have a separate insulated wire connecting the negative or neutral to a separate bolted terminal on the respective bars. The ac and dc circuits, or circuits of different voltages, connected to the same earthing bar, shall be arranged in groups of like circuits.

Low voltage and extra low voltage earthing bars shall be directly bonded to the car body.

The high voltage earth return circuits shall be arranged in a manner that avoids the possibility of leakage paths through wheel set bearings and stray ac signal induced currents elsewhere.

Earthing bars for high voltage circuits shall be connected to rail by two separate paths that are insulated from the car bodies of the train up to the earth return brushes on the wheel sets. These two separate paths shall go to wheel sets on separate bogies in the same car. The high voltage earth return cabling shall not have direct electrical connections with the car body or bogie frames, apart from the wheel set earth return brushes.

The car body shall be earthed directly to earth return brushes on the wheel sets by at least two separate paths. These two separate paths shall go to wheel sets on separate bogies and these paths shall be independent from the high voltage earthing paths. Intermediate electrical connections to bogies are not permitted.
Bogie frames and bogie-mounted traction motor frames may share common electrical connections to earth return brushes on the wheel sets.

Earthing connections shall be made onto surfaces suitably prepared to provide adequate earthing continuity that are cleared of surface contaminants such as oils or paint.

Where special earthing arrangements for electronic equipment are required, these arrangements shall be submitted to the authorised TfNSW contract representative for approval.

The use of unearthed circuits shall require a concession to this standard.

9.4. Colour coding and marking of cables

The colour coding and marking of cables shall be in accordance with T MU RS 00164 ST.

10. Auxiliary contacts

An auxiliary contact is a contact in a circuit, up to and including low voltage, which is not fitted with arc suppression devices.

Auxiliary equipment that use contacts such as control voltage contactors, relays, master controllers and manual switches should use silver contacts with a self-cleaning action as a method of prolonging contact life.

Condensation of moisture inside the contact enclosure shall be prevented.

Auxiliary contacts should be positioned to ensure isolation of creepage from high voltage circuits.

11. Power contactors and arc control devices

All power contactors shall be fitted with contact tips, securely fixed to their support and arranged for easy removal without further dismantling.

Contact screws of size M8 or larger shall not be provided with screw driver slots.

Current shall be taken from moving contacts by flexible shunts having crimped end connections, with flared ends to avoid abrasion of the shunt.

Shunts shall be supported and restrained to prevent damage due to movement or vibration or both.

The passage of current through springs or bearings shall be prevented.

Contacts shall be protected against corrosion.

Power contacts shall have a wiping action to avoid contact arcing causing deterioration of contact surfaces.

Blow-out coils shall be connected to the positive side of the contacts.
All arc chute components have adequate resistance to erosion and burning from the arcs to which they might be subjected.

12. **Coils and windings of small inductances and transformers**

All coils shall be continuously rated and mechanically suitable for the railway environment.

Encapsulated coils shall be suitable for a temperature in service of up to 150°C. Where the maximum temperature in service will exceed this figure the coil details shall be submitted to the authorised TfNSW contract representative for approval.

Insulated coils shall be fully impregnated to prevent the ingress of fluids.

The coil conductor and its insulation system shall have mechanical protection to prevent any chafing or movement damage caused by normal installation, removal or storage conditions.

Connections to coils shall be to terminals securely fixed to the coil body or adjacent to the coil body so that rewiring is unnecessary on coil replacement.

13. **Cable connectors and plug-in components**

All cable connectors and plug-in components including relays, printed circuit boards and electronic cards or racks shall comply with the following:

- the plug or device shall be adequately and positively secured against working loose by means additional to the friction of the electrical contact
- the plug contacts shall be adequately safeguarded against failure to make good contact
- incorrect insertion of the plug or device shall be prevented by use of a guide, shield, or otherwise
- where non-interchangeable parts have similar plug in components they shall be provided with a means to prevent them being inserted in the wrong position

Circular cable connectors, upon connection, shall produce an audible or otherwise mechanical feedback, able to be sensed by the technician, to indicate that the connector has locked into position.

14. **Calibrated devices**

Calibrated relays or electronic modules shall have their adjusting mechanism securely locked after setting.
15. **Low voltage, extra low voltage switches and push buttons**

Low-tension tumbler or rotary switches shall have a quick action mechanism. Switch contacts shall be of the wiper or wiping butt type.

Rotary switches which have more than two positions shall be capable of continuous rotation in either direction.

Rotary switches shall have all positions clearly marked.

Rotary switches of all types shall have a shaft suitable for the application required to prevent failure between maintenance cycles.

Tumbler switches shall have the ‘off’ position upwards (2 position type) or in the mid position (3 position type) except where otherwise approved.

Push buttons, except where otherwise specified, shall be shrouded and secured from behind. After installation, the design shall prevent dismantling from the front by unauthorised persons.

16. **Circuit breakers**

Miniature circuit breakers shall be back connected except where otherwise approved by TfNSW in writing.

In ac circuits above 100 A and those up to 400 A, circuit breakers shall be the magnetically tripped type.

The operating lever shall be down in the ‘off’ or ‘tripped’ position, and the ‘off’ position shall be clearly marked.

Each circuit breaker shall be labelled with the circuit it protects.

Circuit breakers shall comply with the following standards:


16.1. **Circuit breakers on general purpose outlets**

All low voltage ac general-purpose outlets shall have residual current device (RCD) protection.
17. **Fuses**

Separate requirements exist in this section for the following classes of fuses:

- low voltage and extra low voltage fuses
- high voltage fuses

17.1. **Low voltage and extra low voltage fuses**

Low voltage and extra low voltage fuses shall be back connected.

Spare fuses of each type shall be mounted in unconnected fuse holders adjacent to each fuse panel, or group of panels in one location. The number of spare fuses of each type at a location shall be equal to the number of fuses of each type divided by three and rounded up.

17.2. **High voltage fuses**

High voltage fuses shall comply with IEC 60077-5 *Railway applications – Electric equipment for rolling stock – Part 5: Electrotechnical components – Rules for HV fuses*.

Spare fuses of each type shall be mounted in unconnected fuse holders adjacent to each fuse panel, or group of panels in one location.

18. **High voltage or heavy current resistors**

High voltage or heavy current resistors shall be prevented from shorting out in overload conditions in normal service.

19. **Light current resistors**

Light current resistors greater than 5 W rating shall be of the wire or strip wound type, with the conductor set in vitreous enamel or silicon/cement coating, in all cases the coating shall not peel off or disintegrate.

The sliders of pre-set resistors shall be adequately locked in position.

Fixed resistors of standard resistance values shall be used. Where this is not possible, the use of variable resistors shall be subject to a concession to this standard.

The value, rating and tolerance shall be marked on the resistor.

20. **Capacitors**

Electrolytic capacitors shall not be used with single-phase capacitor start motors.

Where capacitors are used as part of a surge suppression circuit, the required capacity shall be available at the surge frequency.
21. **Electrical measuring instruments**

All analogue electrical measuring instruments and their accessories shall comply with IEC 60051-1 *Direct acting indicating analogue electrical measuring instruments and their accessories Part 1: Definitions and general requirements common to all parts* and have a true zero and movements suitably damped for railway service.

Instruments shall be suitable for mounting in any orientation and on ferro-magnetic material.

All electrical displays are to be solid-state displays.

All instruments and their parts are to be accessible for removal by maintenance staff only.

21.1. **Instrument accuracy**

All instruments shall be accurate to ± 0.75% of full scale or better.

Discharge resistors shall not be integral with the capacitors.