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Technical Information

RailCorp Electrical System General Description

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Standard Approval

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Document Control

Version	Summary of Change
1.0	First issue

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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.

The Asset Standards Authority 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 00 00 00 01 TI *RailCorp Electrical System General Description*.

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. Introduction

This document provides basic general background to RailCorp electrical infrastructure and assets located within the Sydney Metropolitan Rail Area, bounded by the geographical extremities as follows:

- Hamilton in the North
- Kiama in the South
- Wallerawang in the West (Bowenfels is the extent of the 1500V DC system)
- Glenlee (Campbelltown) in the South West

The electrical infrastructure includes a high voltage ac distribution network and a 1500V dc traction system.

The whole of the high voltage ac distribution network and the 1500V dc system (except for overhead wiring) is designed to withstand a failure of any ONE item of equipment without major impact on train operations. This is defined as a 'single contingency' failure mode. At some critical locations such as the City Underground, double or triple level of contingency failure mode mitigation is provided for a more secure power supply.

2. High voltage aerial lines and underground cables

Power supply to traction (and other) substations is sourced via high voltage aerial lines and/or high voltage underground cables connected to the local electricity distributor.

The aerial lines are typically of wood pole construction with aluminium or copper conductors supported from glass or synthetic insulators supported off cross-arms.

Typical high voltage cable types used include paper insulated lead sheathed and XLPE insulated PVC sheathed.

Standard nominal voltages used are 11 kV, 33 kV, 66 kV and 132 kV.

3. 1500V traction system

The traction system is a nominal 1500 volt direct current system (1500V dc).

Power to trains for electric traction is supplied from traction substations by means of the overhead wiring (OHW) system. The train pantograph sliding under the contact wire collects current to operate the motors, the current returning back to the substations through the traction rails.

The design and maintenance of the rail traction return circuits is managed by the Signalling Discipline. (See SPG 0709 *Traction Return, Track Insulation & Bonding*).

The overhead wiring is positive and the rail negative. The rails are intentionally not earthed, to reduce electrolysis, but are 'close to' earth potential.

4. Substations

The most common traction substation configuration is to have two 4 MW or 5 MW rectifiers supplied from 33 kV transformers and two 33 kV supply feeders.

The transformer and rectifier pair transform the 33 kV alternating current supply to 1500 volt direct current for train operation.

Substation spacing varies between 4 km in high load areas to 15 km on flat country with predominantly suburban passenger traffic.

Substation spacing is determined from train loads, grades, OHW types (resistance & thermal rating), train headways, losses, rail-earth potentials and electrolysis.

Protection for the overhead wiring system is provided by high speed circuit breakers and overall control and monitoring of the substations is by a supervisory control and data acquisition system (SCADA).

Sectioning huts, containing dc circuit breakers, are provided between substations for protection and sectioning of the overhead wiring system and, on multiple tracks, to improve voltage regulation.

Generally, a section of OHW is fed by two dc circuit breakers - one at each end - both of which are normally closed.

5. Overhead wiring

Three basic types of overhead wiring (OHW) are in use:

a) A simple catenary, where the contact wire is supported from the catenary wire by droppers spaced along the catenary. Both single and twin contact wire arrangements are used.

b) A compound catenary, where a main catenary supports an auxiliary catenary which in turn supports the contact wire by means of droppers.

c) Contact only which has no catenary or droppers.

The majority of overhead wiring is the simple catenary type, the compound catenary is used west of Penrith and contact only is used in yards for slow running. Types (a) and (c) can be either fixed anchored, where the tensions in the wires vary with temperature, or regulated tension, where the wire tensions are held approximately constant by means of weight or gas tensioning devices. Type (b) system is fixed anchored.

In all three types of OHW, the supports for the overhead wires can take the form of wire polygons (suspended between wood poles or steel masts), cantilever arrangements (erected on wood poles or steel masts), or portal structures.

The contact wire is supported against wind and directed around curves by pull-off arms. In span wire construction the pull-off arms are held by span wires stretched across the tracks between masts. In independent registration arrangements the pull-off arms are attached to the structure or cantilever so that the wiring for each track is mechanically and electrically independent of adjacent tracks.

Insulators are used to separate the live 1500 volt overhead wires and equipment from the support structures and to provide electrical separation between the wiring for each track.

Stranded bare copper is used for the catenary, the most common size being 37 strands of 3.05 mm diameter (270 mm^2). Other sizes used are 510 mm^2, 327 mm^2 and 165 mm^2. In early construction, steel catenary was used but is now being replaced due to corrosion problems.

Two sizes of contact wire are used, 193 mm^2 and 137 mm^2. The material is hard drawn copper for the regulated systems and cadmium-copper or tin-copper for the fixed anchor systems which have to withstand higher tensions. The 137 mm^2 contact is preferred because it is easier to install and does not 'kink' as readily as the 193 mm^2.

The preferred type of OHW is a 270 mm^2 catenary with twin 137 mm^2 hard drawn contacts, regulated, supported by steel masts with independent registration of each track.

For protection, operation and maintenance purposes, the overhead wiring is divided into switchable sections at substations, sectioning huts and field switches.

6. Electricity supply to signalling locations

Electricity supply for signalling operation is sourced from two separate independent power sources to ensure reliability of supply.

The standard arrangement is for the 'normal' supply to be obtained from the RailCorp high voltage ac distribution network. A 'back-up' supply is obtained from the Local Distribution Network Service Provider. These supplies are then fed into a change-over contactor arrangement for automatic change-over.

Improved UPS arrangements are now being deployed to manage and provide reliable electricity supply to signalling locations without interruption during change-over.

Where supply is taken from a Local Distribution Network Service Provider, precautions have to be taken to prevent stray traction current leakage into the MEN system.

7. Electricity supply to stations, buildings and workshops

Electricity supply for stations, buildings and workshops is normally sourced from the RailCorp high voltage ac distribution network. Substations transform the voltage down to 415 V or 240 V as required.

8. Reference documents

Legislation

- Electricity Supply Act 1995
- Electricity (Consumer Safety) Act 2004

Transport standards – as published on the ASA website

- SPG 0709 Traction Return, Track Insulation and Bonding