Superseded by T HR SS 80002 ST v1.0, 21/06/2018

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Technical Note - TN 074: 2016

Issued date: 01 November 2016

Effective date: 01 November 2016

Subject: Update to infrastructure lighting requirements contained in RailCorp standards

This technical note is issued by the Asset Standards Authority (ASA) to notify that the sections of the RailCorp standards listed in Table 1 are now withdrawn from use:

Table 1 – Withdrawn sections of RailCorp standards

RailCorp standard	Withdrawn section
ESB 004 *Station Services and Systems*, version 1.1	Section 4.3.2.9
ESB E001 *Low Voltage Electrical Standards,* version 1.0	Section 23 Section 24
ESC 340 *Tunnels,* version 2.3	Section 9.6 Section 9.7
EP 23 10 00 01 SP *LV Tunnel Services Board,* version 2.1	Section 6.4 Section 6.5 Section 6.6

The infrastructure lighting requirements contained in these sections are now superseded by the requirements specified in T HR SS 80001 ST *Infrastructure Lighting* and T HR SS 80003 ST *Infrastructure Emergency Lighting*.

Authorisation:

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Technical Note

TN 034: 2014

Issued date 20 March 2014
Effective dates 20 March 2014 to 20 March 2015

Subject: Update to ESB E001 Low Voltage Electrical Standard

This technical note is issued by the Asset Standards Authority as a temporary update to RailCorp standard ESB E001 *Low Voltage Electrical Standard*, Version 1.0.

Section 19.2 of ESB E001 outlines the requirements for the use of rigid PVC and galvanised steel conduits. In addition to the requirements detailed in Section 19.2, the following requirements shall also be complied with:

- all rigid PVC conduits and fittings shall be protected against solar radiation (T), be of a non-flame propagating type and shall pass the test of ignitability and flame propagation in accordance with AS 2053 *Conduits and fittings for electrical installations*, Part 1
- additionally, conduits and fittings for underground stations, enclosed stations and tunnels shall be halogen-free (HF)
- all installations shall comply with the requirements of the Building Code of Australia

Authorisation

	Technical content prepared by	Checked and approved by	Interdisciplinary coordination checked by	Authorised for release
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ESB E001

LOW VOLTAGE ELECTRICAL STANDARDS

Version 1.0

Issued July 2012

Owner:	Chief Engineer, Stations and Buildings		
Approved by:	Gary Bayman Chief Engineer Stations and Buildings	Authorised by:	Natalie Richardson A/General Manager Chief Engineers Division

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Engineering Standard

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Document control

Version	Date	Summary of change
1.0	July 1993	First edition under previous document identification
Drafts 2.0 to 7.0	August 2010 to July 2012	Re-written and significantly expanded
1.0	July 2012	Issued with new document number incorporating changes. Subsequent correction made to version number on front cover.

Summary of changes from previous version

Summary of change	Section

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1 Introduction

The purpose of this standard is to outline the various requirements associated with the provision of electrical supply to all RailCorp LV installations in the rail corridor and other premises, such as train stabling and tunnels, within the RailCorp property boundaries. These requirements include technical, delivery and operational matters.

Requirements for station systems and items such as concessions, public toilets, waiting rooms, tariffs, public and commuter phones, public address systems, AFC equipment, clocks, hand dryers etc. are outlined.

Within RailCorp, the accountability for electrical infrastructure is shared between the Chief Engineer, Stations and Buildings and the Chief Engineer, Electrical.

As this standard deals with LV aspects of railway stations and buildings within the rail corridor, some of the information in this section (e.g. regarding HV) is provided for general information only. The HV aspects of RailCorp infrastructure is the responsibility of the Chief Engineer, Electrical.

The electrical responsibilities are delineated as follows:

Chief Engineer, Stations and Buildings: LV electrical systems and works from the load side of the LV isolating switch located on the Distribution Supply Main Switchboard (DSMSB). Specialised systems such as signalling, communications and security are dealt with by others.

Chief Engineer, Electrical: HV Systems and up to the line side of the LV isolating switch located on the Distribution Supply Main Switchboard, as well as earthing and bonding matters.

Where the above delineation does not model the project scope responsibilities, Engineering Authority shall be sought from both Chief Engineers, as well as applicable standards.

2 Scope

The scope includes electrical design and installation issues, sources of supply, cables (types, selection, segregation, routing, wiring method etc.), cable enclosures and support systems, switchboards, circuit protection, voltage drops and fault operation. In addition, matters such as staging of works and temporary supplies, as well as matters that impact on the environment including overhead and underground services, lighting, emergency lighting are also dealt with as well as other services.

2.1 Exclusions

Specialised systems such as the following are excluded from this standard:

- Signalling power supplies
- Shore supplies for Maintenance Centres (power when normal power supply is not utilised such as for maintenance)
- Pumping and other specialised electrical services
- Photovoltaic arrays and other embedded power generation
- SCADA and building automation systems
- Earthing and bonding

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3 Reference documents

Documents listed in this section are for information only and shall not be assumed to be current, complete or comprehensive.

3.1 Statutory documents

Transport Administration Act 1988

State Owned Corporations Act 1989

Rail Safety Act 2008

Rail Safety Regulations

Environmental Planning and Assessment Act 1979

Environmental Planning and Assessment Regulation 2000

Planning Instruments (SEPPs, REPs, LEPs etc)

National Construction Code

Nominated Australian Standards

Electricity Supply Act 1995

Commonwealth Disability Discrimination Act 1992

Disability Standard for Accessible Public Transport 2002 and *Amendments*

Anti-Discrimination Act 1977

Heritage Act 1977

Heritage Regulations

Service and Installation Rules of New South Wales

Work Health and Safety Act 2011

Work Health and Safety Regulation 2011

WorkCover Codes of Practice

Notes:

1. RailCorp Standards are generally made pursuant to a number of these Acts and are reflective of RailCorp's obligations under them.
2. Some of the above may have changed. Refer to the following website for updates, as applicable.
3. Legislation used shall be current at the time of Development Consent when undertaking new work, or at the time of tendering when undertaking like for like replacement as part of maintenance, unless otherwise advised.

NSW State legislation is available at www.legislation.nsw.gov.au

3.2 Australian standards

AS/ACIF S009 Wiring rules

AS/NZS 1158.3.1-2005 Lighting for roads and public spaces – Pedestrian area (Category P) lighting – Performance and design requirements

AS 1319 Safety signs for the occupational environment

AS 1530.4 – 2005 Methods for fire tests on building materials, components and structures - Fire-resistance test of elements of construction

AS/NZS 1657-1992 Fixed platform, walkways, stairways and ladders – Design, construction and installation

AS/NZS 1680.1-2006 Interior and Workplace Lighting - General principles and recommendations

AS/NZS 1735.2-2001 Lifts, escalators and moving walks. Part 2: Passenger and goods lifts – Electric

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AS/NZS 1768 Lightning protection

AS 2293 Emergency Escape Lighting and Exit Signs

AS/NZS 3000-2007 Electrical Installations (known as the Australian/New Zealand Wiring Rules)

AS/NZS 3008.1.1 2009 Electrical installations – Selection of cables – Cables for alternating voltages up to and including 0.6/1kV – Typical Australian installation conditions

AS/NZS 3011, parts 1 and 2, Secondary batteries

AS/NZS 3012 Construction and demolition sites

AS/NZS 3013-2005 Electrical installations – Classification of the fire and mechanical performance of wiring system elements

AS 3439.1 Low voltage switchgear and control gear assemblies

AS/NZS 3760-2010 – In-service safety inspection and testing of electrical equipment

AS 3851 The calculation of short-circuit currents in three-phase a.c. systems

AS 4282-1997 Control of the obtrusive effects of outdoor lighting

AS 4070 Recommended practices for low-voltage electrical installations and equipment in MEN systems from transient overvoltages

AS/NZS 4536-1999 Life cycle costing - An application guide

AS 4777.1-2005 Grid connection of energy systems via inverters

AS/NZS 4836-2001 Safe working on low-voltage electrical installations

AS/NZS 5033 - 2005 Installation of photovoltaic (PV) arrays

AS 60529 Degree of protection provided by enclosures (IP Code)

AS/NZS 61558.1-2008: Safety of power transformers, power supplies, reactors and similar products - general requirements and test (IEC 61558-1 Ed 2, MOD)

AS/NZS 62040.1.1 Uninterruptible power systems (UPS)

Note: Some of the above Australian Standards are mandated by law; others represent current acceptable practice in case law. **Where interpretation is necessary refer to advice from the appropriate Chief Engineer.**

3.3 RailCorp standards and documents

RailCorp has adopted a series of internal Standards for use within the design of rail infrastructure. Refer to RailCorp Engineering Management Procedure ED 0006 P for full description of the standards. The following is a limited list of RailCorp standards and documents frequently utilised in LV works.

For external consultants or contractors access is via the following website: http://engineering.railcorp.nsw.gov.au

C-4501 Metallic Lineside Fencing in Electrified Areas

EPA 240 Design Competence Framework

EPA 241 Engineering Authority for Design

EP 00 00 00 16 SP Electrical Power System Signage

EP 08 00 00 14 SP Services Erected Above Overhead Wiring

EP 12 00 00 02 SP Low Voltage Distribution and Installations Earthing References and Definitions

EP 12 10 00 11 SP Distribution Substation Earthing

EP 12 10 00 20 SP Low Voltage Distribution Earthing

EP 12 10 00 21 SP Low Voltage Installations Earthing

EP 12 30 00 01 SP Electrolysis from Stray DC Current

EP 17 00 00 06 SP Installation Inspections

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EP 17 00 00 11 SP Low Voltage Isolating Transformer

EP 17 00 00 12 SP Demarcation of RailCorp Low Voltage Distribution System

EP 20 00 04 02 SP Underground Cable Route Marking

EP 20 00 04 05 SP Cable Pits

EP 20 00 04 06 SP Underground Cable Location Recording

EP 21 00 00 01 SP Insulation Co-ordination and Arrester Selection

EP 23 00 00 01 SP Low Voltage Fire Rated Power Supply Cables

EP 23 10 00 01 SP Low Voltage Tunnel Services Board

EP 23 10 30 01 SP Tunnel Emergency Light Fittings

EP 90 10 00.02 SP Standard Voltage Tolerances for LV

EN 0555 Locking Systems for Electrical Equipment

EN 0557 Inspection and Testing of Electrical Equipment

EN 0574 Isolation and Energisation of Low Voltage Equipment

ESB 000 Station Design Standard Requirements - Introduction

ESB 001 Station Design Standard Requirements – Context and Processes

ESB 002 Station Design Standard Requirements – Design Principles

ESB 003 Station Design Standard Requirements – Station Functional Spaces

ESB 004 Station Design Standard Requirements – Services and Systems

ESC 340 Tunnels

ESC 540 Service Installations within the Rail Corridor

ESM 109 Communications Earthing and Surge Suppression Standard

F2010/52647 Enhanced PA System Design and Installation Guide

Guideline on Earthing and Bonding at Railway Stations

RailCorp SMS-06 – GD0268 Working around electrical equipment

Railsafe Network Rules and Procedures

RSS 001 RailCorp Security Standard -Stations 2008

RSS 002 RailCorp Security Standard – Stabling Location and Maintenance Centre

Standard Requirements for Fire and Life Safety in Underground or Enclosed Railway Stations (April 2009, in draft status)

SPG 07 05 Construction of Cable Routes and Signalling Civil Works

SPG 07 12 Lightning and Surge Protection Requirements

SPM 01 23 Reinforced Pre-Cast Concrete Cable Pits

Tenancy Fitout Guide for Retail Premises – issued by the Property Division of RailCorp

TMG 1440 Requirements for the Location of Underground Services in the Rail Corridor

Transport for NSW - NSW Sustainable Design Guidelines for Rail

Three letter acronyms for RailCorp locations associated with equipment classes used in Ellipse available at:

http://intranet.railcorp.nsw.gov.au/business%20groups/asset%20operations/asset%20planning%20&%20performance/asset%20information%20&%20register/_documents/_ellipse/%7ebuilding&services_equipment_template.xls

A full listing of current RailCorp Standards is available at http://engineering.railcorp.nsw.gov.au

3.4 RailCorp drawings

D-85221 Railway Station Lighting, Platform Standard, single or Double Arm Support Details

A1-88496 Station Low Voltage Electrical Services: General Information

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C-88524 Railway Station Lighting, Platform Lighting Column Type 3g – General Arrangement

K-88525 Station Lighting: Typical Arrangement Details for Platform Lighting Columns (Platform Standards)

B-88550 Railway Stations: Remote Controlled Door Lock for Public Toilets

B-88557 Railway Station Lighting, Lighting Pole for Type 3f & 3g Lighting Column – Details

EL 0024639 Underground Cables: Undertrack Crossing Arrangement

EL 0035272 Distribution Padmount Substation 415/415 or 240/240 Whole Current Metering – General Arrangement, Internal Details

EL 0170330 Low Voltage Double Insulated point of Supply – General Arrangement

EL 0455388 RailCorp 11kV/415v Padmount Assembly – Minimum Requirements Information – Footprint Arrangement

EL 0464956 A: Distribution Supply Earthing and Bonding of LV Installations (sheet 1)

EL 0464957 A: Distribution Supply Earthing and Bonding of LV Installations (sheet 2)

EL 0474149 Distribution Padmount Substation - Double Insulated Metering Panel – General Arrangement – Type 2

EL 0474151 Distribution Padmount Substation Low Voltage Switchboard (DSMSB) – General Arrangement – Distribution Only – Type 2

EL 0474159 Distribution Padmount Substation – Type R Kiosk Assembly

EL 0480479 Distribution Padmount Substation 415V/415V Isolation Transformer

EL 0480481 Distribution Padmount Substation 11kV/415V Distribution Transformer – General Arrangement – Type 2

EL 0494646 Distribution Padmount Substation – 415V/415V Isolation Transformer – Schematic Diagram – 3 Phase

EL 0494650 Distribution Padmount Substation, RailCorp Dual Supply Arrangement, without UPS

EL 0497871 Distribution Padmount Substation LV Kiosk – 25kVA XFMR with Remote Metering – General Arrangement

Note: Drawings are available from the RailCorp Plan Room.

3.5 Codes of practice and guidelines

Electricity Association of NSW Code of Practice – Installation Safety Management

Transport for NSW – NSW Sustainable Design Guidelines for Rail

ISSC 28 Guidelines for Enclosed Spaces in NSW Electricity Networks

3.6 Selection and interpretation of standards

All electrical work shall be carried out in compliance with appropriate legislation and standards and RailCorp requirements. The order of precedence shall be as follows:

- legislation
- standards required by legislation
- RailCorp standards

Consultants shall accept responsibility for the selection and use of relevant Australian, International and RailCorp standards. Although a number of standards and drawings are specified in this document they are not definitive and it is the responsibility of Consultants to fully acquaint themselves with the various standards and select those that are relevant in meeting specific RailCorp project requirements.

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Interpretation of any or all of the above will be at the discretion of and to the approval of the appropriate Chief Engineer or delegated representative. It is anticipated that in the first instance interpretations are proposed by competent professional engineers in RailCorp's interest.

Project Scopes will be assumed to include all necessary work to provide an installation which is fully compliant and safe to operators and rail customers. Any upstream or downstream risk which exists shall be improved and NOT increased. In particular, overloading of switchboards in excess of legislated or standards requirements will not be tolerated as a matter of safety.

Designers and tenderers must familiarise themselves with the project site and become aware of all aspects of a project by site inspections and making all appropriate enquiries and tests. This assessment needs to be undertaken prior to tendering and include all necessary work.

It is up to the proponent to satisfactorily demonstrate the above to RailCorp.

4 Terms and definitions

The following terms and definitions apply in this document:

Adaptation the process that takes place as the eye adjusts to the brightness, darkness or colour of the visual field.

Cess the space between the outermost rail and the boundary fence, or 15 metres from the outermost rail if there is no fence.

Circuit breaker a switch that automatically interrupts the flow of electric current if the current exceeds a pre-set limit, measured in amperes. Circuit breakers are used most often as a safety precaution where excessive current through a circuit could be experienced. However, it is utilised to protect the electrical infrastructure. Unlike fuses, they can usually be reset and re-used.

Consumer's mains these are the conductors between the point of attachment and the service equipment. They are determined in accordance with the Service and Installation Rules of NSW and AS/NZS 3000.

Contractor the term Contractor, in the context of this standard, means either a building or electrical contractor responsible for and licensed by the NSW Department of Fair Trading, to undertake electrical work referred to herein.

Designer a competent skilled person who has been granted an Engineering Authority (refer to Section 6.1) to undertake design work on a RailCorp project. Designers may be RailCorp employees, contractors, consultants or employed by consultants.

Discrimination electrical discrimination is achieved when a lower rated protective device (circuit breaker or fuse) located closer to an electrical fault, operates before a higher rated circuit breaker which is further away (upstream) from the lower rated device and the fault. Without discrimination, if an upstream protective device operated before or at the same time as the downstream device, then circuits that do not have a fault would also trip.

Distribution board (DB) this is a switchboard that is downstream from a major switchboard, such as the Installation Supply Main Switchboard. Its purpose is to be located in a targeted electrical load area thus reducing the required cable sizes and to better deal with volt drop issues.

Distribution supply main switchboard (DSMSB) this is the first low voltage switchboard between the transformer terminals and the low voltage installation. The DSMSB is owned by RailCorp and is the location to establish the one and only

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connection between earth and neutral. In some installations there is no DSMSB. Refer also to Installation Supply Main Switchboard.

Earthing system this includes the earth grid and all conductors, piping, electrodes, clamps and other metalwork connected thereto. Whereas the Local Electricity Distributors in NSW generally use a Multiple Earthed Neutral (MEN) earthing system, the RailCorp distribution system uses a modified direct earthing system. The reason for the latter is to reduce the risk of DC traction current flowing into the low voltage distribution system.

In RailCorp's electrical distribution system there is *only one main earth-neutral link* and hence the system is not a Multiple Earthed Neutral system.

Electrical fixture a power outlet, light fitting (or group of fittings), permanently connected electrical equipment that is supplied by an electrical circuit for its operation or for the operation of devices connected thereto.

Electrolysis refers to the process where corrosion occurs to a buried metal structure when DC current leaves the structure to enter the electrolyte of the surrounding soil. The degree and rapidity of electrolytic action depends upon the amount of current flowing, and the type of soluble salts found in the surrounding soil. Chlorides or nitrates in a clayey or loamy soil favour electrolytic action, whereas minimum electrolytic corrosion occurs in clean, dry sand.

High voltage (HV) this is a voltage exceeding 1000 Vac or 1500 Vdc.

Horizontal illuminance the illuminance on a horizontal plane.

Illuminance the luminous flux density (lumens/m^2or lux) at a surface in a defined plane.

Installation supply main switchboard (ISMSB) this is a low voltage switchboard from which the supply to the whole installation can be controlled. In AS/NZS 3000 this is referred to as the "main switchboard". The "installation" prefix is used in this document to distinguish the Installation Main Switchboard from the Distribution Supply Main Switchboard.

An "installation" is as defined in AS/NZS 3000. For installations connected to RailCorp's LV distribution system where there is no DSMSB, this switchboard usually contains the Point of Supply, the main earth terminal and may have a main earth–neutral connection.

IP rating this is the **I**nternational **P**rotection rating or Ingress Protection rating which denotes the environmental protection provided by enclosures e.g. switchboard panels. The IP rating normally has two numbers (refer to AS 60529):

- the **first digit** represents protection against ingress of solid objects
- the **second digit** represents protection against ingress of liquids

For example, in equipment rated as IP65, the first digit (6) denotes that the ingress protection is rated for total dust exclusion, and second digit (5) denotes protection against low pressure jets of water from all directions (limited water ingress).

Isolating transformer a transformer with protective separation between the input and output windings which conforms to AS/NZS 61558. Generally, this is a three phase Dyn1 415V/415V transformer or single phase 240V/240V transformer that isolates the Local Electricity Distributor's Service Equipment (MEN earth) from any part of the RailCorp distribution system (refer to EP 17 00 00 11 SP).

Life-cycle costing a procurement costing technique that considers all life cycle costs. The aim is to determine the lowest cost of ownership of a fixed asset (initial price, installation, operation, maintenance, upgrading, disposal, and other costs) during the asset's economic life.

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Like for like replacement this is a change in an installation element, usually considered to be minimal in nature, not requiring confirmatory validation testing e.g. replacing an existing water heater with one of similar rating but which may differ in appearance and manufacturer. In all situations safety must not be compromised.

Local electricity distributor this is an organisation which owns and controls the principal distribution system in the Distribution District in which the installation is located. In general, it owns and controls the wiring, poles and associated infrastructure which conveys electricity to a consumer. RailCorp is an Electrical Distributor but never the Local Electricity Distributor.

Low voltage (LV) this is a voltage exceeding 50 Vac or 120 Vdc but not exceeding 1000 Vac or 1500 Vdc.

Luminaire an apparatus specially designed to control the light emitted by a lamp or lamps. This includes the fitting, and all components required to fix and protect the lamps and to enable it to properly operate and deliver the required light distribution.

Point of attachment this is the point at which a Local Electricity Distributors overhead service or aerial Consumer's Mains are terminated on a RailCorp building, pole or structure.

Point of supply the point at which the distribution system is connected to the consumer's installation. The Point of Supply defines the boundary between the customer's installation and Electricity Distributor's system.

- in most cases this will be the load side terminals (links or circuit breaker terminals) of the Distribution Supply Main Switchboard.
- in major installations, and where there is no Distribution Supply Main Switchboard and multiple 415V switchboards with 415V bus-ties and multiple incoming supplies are installed. These switchboards are defined as the Installation Supply Main Switchboard and the Point of Supply is on the line side of the supply main switches.

Possession this refers to the planned safety arrangements which control or prevent the normal movement of rail traffic between defined locations and for a pre-determined period.

Prospective fault level refers to the maximum current (r.m.s) that is expected to flow into a short circuit at a stated point on an electrical system, which may be expressed in kA or in MVA.

Quality assurance (QA) refers to a program for the systematic monitoring and evaluation of the various aspects of a project, service, or facility to ensure that required standards and outcomes are met and delivered. This requirement applies to both design and electrical work on site.

Note that quality is determined by the program sponsor. QA cannot absolutely guarantee the production of quality products, but makes this more likely.

Two key principles characterize QA: "fitness for purpose" (the product shall be suitable for the intended purpose) and "right first time" (mistakes shall be eliminated).

It is the responsibility of the firms undertaking design and electrical work to demonstrate compliance with all requirements as a condition precedent of payment.

RailCorp's service mains these are the conductors between the Distribution Supply Main Switchboard (or change-over panel, if there is a back-up supply) and the RailCorp Consumer's Terminals on the Installation Main Switchboard.

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Railway corridor this is any land owned by a rail entity nominated under the Transport Administration Amendment (Rail Management) Act 2000.

Residual current device (RCD) a circuit-breaking device installed in electrical equipment to protect the operator from electrocution by sensing currents leaking to earth. Circuit breakers with fixed 10mA or 30mA coils are commonly used.

Service equipment this is the metering and control equipment supplied and installed as specified in either RailCorp's or the Local Electricity Distributor's service and installation rules. It may include service fuses, circuit breakers, meters, current transformers, and links.

Service mains these are the conductors supplied by a Local Electricity Distributor to the Point of Attachment. Note that the Service and Installation Rules of NSW refer to “Overhead” and “Underground Services”, rather than Service Mains

Switchboard (SWB) this is a single panel, frame, or assembly of panels on which are mounted, on the face, back, or both, switches, over-current and protective devices, busbars, and instruments. Switchboards may be accessible from the front or rear and have top or bottom cable entry provisions. Where access is restricted, large switchboards are often manufactured in transportable sections for site assembly.

Tunnel an underground enclosed structure provided to permit the railway and train sets to pass under higher land, buildings or water.

Uniformity in lighting terms, it is a ratio of illuminances that describes the constraint in illuminance values. For illuminance or illumination values, the maximum, average and minimum illuminance are respectively designated by E_{max}, E_{ave} and E_{min}. There are two main uniformity ratios, U1 and U2. U1 = E_{min}/ E_{ave} and U2 = E_{max}/ E_{ave}.

Vertical illuminance the illuminance on a vertical plane.

Waiver is an approval, granted by the Chief Engineer having technical responsibility.

5 General electrical project requirements

There are aspects of projects that apply throughout, from project inception through to their completion. In particular, these include safety, fitness-for-purpose, life cycle costing, quality assurance, durability and others, as described below. These must all be considered within the rail perspective.

5.1 The rail context

This section is a very brief and general outline of the context within which station and building design for RailCorp takes place. Typically, this would include LV electrical works in stations, depots, offices and amenities buildings, car parks, stabling yards, and maintenance centres and others.

The context in which buildings and building services are provided for railways in NSW is unique. It extends beyond the context that is usual in the broader community, due to the different physical environments in which rail operations and construction takes place, together with its associated operational dangers. In practice, this means that considerations, in addition to those that would normally be applicable outside the railway environment, must be addressed and implemented. Because of the unique railway environment, and to meet the requirements of the *Rail Safety Act*, Designers are required to be granted an Engineering Authority (refer to Section 6.1) prior to undertaking design work, after an acceptable assessment of qualifications, expertise and experience.

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5.2 Safety in design and construction

All design and construction activities shall appropriately consider and incorporate safety in design and construction. This shall include construction work, accessibility, operational and maintenance consideration. Refer to *Work Health and Safety Act 2011* and *Work Health and Safety Regulation 2011*.

In addition to the above, refer also the RailCorp Safety Management System (SMS) and *RailCorp SMS 06 – GD0268 Working around electrical equipment*.

5.3 Fitness for purpose

All services, equipment and devices to be installed on RailCorp projects shall be fit for the intended operational purpose.

Fitness-for-purpose refers to fitness for the specifically intended purpose by RailCorp in the context of their existing and ongoing operational context including all high level aims or overt or implied aims, as well as the detail required for the design life and whether overtly and systematically stated or implied.

The fitness-for-purpose shall incorporate the life cycle cost elements of Section 5.4. In particular, accessibility, maintainability, operational factors to ensure ease of maintenance, minimisation of energy consumption, economic considerations and effective utilisation of operational personnel.

5.4 Life cycle costing

It is a basic RailCorp requirement that a whole of life view be taken for design decisions. Consequently, the specification and selection of systems, products and materials shall be considered over a product life cycle and not merely based on initial capital cost. Therefore, Life Cycle Costing (LCC) shall consider the initial capital cost, operational costs (e.g. energy usage and cost), longevity and maintenance costs. This can be described as:

LCC = Cost of (initial capital + repairs + maintenance + operation + energy + disposal)

Where:

Initial Capital Cost includes removal of redundant existing equipment and cabling, design, project management, installation/construction, testing and commissioning and handover.

Repairs include unplanned non-maintenance activities e.g. broken wires, equipment failure etc.

Maintenance includes such items as recurrent work (e.g. lamp replacement), lubrication, calibration, software upgrade or replacement. Note that some systems or equipment elements may have a reduced life compared with the rest of the installation. These need to be replaced at appropriate times and due allowance is required to be made in maintenance plans and procedures.

Operation relates to those activities that are required to ensure proper on-going functionality of the installation and equipment. It is important that Designers consider this aspect fully; otherwise additional downtime, staffing and shift work may be unnecessarily required.

Energy is total energy (usually in kWhrs) required to effectively operate the plant, system or installation over their operational life.

Disposal is the activity incurred at the end of the equipment or installation life and includes demolition, removal from site and appropriate disposal. In addition, some

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equipment may contain toxic or hazardous components which may require to be disposed by specialist organisations at significant cost.

In most instances there are competing products, services and systems available in the market and it is expected that various options are considered and suitable recommendations and selections made on a life cycle costing basis. Any design change shall be able to be justified in this way.

LCC is required to consider that equipment or systems may have elements incorporating different useful lives. For example a control system would include field devices, cabling, marshalling panels and the like with a particular life but associated computer hardware and software would have a much shorter life. Maintenance and costing provisions are required to reflect these diverse subsystem life cycles within an overall system or installation.

It is expected that comparative LCC be demonstrated as the basis for the selection of all systems, products and materials when fitness-for-purpose has been established.

Refer to NSW Treasury Guidelines on life cycle costing for guidance of what factors shall be considered in assessing life cycle costing (refer also to *AS/NZS 4536-1999 Life cycle costing - An application guide*).

5.5 Quality assurance (QA)

The provision of specified outcomes is required to be appropriately managed via a Quality Assurance program. This requires Consultants and Contractors to maintain an approved quality system in accordance with the ISO 9000 series of standards. This shall be auditable at any time by RailCorp.

Evidence of compliance and suitability shall be demonstrated as a condition precedent for payment.

QA is a contiguous system which needs to be implemented from project commencement through to project completion. It encompasses all elements of design, tendering, construction, testing and commissioning, documentation and handover.

Whilst in larger projects QA systems must work in unison with the Contractor and/or other trades, each Contractor/subcontractor must produce, at the beginning of works projects, at least:

- a project quality plan for their work
- a list of quality deliverables at each submission of design and documentation
- coordinated quality checklist for interface issues

5.6 Durability considerations

The minimum design life requirements for various assets are specified in Section 2.11 of ESB 002. For LV electrical items, these include:

- LV switchboards, luminaires and electrical systems 25 years
- cabling and support systems 25 years

5.7 Environmentally sustainable design (ESD)

Wherever applicable, relevant elements of ESD shall be incorporated in LV electrical design. The use of proven innovative technologies that exhibit low energy consumption, demonstrate longevity and attendant low maintenance profiles, are typical factors to be assessed and considered. In addition, care shall be taken to avoid the use of products that incorporate hazardous or polluting materials. If their use is unavoidable, safe

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disposal of these shall be incorporated in Life Cycle Costing (e.g. phosphors and mercury in fluorescent tubes).

RailCorp approval is required for the utilisation and implementation of new technologies.

A key factor of ESD is to consider a holistic life cycle cost approach of an installation or service.

For an outline of ESD considerations and requirements and what must be considered in relation to ESD for a project, refer to the Transport for NSW - *NSW Sustainable Design Guidelines for Rail*.

6 Electrical design process and deliverables

It is expected that Designers, with Engineering Authority (refer to Section 6.1), will undertake design of all electrical system elements.

Designers should not provide “performance” specifications and then leave design or details to be undertaken by sub-contractors or suppliers. Designers must be responsible for design.

Designs shall be complete in both scope and detail and serve as a firm basis for pricing. Where appropriate, alternative designs may be invited but will only be considered if it is demonstrated to the full satisfaction of the Chief Engineer, Stations and Buildings, to be equivalent in all respects to the original accepted design.

On completion of work, but before handover to RailCorp, all operation and maintenance manuals, including all as-built documentation must be checked and verified as being a true representation of what has been built by both the sub-contractor/supplier responsible for the work and contractor responsible for coordination at a higher level. A formal written statement attesting to the successful undertaking of this procedure (when achieved) shall be provided to RailCorp.

This section deals with processes and aspects that would normally form an inherent part of a project. They assist in ensuring that the project outcomes are suitably delivered, are appropriate, and able to be properly maintained and operated. They shall be included in all projects whether specifically mentioned in contract documents or not.

6.1 Design and engineering authority (EA)

Engineering design shall only be undertaken by approved Consultants who are pre-qualified by either being on an appropriate panel or who are able to demonstrate their firm’s capability, capacity and systems are adequate to undertake the required work.(e.g. design consultants) and individual personnel in those firms that have been granted Engineering Authority for a specific project,

The granting of EA for one project does not imply that the individual within an organisation has that authority for any other RailCorp project.

At no time shall an Electrical Contractor or Consultant undertake any design work unless specifically granted Engineering Authority.

EAs can be applied for prior to the commencement of design. Refer to EPA 241 and associated documents on the RailCorp engineering internet site:

http://engintranet.railcorp.nsw.gov.au/All%20Disciplines_Forms.asp

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6.2 Design deliverables

Project design is broadly undertaken in three distinct stages of deliverables; Feasibility Options, Concept/Reference Design and Final Design documentation, which are detailed below.

Project scopes will vary and stages may be compressed on smaller projects. However, this will not obviate the need for adequate and complete documentation at the 100% design stage.

The three stages shall be complete for the intended purpose that they are required. In addition, each stage shall incorporate the previous stage such that the stage that follows begins where the preceding stage ends.

6.2.1 Feasibility options

The aim is to examine alternative electrical system schematics and contents with a view to selecting the best option in conjunction with selected building and services option. Typically, the following need to be considered based on experience and knowledge of standards:

- electrical load based on a VA/m^2 assigned from experience and knowledge
- general assessment of issues regarding the supply and distribution of electricity
- basic design elements and notional load centres
- basic lighting design e.g. lux levels, VA/m^2
- building automation system (where required) on a cost/control point basis
- electrical project options costing on a cost/m^2 basis

6.2.2 Concept design

The aim of this stage is to define the electrical system, element capacity and capability. And accommodation, including cables routes with a view to defining adequate spatial requirements in conjunction with the building design and site details. Typically, these are as follows:

- provision of 1:50 scale room plan layouts and elevations, including reflected ceiling plans
- defining spaces for cable risers, electrical cupboards, switchboard locations
- determining switchboard requirements and their location
- a basic electrical power arrangement, with due consideration of anticipated electrical load centres
- a trial lighting design showing location and heights of luminaires to achieve the desired lighting levels
- preliminary prospective fault levels
- provision of appropriate specifications for the installation and its elements
- design to be at a level to enable a preliminary estimate to be provided
- provision of a preliminary cost estimate (+/- 30%)

6.2.3 Reference design

This is similar to a concept design except that more details are known, consequently the basic design and cost estimates (+/- 20%) are required to be more refined with a higher degree of design finality than that for the concept design.

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6.2.4 Final design documentation (100%)

The aim of this stage is to provide detailed design and specifications for the electrical installation and systems, including all elements, for tender and construction purposes. This would include the following:

- determination of activities in the project areas
- buildable designs and specifications (clearly marked “For Construction”) which, when implemented, shall deliver the project electrical requirements. These documents shall be clear and unambiguous requiring no further interpretation, and include operational efficiency as well as life cycle costing (refer to Section 5.4) in the considerations.
- a formal design report, demonstrating means of compliance with AS/NZS 3000 cause 1.9, clearly identifying and explaining any departures from Part 2 of AS/NZS 3000, as in Clause 1.9.4 (i.e. engineered design to RailCorp standards for modified direct earthing system etc
- compliant designs and electrical installations. Non-compliances shall be specifically highlighted, together with reasons why not achieved or not achievable. For statutory requirements non-compliances will not be entertained. Non-compliances with RailCorp requirements shall be subject to waiver approval.
- identification of hazards related to electrical design which impact on installers, maintainers and the public. Designs shall eliminate all risks. Where complete elimination of risk is not possible it shall be minimised in accordance with RailCorp’s Safety Management System.
- all necessary grading studies, working calculations such as prospective fault levels (three-phase and single-phase to earth), earth fault-loop impedance, protective device selection and selectivity in operation, maximum demand, voltage drops, lighting calculations (including isolux diagrams for all areas) and such other calculations as may be applicable to a specific project. This information is required in a report form.
- cable installation, cable enclosures, cable routes, cable trays and cable ladders, location of equipment etc.
- cable and short circuit protective device schedules, with provision for as-built measured values.
- site plans showing distance from tracks (where applicable), necessary for safety assessment when planning installation or construction.
- location of lighting columns relative to insulation panels in line side fencing, retaining wall structures and galvanised steel trunking.
- clearances of earthed electrical apparatus, metallic wiring enclosures etc from OHW structures and detail of insulation/isolation, where applicable, at less than mandatory minimum clearances for touch potentials.
- Single Line Diagrams (**SLDs**) that clearly show the various switchboards, systems and sub-systems. Generally, overlaying of different systems on the one drawing is not acceptable.
- details of protective devices such as circuit breakers and fuses shall include type, frame size, settings, and rating as well as overcurrent protection settings. This information shall be provided on drawings, site-specific installation details e.g. switchboard transport sections,
- equipment installed in locations where these are fully accessible for operation, repairs and maintenance.
- installations and equipment on a fitness-for-purpose basis (refer to 5.3).
- equipment selection
- utilisation of daylight in lighting design
- choice of luminaires, lamps, columns, height of luminaires etc
- operational and maintenance requirements
- cost estimate (+/- 10%)
- tender drawings marked “For Construction” and associated specification and documents. These shall be 1:100, 1:50, 1:5 scale plan and elevation drawings for

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internal buildings and services, with 1:200 scale drawings for external services. Other scales may apply according to site requirements.
- Certificate of Compliance for Design (refer to Section 6.3)

6.3 Certificate of compliance for design

At 100% design stage a complete set of documents, including drawings and specifications, shall be provided by the Designer or design consultant that were granted Engineering Authority for design (refer also to Section 6.1).. These shall be marked “For Construction” and fully address the project LV electrical requirements. A *Certificate of Compliance for Design* shall be forwarded to RailCorp with these documents by the Designer or design consultant and shall include:

- complete list of documents being certified
- complete list of applicable legislation and standards being certified against
- no exclusions unless prior agreement by the relevant RailCorp Chief Engineer.
- any waivers granted from RailCorp standards
- certification of “fitness-for-purpose” in accordance with the scope of work

7 Electrical construction process and deliverables

The construction stage of a project is where the design is implemented. During this phase variations to the original design documentation often occurs for a variety of reasons. If approved, these are incorporated within the works and the As-built documents.

Personnel working on station electrical infrastructure shall be appropriately qualified, licensed and experienced in the works to be undertaken, whether in design or implementation of site works. These are required to conform to the *Rail Safety Act,* where RailCorp has the responsibility to provide both a safe working environment as well as a safe environment for the public in areas under its jurisdiction.

The following are required, or shall be provided, to RailCorp for each electrical project:

a) samples of luminaires and accessories (refer to Section 7.5)

b) installation testing and commissioning plan incorporating applicable pass/fail criteria

c) manufacturers’ test certificates or type test data, as applicable

d) manufacturers’ documentation for design, installation and warranty information

e) “As-built” drawings and documents that accurately depict the installed works (including all variations to the original design). This type of documentation must be verified on site prior to presentation to RailCorp.

f) a *Certificate of Compliance (Construction)* at project completion (refer to Section 7.13).

7.1 Workmanship

All electrical equipment and components shall be installed in accordance with good trade practice, and to comply with appropriate standards and RailCorp requirements. Current installation will not necessarily be accepted as a precedent.

Workmanship, scope and coordination should be acceptable by the subcontract trades or suppliers undertaking the works and those immediately above these that are responsible for coordination work.

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Acceptance or rejection of workmanship will be at RailCorp's (Project Manager and relevant Chief Engineer) discretion in each project.

7.2 Use of new materials

All materials, components and equipment shall be new (and of demonstrated suitable quality), unless otherwise directed by RailCorp.

7.3 Use of approved materials and equipment

Only materials and equipment approved for installation on railway stations shall be used.

Refer to:

- Schedule of "Standard Lighting Columns", Drawing No. K88525.
- Schedule of RailCorp "Standard" Electrical Drawings.

Refer to Sections 3.3 and 3.4 for further details. Refer also to Section 7.5 regarding samples.

Use of non-approved equipment requires specific approval by RailCorp.

7.4 Equipment location

The location of all equipment depicted on drawings is diagrammatic and unless dimensioned details are specified the exact location shall be determined on site to the approval of RailCorp.

Where plant, switchboards, equipment racking, ducts, pipework. cable trays or other services are installed check site conditions such that the when power outlets, luminaires, switchboards, cabling and the like are installed clear of any obstructions.

7.5 Samples

Submit samples of all luminaires, fittings and accessories proposed to be incorporated in the electrical works. Such items are not to be installed until RailCorp approval is obtained.

Samples shall be retained on site and be used as "benchmarks" with which subsequent fixtures of the same type are compared.

It is the responsibility of the Designer to ensure that the specification meets the site requirements and those details are appropriate and fit-for-purpose. Note that RailCorp is not responsible for the assessment of the lighting distribution of luminaires.

7.6 Redundant equipment and cables

Unless otherwise specifically directed, all electrical equipment, material and cables that become redundant as a result of works undertaken shall become the property of the Contractor and be removed from site. All adjustments to existing equipment, cables and the like shall be undertaken in accordance with relevant Australian and RailCorp standards. In any event these shall be tidied up in a tradesman-like manner and made safe.

Where, for various reasons, redundant services are left on site or discovered in the course of work, such services location shall be documented on as-built drawings and marked as redundant, both on drawings and in-situ.

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7.7 Penetrations

All electrical services penetrations through horizontal and vertical openings through floors, walls and ceilings shall be effectively sealed for fire and smoke as per AS/NZS 3000, Clause 3.9.9.3, and using intumescent materials as per manufacturer's fire test certification and in accordance with AS1530.

Fire resisting material shall provide a fire rating not less than the floor, wall or ceiling being penetrated. Seal all other penetrations in order to prevent entry of rodents, birds, insects or other vermin.

7.8 Search for underground services/excavations

Prior to probing, pegging, digging, boring, drilling, driving of stakes/pipes, excavating, grading or otherwise lowering the existing ground cover or inserting an object into the ground, the Contractor shall determine the locations of all underground services. In particular, by:

- detailed site inspections and, if necessary, site survey
- obtaining RailCorp's underground services search reports. Use *Service Search Request Form* SMS 06 FM 0384 and forward to the Service Request Co-ordinator at Services.Request@RailCorp.nsw.gov.au.
- enquiries directly to Public Utilities for bridges, subways and land adjacent to platforms.
- contacting the Infrastructure Facilities Unit.

The Contractor shall assume that the information provided by the RailCorp search reports and enquiries to Public Utilities may not necessarily be totally comprehensive or accurate, and the Contractor shall use the plans only as an aid, and not undertake any work in reliance on them. The depth of cables may be different from specification depth due to subsequent grading operation or other earthworks; hence the Contractor shall take all necessary precautions against damage to services or risk of electric shock.

The locations of live services shall be verified by an appropriate services locator and/or by hand excavation.

If underground services are exposed take all necessary steps to protect them from damage due to the construction work or potential vandalism. Ensure that the RailCorp Safety Management System (SMS) is implemented. Assume services are operational unless determined otherwise.

In the event of any damage to cables, pipe work, etc., the Contractor shall immediately inform RailCorp and take all necessary precautions to protect the damaged portion. In the case of damage to cables assume the cable is still "alive" until advised otherwise and take all necessary steps to prevent risk of electric shock to workers or the general public. Refer to the RailCorp SMS for process of notification.

Unless approved in writing, and supervised by RailCorp, the Contractor shall not disturb any existing cable or troughing routes during the installation of new cable routes and equipment. Except in cases of emergency, staff shall not sit upon or climb over troughing routes unless special protective measures are taken, including steps or ramps, approved in writing by RailCorp, are constructed by the Contractor.

It is the Designer's responsibility to accurately identify site services. It is the Contractor's responsibility to verify the exact location of all services on site by survey or inspection services locators, is required in some form in all projects.

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Note:

- the search for in-ground services in highly serviced areas such as station platforms may take quite some time to finalise. Contractors that intend to trench such areas shall make appropriate allowances in their works programme for potential delays in obtaining services details.
- **services locators can interfere with Signals equipment** and therefore their use is restricted in some areas. Refer to TMG 1440 R*equirements for the Location of Underground Services in the Rail Corridor*.
- induction hearing loops are being increasingly installed at railway stations. In particular, these may be located near the platform finished surface, generally at platform edges and external walls of platform buildings. Care shall be taken not to damage these. Where damage occurs it must be repaired by the loop installer, at the expense of the party responsible for the damage

7.9 Identification and labelling

Each dedicated electrical services room shall be identified by a suitably worded sign and/or room number. Wording shall be approved by RailCorp.

Every distribution board shall be labelled to identify it and advise information on supply and rating of fuse and circuit breaker protecting it, and the size of sub-mains.

All circuit breakers shall be clearly labelled to identify the equipment/circuit they supply.

Refer to Section 7.9 of this document and also AS/NZS 3000, Clauses 2.3, 2.9 and 7.2.6, as well as EP 00 00 00 16 SP Electrical Power System Signage (Clause 9.3.2).

7.10 Locks and access to switchboard rooms

Where electrical distribution switchboards are located in a dedicated room or cupboard, then that room or cupboard shall be secured by a standard electrical discipline key to enable access in an emergency situation.

- substation rooms shall be fitted with C1A locks.
- installation Main Switchboard Rooms to be fitted with C1B locks.
- distribution Supply Switchboard Rooms and Battery Rooms shall be fitted with C1A locks.

Contact the RailCorp Locksmith to install appropriate final lock barrel and provide the requisite keys.

Note that temporary builder's locks may be fitted prior to hand-over to RailCorp. The RailCorp locksmith needs to be advised to change the locking to fit standard RailCorp Electrical Series locking to switch rooms.

Refer also to the Electricity Network Rules, EN00555 Locking Systems for Electrical Equipment.

Access to switchrooms is only permitted to an Authorised Person.

7.11 Disposal of redundant plant and equipment

At the end of operational life or as a result of refurbishment or upgrade works, redundant plant and equipment shall be disposed of in a safe manner and appropriately recorded.

Disposal of non-fixed items shall be recorded in Form LOG702F1 *Disposal of Non-fixed Assets*.

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7.12 Testing and commissioning requirements

Prior to permanent connection to supply, all installation work carried out shall be tested, and a test report completed and forwarded to the relevant District Electrical Inspector. This shall be carried out by the installing electrical contractor (or another electrical contractor engaged by the installing electrical contractor to undertake this work on their behalf).

The tests are required to check that the installation is safe and that it complies with the relevant Australian Standards. RailCorp may also specify additional particular tests for individual projects. Refer to *Electricity Association of NSW Code of Practice – Installation Safety Management* for a list of tests and *EP 17 00 00 06 SP Installation Inspections.* Refer also to *AS/NZS 3670 – in-service safety inspection and testing of electrical equipment*.

Testing shall also be undertaken in order to verify compliance with all legislation, standards and requirements.

After testing is completed, all electrical installations, systems and sub-systems shall be commissioned in accordance with a check list of actions or activities that are specifically developed for the project. Note that the Contractor shall undertake all relevant pre-commissioning tests prior to inviting appropriate parties, including RailCorp, to witness site testing and commissioning.

Confirm that circuit protective devices are sized and adjusted as required to properly protect the installed circuits and equipment.

Three-phase electrical installations shall be tested at all three-phase switchboards and three-phase outlets to ensure proper phase sequence is present; if not, modify to achieve this.

All commissioning results shall be documented in a clear and concise manner stating the measured values obtained (where relevant), set points and alarm status, storage container liquid levels, as well as other required features and whether the tests passed or failed, or what remedial action was taken. The results of the testing and commissioning shall be bound in a report, a copy of which shall be forwarded to RailCorp.

If installation or system failure is observed during testing and commissioning, after modifications are effected, re-testing shall be repeated until satisfactory outcomes and installation or system operation are achieved and documented as described above.

RailCorp requires one week's notice to inspect any work that is to be concealed to enable photographic records and measurements to be taken.

Contractors shall provide all tools and equipment required to undertake the requisite testing and commissioning of the installations or systems.

Test instruments shall be certified as to their accuracy, calibration dates shall be stated as well as by whom calibrations were undertaken.

7.13 Certificate of compliance (construction)

A *Certificate of Compliance (Construction)* for LV electrical work, in full compliance with the design and associated approved variations, workmanship and requirements covered by this standard, with appropriate supporting evidence, shall be submitted to the project manager within fourteen (14) days of completion of project electrical works. This shall confirm compliance with RailCorp Standards, Australian Standards, Codes and Guidelines, government Acts and Regulations, and other relevant standards as may be applicable.

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Upon receipt of this *Certificate of Compliance*, an inspection of the electrical installation may be carried out, limited to the electrical works covered by the certificate, which shall cover the extent of such works.

This certificate should not be confused with, and is in addition to, the *Certificate of Compliance - Electrical Work* required by the Office of Fair Trading and the Local Electricity Distributor.

7.14 Application for connection

The individual Districts of the Infrastructure Maintenance Division represent RailCorp in its capacity as an Electricity Distributor within their respective boundaries.

The appropriate District is responsible for carrying out electrical installation inspections, upon receipt of a *Certificate of Compliance*. In addition, when an *Application for Connection (EP 95 00 30 03 SP FM 02*) is received, the District Installation Inspector will determine if the associated substation and the Distribution Supply Main Switchboard have the capacity to supply any additional load required. Refer also to Information Regarding Application for Connection form *EP 95 00 30 SP FM 01.* Both these forms are available on the RailCorp Engineering Intranet*, Electrical, – Standard Forms.*

It is the responsibility of the installing electrical contractor (or electrical consultant responsible for design) to determine whether the installation has the capacity to accept the additional load and to ensure adequate design is undertaken accordingly. Note that early advice is required to be provided to the Local Electricity Distributor to ensure that appropriate electricity supply is provided in a timely manner.

A connection letter to RailCorp, at the system design review phase, shall confirm the existence and availability of supply assessed maximum demand of the installation. Where no existing capability is available, it may take quite some time to resolve the matter (weeks/months), depending on site conditions and needs. No compensation shall be made for premature expenditure where the Distributor (RailCorp) cannot provide the supply of appropriate capacity.

All electrical works shall comply with the NSW Service and Installation Rules, and any relevant RailCorp Engineering Standards.

Any directions made by the District Electrical Inspectors shall be complied with by their authority under the Electricity Supply Act 1995 and RailCorp's statutory duty as a supply authority under that Act.

7.15 "As-built" drawings

On completion of an installation, Electrical Contractors shall submit accurate detailed drawings of archiveable quality to show the route, depth and arrangement of all underground cables installed by the Contractor.

Archiveable quality drawings shall be CADD drawings of a thermal process or ink type plotter process. Soft copies of all drawings shall also be provided, compliant with RailCorp's CAD standards.

Update all single line diagrams when new work is undertaken.

Provide an *Excel* spreadsheet for circuit schedules. A hard copy shall also be provided for the relevant switchboards on site. A soft copy shall be provided for each schedule to enable easy upgrade when required.

The as-built drawings shall accurately reflect the installed undertaken works. Details shall include:

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- title page with relevant drawings list and legend
- Single Line Diagrams (SLDs) for LV services, with new works clearly delineated. SLDs shall show all interconnections between switchboards on the one drawing (unless unable to do so due to excessive number of switchboards)
- switchboard disposition, location and access points
- switchboards details, including general arrangement, form of construction, fault levels, circuit breakers, circuit breaker frame sizes, circuit breaker settings
- labelling of devices, short circuit protection details, cables and circuits on switchboards
- lighting and power layouts on separate drawings, except for small projects where several services may be co-depicted and clearly differentiated on a drawing.
- cable routes, cable sizes, cable types, cable trays and enclosures
- IP ratings (refer to Section 4)
- relevant cross-referencing
- title, drawing number (including revision)
- endorsement by the electrical contractor, with names of Designer and checker or verifier (including signatures); initials are not acceptable
- date drawing is applicable

Drawing shall be available to the District Inspector for pre-commissioning, with signed soft and hard copies available within two weeks of commissioning incorporating appropriate RailCorp EDMS numbers.

7.16 Operational maintenance

The life cycle cost approach which balances the capital and maintenance costs shall be applied to item and system choice.

All electrical systems and services that require periodic maintenance shall be provided with suitably detailed site-specific documentation for such maintenance to be appropriately rendered. Such documentation will include operation and maintenance manuals compliant with the requirements of the law, standards and good practice in a form that can be used by RailCorp to incorporate into its Technical Maintenance Plans (**TMPs**).

7.16.1 Operation and maintenance manuals

Site and project specific maintenance manuals shall be provided and shall include the following, in the order indicated:

- safety warnings and electric shock survival guide.
- a contents page inside the front cover of each volume, with the title to match the title on the cover and the content of the respective volume.
- a legend/directory with names, addresses, telephone, facsimile numbers and email addresses of the principal consultant, sub-consultants, contractor, subcontractors and other responsible parties.
- a general description of the installation to provide an overview and understanding of the equipment and its operation.

Equipment description:

- manufacturers' site-specific technical literature, excluding irrelevant matter. Each product data sheet marked to clearly identify the specific products and components used in the installation and the data applicable.
- equipment schedules consisting of a unique label cross-referenced to the record drawings, the manufacture name, address, telephone and facsimile number, the equipment model number and ratings as appropriate, for each type of equipment.
- technical data as necessary for the efficient operation and maintenance of the installation.

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- a list of recommended spare parts, with associated list of suppliers, their addresses and contact telephone numbers, and email addresses.

Operational procedures

- manufacturers' technical literature as appropriate for the respective installation, system and equipment. For other than common accessories, where no manufacturer literature is available a precise and concise description of the operation procedure in plain English is required.

Maintenance procedures:

- manufacturers' technical literature, as may be appropriate.
- detailed recommendations for the frequency and procedures for preventive
- maintenance.
- an inspection and monitoring programme through the product or installation life to ensure design functionality is maintained.

Instructions on the safe disposal of hazardous substances including, but not limited to:

- asbestos material (e.g. asbestos cables
- fluorescent lamps containing mercury and phosphorus
- smoke detectors containing radioactive ionisation material

Certificates:

- Certificate of Compliance for Design
- Certificates of Compliance (Construction)
- Certificates from authorities e.g. Local Electricity Distributor, Fire Brigade etc.
- copies of manufacturers' warrantees and guarantees.

7.17 Training

Where training is required to be provided to enable RailCorp personnel to properly operate or become familiar with an installation or system, this shall be provided in a format and depth that is required to achieve competency. A trainer may be required to be provided by the Contractor for this purpose. The actual number of trainees and training sessions shall be agreed with RailCorp prior to finalising a price for this work.

For an outline of ESD considerations, and what must be considered in relation to ESD for a project, refer to the Transport for NSW – *NSW Sustainable Design Guidelines for Rail*.

8 Electricity Supply

8.1 General

Electricity Supply to Railway Stations, other buildings and installations in the Rail Corridor may be from the RailCorp distribution system or from the Local Electricity Distributor. This will be determined by the Chief Engineer Electrical.

Installation of a new supply, either from the RailCorp distribution network or from the Local Electricity Distributor, or changes of Electricity Distributor shall be approved by RailCorp.

For Underground Stations reference shall be made to the RailCorp *Standard Requirements for Fire and Life Safety in Underground or Enclosed Railway Stations (August 2009, currently a draft).*

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Refer to Standard Drawings A1-88496 and K-88525 for specific information and connection details.

For additions or changes to existing electrical infrastructure an *Application for Connection* shall be forwarded to the appropriate RailCorp Electrical Maintenance District Electrical Inspector (refer to 7.14) when load calculations can be accurately estimated.

The standard voltage tolerance for low voltage is +5%, -8% steady state. Nominal voltage is 415V/240V.

8.2 Supply by RailCorp

Location of Distribution Transformer and Isolation Transformer substations as well as associated DSMSB shall be determined by RailCorp.

High Voltage (HV) Transformers are purchased to RailCorp Specifications and are dealt in other RailCorp standards.

8.3 Supply by Local Electricity Distributor

In electrified areas, an Isolating Transformer shall be provided in accordance with RailCorp Standard EP17 00 00 11 SP *Low Voltage Isolating Transformer* and installed in a position nominated by RailCorp.

Location of service pole (where required) shall be determined jointly by RailCorp Distribution and the Local Electricity Distributor.

Point of Supply would normally be on the service pole, height to be determined by local conditions, e.g. crossing roads, etc.

The Meter Board would normally be mounted on the service pole and installed in a suitable lockable housing, all in accordance with the Service Rules and Supplementary Publications of the Local Electricity Distributor.

8.4 Isolating transformers

When required, isolating transformers located within padmount kiosks shall be selected from the follow standard ratings:

- 25kVA, single-phase LV type enclosure, whole current metering
- 75kVA, three-phase R type enclosure, whole current metering
- 200kVA, three-phase R type enclosure, current transformer metering
- 315kVA, three-phase R type enclosure, current transformer metering

Refer to drawings EL0497871, EL0480479, EL0035272, EL0464957 and EL0170330.

8.5 Metering

For installation on RailCorp property, whole current metering (usually for less than 100 amps) is implemented on the service pole located on the fence line.

Current transformers (CTs) in padmount kiosk substation, with fencing arranged to permit meter readers to access meters without entering the rail corridor.

Note that site situations vary and may impact on the location and access provisions which need to be designed for individual requirements.

Refer also to Section 12 for switchboard metering.

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8.6 Load shedding

Load shedding is available from RailCorp Distribution padmount kiosks (refer to drawing EL0494650). The shedding of electrical load feature can be effected when supplying an installation from a back-up electrical supply which is not fully rated.

8.7 Supply to car parks

Car parks owned and operated by RailCorp shall be supplied via metered sub-mains from the Installation Main Switchboard, fed from the Local Electricity Distributor supply.

Supply from the Local Electricity Distributor shall be via isolation transformer (to minimise stray currents) where any portion of the car park installation earthing system is located within 20m of the electrified track or within the corridor boundary, subject to risk assessment.

8.8 Supply to rail yards

Electricity supply to rail yards shall be in accordance with relevant RailCorp standards and guidelines as well as relevant Australian standards. Particular attention is required regarding voltage drops and fault rating of cables and protective devices such as circuit breakers and fuses to ensure safe and proper operation during normal use and under fault conditions. Appropriate cable selection shall be made with due consideration of these issues and must be demonstrated by calculation.

Refer to EP12 10 00 21SP regarding electrical supply to rail yards.

Note that underground services are frequently found in rail yards. Care shall be exercised when excavating or installing new services (refer also to Section 19.5).

8.9 Supply to RailCorp buildings in the rail corridor

As there are a variety of buildings and building services requirements within the Rail Corridor, the general requirements of Section 8.3 would equally apply. In addition, there would be requirements for essential services (e.g. lifts) where special fire rated cables and mechanical protection will be required (refer to Section 18.10).

Some critical services may also need to have the electrical supply protected from physical and fire damage.

9 Service/Consumer mains

Whilst the following details relate to Service/Consumer Mains, the requirements are also applicable to other power cabling, except for specific Consumer Mains cable requirements such as WS52W designation.

9.1 Cables

Service/Consumer Mains for supply to installations within the rail corridor are deemed to be part of the distribution system (refer to EP 17 00 00 12 SP).

The National Construction Code (BCA) requires that Consumers mains to the ISMSB shall be not less than WS52W designation.

Cables shall be stranded copper.

The voltage drop of service/consumer mains shall not exceed 1.5% of nominal 240V voltage.

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Entry of consumer's mains shall be through the bottom of the switchboard. No conduits or cables shall enter through the top housing surface.

Joints in Consumer's Mains are not permitted.

Refer also to Section 18.8.

If lifts form part of an installation, all supply cables from the DSMSB to the IMSB and to the lifts or other essential services shall be fire rated and approved by RailCorp.

9.2 Conduits

Consumer's mains shall be enclosed in conduit, for mechanical protection, from the point of supply to the meter box, and from the meter box to the Distribution Supply Main Switchboard, thence to the ISMSB. Conduit shall be "weather set" at the Point of Attachment and securely saddled as required by AS/NZS 3000.

Cables run underground shall comprise single core double insulated cable, enclosed in heavy duty rigid UPVC conduit of 32mm minimum diameter, suitably sealed to prevent ingress of water.

9.3 Cable routes

Route of underground installation shall be approved by RailCorp. Some factors in selecting the best cable route include:

- access, including access to all connection points for control functions
- future proofing
- cable size
- voltage drop and anticipated prospective fault levels
- protection against mechanical and fire damage
- influence and impact of other elements

9.4 Cable route marking and recording

Service/Consumer's mains installed underground shall have the route identified by suitable markers/monuments. In addition, suitable "as-built" drawings shall be provided to accurately record locations in 3D, as well as access points, change of direction, electrical elements, pits, jointing boxes.

The philosophy for underground cable route marking and identification shall follow the arrangements detailed in the following standards;

- AS/NZS 3000
- EP 20 00 04 02 SP, Underground Cable Route Marking (Clause 7).
- EP 20 00 04 06 SP, Underground Cable Location Recording

If there are inconsistencies between AS and RailCorp standards, the latter shall prevail.

9.5 Cable pits

Suitable pits (with covers) shall be installed to assist with installation of consumer's mains as well as other large cables. These shall be suitably sealed, drained and where possible located above water collection points. Pits shall be interconnected and accessed by means of appropriate heavy duty UPVC conduits.

Pits are required to address a number of practical site conditions, some of which may include the following:

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a) suitable and accessible LV pits, with a type and dimensions to Civil design for specified minimum bend radius.

b) maximum spacing between pits to suit pulling tension of the cable types and size

c) bell-mouthed ducts

d) removable lids with the aid of special tools

e) load rating of multiple lids to AS 3902

f) defining confined space - where on entry to a pit, the head and shoulders of a person may pass below the upper level of the pit or ground level.

g) horizontal access to deep pits/confined spaces shall be in accordance with AS/NZS 1657, Clause 5.2

h) design load requirements specified for Signals And Communication pits in SPM 0123 *Reinforced Pre-Cast Concrete Cable Pits* shall be adopted where applicable.

Refer also to EP 20 00 04 05 SP.

10 Electrical protection and discrimination

10.1 Fault level determination

To determine the required fault capability of switchboards and associated equipment Designers shall determine the prospective fault levels at the required switchboard locations. In some instances RailCorp's District Electrical Inspectors may be able to assist in this task by providing the fault level at some point, not necessarily at the desired switchboard locations.

It is the Designer's responsibility to determine the fault levels for the purposes of specifying the appropriate electrical equipment and system capability (but not lower than the fault level requirements stated in the Service and Installation Rules of NSW).

For new works. Designers shall provide working calculations to RailCorp to demonstrate that the appropriate equipment and switchgear has been specified. Calculations shall be made at all required switchboard locations (including mechanical services switchboards and others, as may be required). In this regard, documented data in the form of either calculations or measurement of both maximum and minimum symmetrical three-phase fault and phase-to-earth fault levels shall be provided. The minimum level shall be based on the normal configuration of the source distribution network.

Where a design is connected to existing circuitry/installation a recalculation of all fault levels for all affected parts is required.

Notes:

- Where light fittings are located near main switchboards, where higher fault levels can be anticipated, ensure that the fuse protection provided within the fittings is appropriately rated.
- Rotating and other stored energy sources shall be included in fault calculations.

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10.2 Load rating

Protective devices shall be selected such that their design function is properly performed within the operating environment. For example, temperature may impact on the nominal continuous load rating of a circuit breaker requiring it to be de-rated for particular in-situ conditions.

10.3 Protection

Details of the type, frame size and settings of protective devices (against the individual protection device) shall be included on the appropriate single line diagram(s).

Apart from their use in some situations as fault current limiters, fuses shall not be used to protect cables.

Note that “duplex” type circuit breakers shall not be used.

10.4 Electrical protection discrimination

The design philosophy shall provide full energy discrimination of the short circuit protective devices (SCPD).

The technique of circuit breaker protection coordination that is dependent on the characteristics of the SCPD as permitted by Clause 2.3.4.5 of AS/NZS 3000 must be supported by data obtained from the manufacturer’s type testing of the devices and accepted by RailCorp prior to implementation.

Designers shall provide sufficient working calculations and time-current curves and such other necessary information required to demonstrate that correct discrimination has been achieved between upstream and downstream protective devices.

Where excessive trip times are required to achieve discrimination, provide options and refer the matter to relevant RailCorp Chief Engineer for direction.

10.5 Selectivity

The importance of achieving discrimination between protective devices is that selectivity is introduced in LV system protection. Selectivity is required to ensure that, where a number of protective devices are effectively in series, the protective device closest to a fault interrupts the circuit first, thus minimising system disruptions.

10.6 Surge protection

Voltage transients and power surges often occur in electrical installation for a variety of reasons. The effect of these is to create sudden rises in system voltage as a result of above normal energy being supplied to the system. The effect of this can be diverse but generally causes heating in cables and devices.

Electronic devices and equipment are particularly susceptible to damage by surges.

In order to protect installations from the effects of system surges, Designers shall assess the need for surge protection with appropriate consideration to the electrical and physical environment of each site. Refer also to AS 4070.

Surge protection shall be graded in a coordinated manner such that devices with the highest energy capability are to be located where electrical supply first enters the facility. Surge protection devices with progressively lower energy capability shall then be sequentially located within the facility, with that having the lowest surge capability being located downstream at the local switchboards. However, due consideration is required to

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incorporate the effects of other transients that may arise due to particulars of location and possible electrical activities that may give rise to system surges. To ensure proper functionality, surge protection devices shall be from the same manufacturer.

Surge protection devices shall be located within switchboard enclosures, and arranged such that they are readily accessible for maintenance or replacement, and are appropriately labelled.

Appropriate maintenance procedures shall be implemented in accordance with manufacturer recommendations.

Lightning strikes are naturally occurring phenomena that give rise to very sharp rising surges (spikes) of short time duration and can result in severe damage to electrical/electronic systems. For details of protective measures refer to AS/NZS 1768.

Refer also to SPG 0712 *Lightning and Surge Protection Requirements,* EP 21 00 00 01 SP *Insulation Co-ordination and Surge Arrester Selection*. And ESM 109 *Communications Earthing and Surge Suppression Standard*

11 Switchboards

11.1 Location of switchboards

AS/NZS 3000, Clause 2.9.2.5 (h), restricts the location of switchboards from egress and exit paths, "…to minimise the impact of any smoke generated by a fault in the switchboard affecting egress". Refer also to Clauses D2.7 and D2.8 of the National Construction Code (BCA) regarding the exclusions and restrictions in locating switchboard cupboards under stairways.

All switchboards shall be located with appropriate consideration of the following:

- fire risk
- impact of smoke and fire on egress paths
- centre of electrical load; impact on cable sizes and volt drops
- minimise impact of Electromagnetic Interference (EMI), particularly to signals and communication systems as well as others such as induction hearing loops
- exposure to external weather conditions and other environmental factors
- ambient temperature; impact on busbar and device ratings
- accessibility for servicing, maintenance and emergency operation
- safety issues, particularly for operators and maintainers
- security – strategic security of a public facility, vandalism
- operational issues e.g. adequate space in front of and adjacent to switchboards

Approval shall be obtained from RailCorp, in particular for installation or relocation of switchboards etc. to confirm intended location is acceptable regarding all the abovementioned issues, as well as other site specific drivers.

11.2 Switchboard type and details

The status quo of all switchboards that impact on a project shall be checked and assessed for operational adequacy and shall be determined prior to defining design scope. In the event that switchboards have no spare capacity, either in spaces or current carrying capability, Consultants and Contractors shall bring the matter to RailCorp's attention as soon as practicable, as these may need to be replaced within the project works. Where determination can't be made, a contingency or PC sum shall be allowed.

The essential parameters required for switchboard design must consider the intended switchboard location, in-situ environmental issues (ambient temperature, humidity),

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ventilation, IP rating, electrical factors (prospective fault levels, including input from rotating or other embedded power sources), transportation and accessibility issues and the impact of interconnection to an existing electrical infrastructure.

Switchboards must be readily accessible and unobstructed by other equipment or stored material. The floor shall be paint marked with suitable trafficable paint) to delineate the exclusion zone.

Switchboards shall be based on a type tested design (part type tested assembly (PTTA) to AS 3439).satisfactory type test certificates from an independent testing authority shall be provided, including appropriate calculations interpolating or extrapolating from relevant type test certificates, where applicable.

Switchboards, switchboard equipment, cables and ancillary works shall be designed by a Consultant holding Engineering Authority for the specific project.

The addition of small switchboards to supposedly overcome deficiencies in existing switchboards is unacceptable. A longer term perspective is required to be implemented where a project causes an existing switchboard to be inadequate.

All switchboards shall be manufactured for prospective fault capabilities to suit the locality and functionality where they shall be installed.

All switchboards shall be fitted with a lockable, load-make, fault-break main isolating switch mounted at centre-top and clearly labelled.

Where a three-phase switchboard is used on a single phase supply, the three contacts of the main switch shall be connected in parallel by cable of the same rating as the consumer's mains.

Major switchboards shall be provided with appropriately pre-drilled or pre-punched connection points and accessible tee-off busbars for the possible future connection of an emergency diesel-generator set. Particular needs shall be discussed with RailCorp technical personnel.

All new switchboards shall have at least 30% spare capacity both in the number of spaces and load carrying capacity and be fitted with a lockable door.

Neutral and earth bars shall have capacity to connect the same number of sub-circuit neutral and earths as actives. Neutrals shall be full size.

All circuit breaker spaces not in use shall be closed by means of suitable pole fillers.

Suitable metering provisions shall be made (refer to Section 12).

Switchboards shall be painted "orange" externally and "white" internally where these are located within a room or electrical cupboard. If located within a train driver's line of sight, the external colour shall be a neutral colour.

Large switchboards are required to be manufactured in transportable sections for easy site access, installation and assembly.

In accordance with Clause 2.5.5.1 of AS/NZS 3000, switchboard with a nominal incoming electricity supply of 800 A, or greater, shall be constructed to withstand internal arcing faults and be designed for arc-containment.

11.2.1 Busbar installation

Switchboard busbars shall be of a type tested design, and be sized and supported in such a way that they are capable of withstanding the mechanical and thermal stresses resulting from the anticipated prospective fault level.

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Busbars shall be made from hard drawn, high conductivity copper, with rolled edges. Square edged busbars shall not be used.

Busbars shall be neatly drilled or punched with round holes with the smallest practicable size for the selected bolt sizes. Excessively large holes or hole elongation for ease of fitting will not be accepted, as these do not provide the maximum conductor contact area

Unless otherwise stated, busbars shall be fixed by a minimum of four high tensile steel bolts by means of a torque wrench. Stainless steel washer shall used both under the bolt head and nut.

Busbar supports shall be made from non-hygroscopic insulating material such as “Permali” or approved equivalent.

Suitably pre-drilled/punched busbar take-off tags shall be provided, in a suitable location, for the connection of cables entering the switchboard.

Removable busbar links shall be provided for current transformers (CTs). These CT links shall be located, and removable, within the CT compartment. The CT busbar link shall not cross between compartments.

11.2.2 Busbar insulation

All busbars shall be insulated and phase colour-coded in accordance with AS3439.1. Insulation shall be provided by one or a combination of the following:

- polyethylene, applied by means of a fluidised bed process and cured onto the busbars. Dielectric strength shall be 2.5kV for one minute.
- close fitting busbar insulation mouldings, at least 1mm thick.
- heat shrink insulation material, only used with busbars having rolled edges.

Due to the need for good busbar electrical contact, insulation shall be removed from the jointing area prior to jointing of busbars. After jointing, insulation of the joint shall be achieved by taping with colour coded, non-adhesive, stop-off tape, to match the respective phase colours. The taping shall be undertaken by means of a half-lapped application mode, to achieve a thickness equal to the solid insulation.

11.2.3 Cables within switchboards

All cables shall be suitably supported to ensure minimum stress on terminations e.g. circuit breaker terminals.

Cables shall not rest on busbars.

Cables shall be neatly run in PVC cable troughing and additionally be tied together with suitable cable ties at intervals not exceeding 200mm.

Cable zones shall be provided with appropriately sized perforated and galvanised cable tray for the support of cables.

All cables shall be appropriately colour coded as follows:

Active Phases	Red, White, Blue
Neutral	Black
Earth	Striped Yellow/green

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11.3 Installation supply main switchboard (ISMSB)

The ISMSBs shall be located in a dedicated electrical switch-room on major stations, or otherwise in the Booking Office or similar secured area with direct access from outside. Note the spatial requirements for clear access in front of the ISMSB.

The ISMSBs shall not be located in public or leased areas, or areas outside RailCorp boundaries (refer to Drawing A1-88496). The location of main switchboards under egress stair areas shall be avoided due to increased potential of smoke and fire risk (refer to Section 11.1).

Where installed, power factor correction equipment shall be located adjacent to the ISMSB.

11.4 Replacement of switchboards

Whenever an existing switchboard is replaced, all circuits shall be tested, identified and clearly labelled on the new switchboard in accordance with Section 13. The prospective fault level shall be re-assessed and suitable circuit breakers selected for the requisite operational environment.

Note: In some circumstances the replacement of a switchboard will require a Possession to be implemented. This has timing, cost and implementation considerations which need to be fully assessed and programmed prior to actioning. If a Possession is required RailCorp will advise when Possession times are available.

11.5 Fault level in switchboard design

The Prospective Fault Level, in kA, shall be calculated individually for each switchboard location and the fault level requirements shall be reflected in the design of the switchboard, busbars and switchgear therein. Refer also to Section 11.

Note that tabulation of computer programs requiring interpretation by manufacturers is not acceptable. The switchboard fault withstand capability shall also be stated in kA for a specified time (e.g. 1second). All items shall be determined by the Designer.

Notwithstanding the above, even if calculations indicate a fault level less than 6kA, the design minimum fault level shall be taken to be not less than 6kA.

Refer to Drawing A1-88496.

12 Switchboard metering

All low voltage switchboards with busbars rated at 100 amperes and above shall incorporate digital smart meters (with local LCD back-lit display). These shall have the ability for remote access via MODBUS TCP/IP communication protocol over Ethernet. A shuttered RJ45 outlet, together with requisite communication cabling, shall be provided within the meter compartment for meter connection. Suitable separation shall be maintained between communication and power cables.

These meters are not ordinary energy (kWh) meters, although they would also have this capability. The meters are for analytical and operational purposes and require anti-drift circuitry to be incorporated in their design to minimise errors being generated or displayed. Although consistency of manufacture is preferred, it is the ability to operate on the same communication protocol that is absolutely essential.

Contractors shall demonstrate remote access capability of the meters in accordance with stated requirements in this document. Apart from purposes of demonstration of

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functionality, the final connection to remote PC(s), including the provision of suitable software, will be undertaken as a separate project by others.

The meters shall have current inputs limited to 5 amperes and be capable of monitoring the following parameters which shall include, but not necessarily be limited to, single and 3-phase:

- volts,
- current,
- power (kW),
- apparent power (kVA)
- energy (kWh)
- power factor (-1 to +1), ,
- total harmonic distortion (volts),

In addition to the above, a pulse measurement feature for water or gas usage (if required in the scope of works or brief)

Suitable DIN rail mounted terminal blocks shall be provided with appropriate shorting links.

Cables for metering shall be multi-strand copper, 2.5mm² minimum cross-sectional area.

Current transformers (CTs) shall be provided with a 5 ampere secondary and have a rated classification of 0.5M. Both wires from each CT shall be brought to the terminal block and be separately terminated. CT polarities shall be clearly labelled. Final bridging, or otherwise, shall be undertaken to suit. Appropriate fuse or circuit breaker protection shall be provided.

The meters shall be mounted on hinged lockable doors in a separate enclosed compartment of the switchboard, which shall also incorporate the terminal block to which voltage and CT wiring shall be wired. Wiring from the terminal block to the meters shall be by means of a flexible loom.

Suitable drawings and documentation shall be provided for the above, both for construction purposes as well as for the “As-built”.

Note:

- meters that are utilised as tariff sub-meters are required to be individually calibrated and certified when initially installed. Factory batch calibration to +/- 0.5% is acceptable for other meters.
- in certain situations, RailCorp may also require digital smart metering for switchboards rated at less than 100 amperes e.g. critical loads, stations with loads less than 100 amperes as required in project brief or as advised.

13 Switchboard labelling

Each switchboard shall be clearly labelled to identify the switchboard itself, sub-circuits and load locations.

The outgoing circuits shall be sequentially numbered on each switchboard. Generally, the sequence shall be top down, or left to right, for vertical and horizontal busbar arrangements respectively. The sequential numbering shall be odd or even e.g. 1,3,5,….21, 23 etc and 2,4,6,8,….24,26,28 etc. for moulded case circuit breaker poles on opposite sides of the busbar herring-bone structure.

If circuit breaker markings are obscured (especially for moulded case CBs) provide markings open to view, on or adjacent to the circuit breakers.

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The cable size and type shall be stated on the labels of all incoming and outgoing circuits.

Earthing and bonding cables within switchboards shall be clearly and individually identified by “Traffolyte” labels (or similar). Engraved labels shall have black lettering on a white background and be fixed to the cables by suitable cable ties.

All devices within a switchboard shall be clearly labelled.

A suitable printed schedule shall be provided and fitted in a holder located within the board enclosure and covered by a suitable clear “Perspex” sheet.

Engraved “Traffolyte” labels, or approved engraved equivalent, shall be securely affixed by screw and glue fixing adjacent to all circuit breakers and switches to clearly denote their functionality. The labels shall be “black” engraved printing on a “white” background.

The Contractor shall provide RailCorp with a soft copy of the circuit schedule in a Microsoft Excel format to enable easy future changes. This schedule shall denote:

- the switchboard
- circuit numbers
- ratings of switches, circuit breakers and fuses
- load types and load locations
- spare poles
- the Contractor and person that updated the schedule (typed names)
- date of schedule update and work to which it is related

Note: Provision of warning signs and labelling are required for dual supply and where UPS or generators are installed. For example lifts are provided with UPS in event there is a power failure. Care must be taken in the design of the system such that back-feed to the switchboard does not occur. Appropriate signage shall be provided at the switchboard and at the on-board lift power supply. Typically, this applies to systems such as lifts, PA, Induction Hearing Loops, Security Systems and such other system that is connected to a UPS or back-up alternating current power supply.

13.1 Labelling schema

The format of switchboard labelling shall depict its location and function in a symbolic format (utilising acronyms) as shown in the examples below, unless otherwise required by AS/NZS 3000 or the *Service and Installation Rules of NSW*:

Table 13.1 Labelling Examples

Facility	Type of Board	Seq No within area or level	Location within facility	Room No.
LIV	ISMSB	N/A	CC(N)	XXX
THM	DSMSB	01	PF1	XXX
BWD	DB	02	PF2/3	XXX
MPL	MCC	03	G	XXX
CEN	DB	04	LG(S)	XXX

All numbers less than 10 shall have a leading zero.

Room numbers represented by XXX are not the same for each row of above table.

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Note:

- new switchboards shall utilise this labelling schema. Labelling of existing switchboards to be changed to this schema progressively as separate projects over time.
- where labelling on existing switchboards, to which additional circuits shall be connected, is confusing and inaccurate, or major changes made to the circuitry, the switchboard shall be re-labelled in accordance with Section 13, Note that this may require the re-labelling of associated outlets and equipment.
- hand written labelling of switchboards is NOT acceptable.
- examples given are not representative of existing switchboards in-situ and are illustrative only.
- each of the tabulated acronyms along a row represents a switchboard at a station.
- three-letter acronyms for RailCorp locations shall be identical with acronyms used in Ellipse associated with equipment classes (refer to Section 3.3). Other acronyms as per this document. For example:

  ISMSB: Installation Supply Main Switchboard

  DSMSB: Distribution Supply Main Switchboard

  DB: Distribution Board

  MCC: Motor Control Centre

  CC: Concourse

  PF: Platform

  G: Ground Level

  LG: Lower Ground Level

  L1, 2…: Levels 1, 2 and so forth

  Example 1:

  LIV-ISMSB-CC(N)-XXX represents the Installation Supply Main Switchboard (ISMSB) at Liverpool Station. It is located on the Concourse area North, in Room XXX.

  LIV: Liverpool Station

  ISMSB: Installation Supply Main Switchboard

  N/A: The sequence number is not applicable for this ISMSB

  CC (N): Concourse North is the switchboard location

  XXX: This is a three digit room number – identical with the sign on the door, with preceding zeros as necessary.

  Example 2:

  BWD-DB-02-PF2/3-XXX represents a switchboard as follows:

  BWD: Burwood Station

  DB: Distribution board

  02: Second switchboard of similar type (e.g. DB, MCC etc) on Platform2/3

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PF2/3: The DB is located on Platform2/3.

XXX: This is a three digit room number – identical with the number on doors e.g. G01, 101, 501, P01 (Platform 1), C01 (Concourse 1).

13.1.1 Electrical fixtures labelling

Electrical fixtures e.g. GPOs, light switches, permanently connected electrical equipment, switchboards, circuit breakers, contactors and other electrical devices shall be labelled.

Labelling of the fixtures circuit shall follow on from that used to denote the switchboard supplying these. The fixture shall comprise of the switchboard descriptor followed by the circuit breaker number supplying the fixture.

Where a wall switch controls a number of luminaires, only the wall switch needs to be labelled.

Taking example 2 above, if a fixture is supplied from circuit breaker number 07; circuit designation would be as follows:

BWD-DB-02-PF2/3-XXX-07

13.1.2 Label lettering

Unless otherwise stated, all label lettering shall be “black”, with a “white” background.

Switchboard labelling shall be as follows (font height in upper case lettering):

- isolating switches: ≥ 5mm
- main assembly: ≥ 25mm
- sub-assemblies: ≥ 15mm
- outgoing functional units: ≥ 8mm
- control circuits and devices: ≥ 5mm
- earthing and bonding cables: ≥ 5mm

14 Earthing and bonding

Earthing and bonding of all conduction materials in the rail corridor are important considerations which impact on safety and the minimisation of stray DC currents and the effect of electrolysis. Unlike installations outside the railway environment, which utilise the MEN (multiple earthed neutral) earthing system, RailCorp uses a modified direct earthing system. It isolates its LV system from the Local Electricity Distributor by means of an Isolating Transformer which separates the Local Electricity Distributor’s MEN earth and neutral from RailCorp’s direct earthing system.

Earthing and bonding of stations shall include consideration of overbridges and other structures (refer to Section 3 of. EP12 10 00 21SP and drawings EL0464956 and EL0464957.

Refer to the RailCorp *Guideline to Earthing and Bonding at Railway Stations*, EP 12 10 00 21 SP *LV Installations Earthing* and ESM 109 *Communications Earthing and Surge Suppression Standard*. .

Refer also to Section 27 where new structures are installed.

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15 Undertrack crossing

Refer to drawing A1-88496 and drawing EL0024639 and ESC 540 *Service Installations within the Rail Corridor* when undertrack crossings are contemplated. Approval of Chief Engineer Track or Civil may be required, as well as work requiring Possession.

16 Staging of electrical works, temporary supplies

Due to the critical nature of station operations any necessary downtime shall be when operations have ceased or are suspended as part of planned Possessions. Stations shall remain operational at all other times, with reliability and availability being key issues.

Work requiring Possession will be a significant cost to the project (e.g. bussing and other costs) and needs to be considered and appropriately factored into the project cost.

Staging of work and temporary works require co-ordination with project personnel and agreement with RailCorp operational staff via the RailCorp Project Manager.

Note that the responsible contractor shall discuss directly with RailCorp, or Local Electricity Distributor, matters regarding any temporary builder's supply needs related to available capacity. It shall not be assumed that RailCorp is capable of providing adequate temporary supply.

For temporary electrical supplies, an *Application for Temporary Connection* (EP 95 00 30 03 SP (Form FM03)) is required to be filled in and forwarded to the relevant District Electrical Inspector for approval.

17 Underground stations

For additional information pertaining to electrical installations for underground stations refer to Standard Requirements for Fire & Life Safety in Underground or Enclosed Railway Stations (April 2009 draft).

18 Cables – type, size, route, segregation and access

18.1 Cable type

Cables shall be stranded insulated copper conductors.

Insulation is 0.6/1kV PVC, minimum V75 grade, unless otherwise stated or required in this document.

Double insulated single core cables shall be used for consumers mains and cables installed underground (RailCorp "Installation of Low Voltage (LV) Electrical Power Cables Underground Standard").

Special requirements exist for cables used in stations, which are within the definition of the Standard Requirements for Fire and Life Safety in Underground or Enclosed Railway Stations (Draft).

Refer to Section 15 for under track crossings.

Use of the following **are not permitted**:

- lead sheathed LV electrical power cables for new construction.
- armoured cables for LV.
- MIMS cables underground, except where otherwise approved by RailCorp. If approved, only the sheathed copper MIMS cable shall be used. In such cases, a

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separate cable shall be run for the neutral. The copper sheath can be used as the earth return (but not as a neutral return).
- earth sheath return (ESR) systems.
- neutral screened cables for LV.
- aluminium cables for LV, except where otherwise approved by RailCorp.

18.2 Cable size and installation details

The size of Consumers Mains based on tables in AS/NZS 3000, developed for an MEN System, may not be adequate for the modified direct earth system used by RailCorp where EP 12 10 00 20 SP restricts location of the only E-N point to the DSMSB that may be some distance from the ISMSB.

Designers must accommodate the necessary short circuit current and fault loop impedance for effective operation of short circuit protective devices (SCPD) and ensure that the volt drop in the earth-neutral return path is less than 50V under fault condition. This may be required for reduction of fault loop impedance to ensure effective operation of the SCPD within the required automatic clearing time.

Minimum size cables for power circuits shall be 2.5mm².

Minimum cable size for lighting circuits, where cable is to be installed underground, e.g. platform lighting columns and illuminated station signs shall be 2.5mm², elsewhere 1.5mm²

Minimum size control wiring is 1.5mm².

A separate neutral shall be run with each set of mains and sub-mains. When sizing neutral conductors consideration shall be given to the presence and impact of harmonic currents.

Unless otherwise approved by RailCorp, the neutral conductors (i.e. associated with the mains, sub-mains and final circuits), whether single phase or multi-phase, shall be such that:

- the total voltage drop of the circuits (active and neutral return) is not greater than 5%, and
- the size of the neutral shall not be less than that of the associated active conductors.

For the size of the main neutral conductor and earth cables refer to the RailCorp *Guideline on Earthing and Bonding at Railway Stations.*

Note that the earthing conductors linking distribution switchboards shall be not less than 16mm^2 in effective cross sectional area.

Minimum size of consumer mains for Railway Station supply is 16mm², except for small Retail Concessions on Railway Stations which can be a minimum of 6mm². However, at no time shall the size of consumer mains be less than required by AS/NZS 3000.

The size of the service/consumer mains shall be such that its voltage drop does not exceed 1.5%of the nominal voltage, unless specifically approved otherwise by RailCorp. Normally approval will be given if the length of the service/consumer mains is longer than usual or if the installation's electrical load is small and the total voltage drop does not exceed 5%.

Similarly, sub-mains shall not exceed 1.5% volt drop (of the nominal voltage) unless specifically approved otherwise by RailCorp.

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The bending radius of cables, both during the course of installation and final disposition, shall be not less than that recommended by the cable manufacturers.

18.3 Cable ratings

Cables shall be selected in accordance with AS/NZS 3008.1.1, based on:

- current carrying capacity, taking into account derating factors for “method of installation”, “grouping of circuits” and “external influences”
- earth fault loop impedance
- voltage drop
- cable short circuit rating

Working calculations for cable selection shall be provided to RailCorp.

Cables sheaths shall be marked with the manufacturer’s name, cable size, voltage and cable insulation details.

Notwithstanding anything stated above, the cable size selected shall concurrently address both volt drop requirements and fault current design needs and the ability of circuit breakers to trip on overload and fault i.e. cable sizes may need to be larger on long cable runs.

18.3.1 Cable de-rating

Particular attention is required regarding the de-rating of cables where these are bunched or grouped together on cable routes or at congested cable areas such as switchboards.

Conduits and cables shall be arranged in such a manner as to permit sufficient space between them for the cooling of the cables and to provide the required current rating without being affected by:

- heating from other current carrying conductors
- self-heating due to inadequate air circulation around the cables

Specified cable ratings for stated cable sizes shall be maintained throughout the cable routes by utilising the appropriate spacing and installation method, as determined from AS/NZS 3008.1.

18.4 Double insulated

An installation shall only be considered to be “double insulated” if the entire installation is double insulated, including terminal strips, junctions, cable insulation and associated devices.

18.5 Segregation

In electrical terms, segregation means the physical separation of cables such that the segregated cables cannot be:

- damaged by a single external physical threat such as mechanical damage or fire
- damaged or affected by one another
- confused with one another when work is being undertaken

This means that segregated cables shall be:

- run in separate labelled conduits
- run in different physical spaces and routes, and separated as far as possible where more effective separation can’t be avoided

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- run in separate fire rated spaces or enclosures, where a fire threat exists
- circuited from different switchboards and, where possible, from different sources of supply

In general, segregation shall be maintained as far as necessary between:

- circuits from different switchboards
- emergency and non-emergency circuits
- circuits from different supply sources
- circuits with different voltages, and
- where particular risks exist e.g. fire, impact, electromagnetic interference to or from other systems

Segregation shall be maintained between different electrical supplies (i.e. from different transformers and between RailCorp and Local Electricity Distributor). Circuits of different supplies cannot be terminated in the same enclosure, unless it is a changeover contactor panel. Hence, separate distribution switchboards are required for each supply.

LV cables shall be run in separate cable trays and have appropriate separation from, the following:

- signals cables
- metallic communications cables on main or secondary routes
- HV cables

Signals and communications cables shall be clearly labelled such that they are not confused.

Signals cables main trunk route shall be separate from local or distribution routes as well as HV and LV cabling.

In addition to AS3000 requirements for segregation, signalling and communication cables and cables for the power supply for signalling and emergency lighting circuits shall also be segregated in their own separate cable enclosures.

Consumer mains shall not be installed in the same conduit, duct or cable tray, etc as other cables.

Sub-mains shall not be installed in the same cable enclosure as final sub-circuits for lighting and general power without prior specific approval of RailCorp. If such approval is granted, all cables in the enclosure shall be double insulated.

In buildings, routes within the same spaces and exposed to the same risk is not considered adequate segregation.

Refer also to requirements of AS/ACIF S009 and SPG-0705.

18.6 Cable routes

Cable routes shall be approved by RailCorp, in particular service/consumer mains and sub-mains.

Normal and back-up power supplies shall follow different routes approved by RailCorp.

Cables shall be arranged such that the minimum bending radius is not less than that recommended by the cable manufacturer.

Cable routes shall have 30% spare capacity to allow for future electrical wiring.

For underground stations, or other situations where there are two independent normal supplies, these shall follow different routes to achieve (if one route is compromised):

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- security of supply
- field separation
- low risk of fire damage
- low risk of mechanical damage

Refer also to Section 18.5 regarding segregation.

Prior to any excavation for proposed underground cable runs a comprehensive services search shall be undertaken and exact location verified on site for existing underground services in order to avoid damaging them (refer to Section 18.5).

Note: LV cables shall not to be located under platform copings. Access to this area can only be achieved by securing a Possession, thus day to day maintenance and repairs cannot be readily undertaken thus affecting reliability and service provision. Additionally, this would result in inherent delays and unnecessary attendant costs as well as operational and public inconvenience. All cables shall be accessible from behind the yellow line on the platforms.

18.7 Wiring method

All wiring shall be installed using the “loop-in loop-out” principle with no intermediate connection between outlets, switches and switchboard.

Wiring within concrete slabs shall be enclosed in minimum 25mm heavy duty rigid PVC conduit. The conduit shall be installed with long sweeping bends above lower reinforcement steel or directly below top reinforcement. The conduit or associated fittings shall not penetrate or come into contact with damp-proofing or waterproofing membranes. Do not compromise concrete cover required by reinforcing.

Conduit cable access points shall be provided to facilitate the installation of cables into the conduits. All necessary j-boxes, inspection joints, bends and connections shall be provided to facilitate the installation of cables.

All conduits and troughing in switchboard cupboards shall be installed in a neat and orderly manner evenly spaced, level and plumb. Unless otherwise approved, TPS cables shall not be exposed to view but enclosed in conduits or cable trough.

Where TPS cables are run in concealed ceiling spaces (e.g. suspended ceilings) these shall be suitably secured to ceiling supports, suspended and self-supporting from the structure or as is preferred, on a cable support system. The cable system shall be accessible from at least one location (not in a public area).

Through joints in cables will not be permitted without specific approval from RailCorp, and then only where such joints are unavoidable (refer to Section 18.8).

If such joints are accepted, their location and type shall be clearly noted on the “As-built” drawings.

Other systems may have specific wiring requirements (refer to Section 25).

Each electrical circuit shall have its own earth cable installed.

18.8 Jointing of cables

In general, the jointing of cables is not permitted.

Whilst cable jointing is not permitted, above ground through-joints may be approved by RailCorp in special circumstances, on an individual basis, dependant on specific situations. Where such jointing is approved, this shall be undertaken in an approved enclosure and suitably accessible. If joints are approved, these are not to be exposed to

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the weather or other agent of degradation. In-situ details shall be appropriately accurately recorded in "As-built" drawings.

Cable size shall remain the same throughout the entire length of each circuit. Changes in cable size may only be made at switchboards, downstream of a SCPD or isolating switch.

Where a platform lighting column is removed for installation of a canopy and an underground pit exists, a new length of cable shall be installed between the next adjacent luminaires (on the same circuit) on either side of the column, to eliminate the underground joint.

Where no pit exists, conduit shall be "made good" by an approved good practice method and the section rewired as above, without joints.

18.9 When to replace existing cables

In general, if working on or about existing cables that have rubber insulation (VIR) then these shall be replaced without exception. However, no action shall be taken until the issue is brought to RailCorp's attention and approval to proceed is granted.

Cables other than VIR insulated shall be tested by means of a 500V "Megger" or equivalent insulation tester.

If the platform is to be resurfaced and the existing installation which becomes exposed does not comply with RailCorp standards with respect to conduit type/size and cable pits, then the system shall be upgraded to compliance level.

Providing that, in the opinion of RailCorp, the condition of the cable is such as not to warrant replacement, then calculations taking into account voltage drop, loop impedance, and de-rating factors shall be the final criteria by which a replacement decision is made.

18.10 Cables for lift installations

Cables for lift installations shall be fire rated and mechanically protected.

AS/NZS 3000:2007, Section 7, *Clause 7.10.7 Wiring Systems,* describes the requirements for wiring systems to lift installation and *Clause 7.2.7.2 Type of Wiring,* outlines the types of wiring that is permitted.

Wiring systems associated safety services (which include lift installations) shall be capable of maintaining an adequate supply to such equipment when exposed to fire and be protected from mechanical damage.

Mechanical protection shall be provided for such cables. This shall be either in the form of a suitable enclosure or to locate the wiring system where it will not be exposed to mechanical damage.

Wiring systems including Consumer's Mains supplying safety services, shall comply with AS/NZS 3013.

Note: Notwithstanding any statement elsewhere, deeming RailCorp Railway Station lifts provided under the Easy Access Program as not emergency or evacuation equipment, the Wiring Rules require that Mains (Station Consumer's Mains) and Lift supply sub-circuit are required to be ***"of a type that is capable of maintaining supply to the equipment when exposed to fire"*** and thus shall be rated for WS52, 2-hour fire resistance rated in accordance with AS 1735.2-2001.

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19 Conduits and cable support

The basic philosophy is to provide cables and supports in locations outside areas that would require a Possession for maintenance or repairs.

Conduits and wiring shall generally be concealed and fixed by suitable supports and cable trays (refer to Section 19.3). No exposed conduits shall be unless agreed to by RailCorp. To this end conduits shall be chased in masonry walls and appropriately sealed in a manner consistent with the finished surface. If surface mounted, these shall be neatly fixed to ensure station or building appearance is not compromised.

Wiring enclosures and systems designation shall comply with AS/NZS 3000, appendix H and compliance tested in accordance with AS/NZS 3013.

19.1 Services erected above OHW

Situations may arise where it is necessary to cross electrical services above the 1500V DC overhead wiring in which event reference must be made to RailCorp standard EP 08 00 00 14 SP Services Erected Above Overhead Wiring. Note the requirements for service to be fully enclosed, protected from heat of diesel engine exhaust gas and method of securing the wiring enclosure.

19.2 Use of rigid PVC and galvanised steel conduits

Rigid PVC conduit shall be UV stabilised, heavy or light duty rated, as required, complying with AS 2053 and with associated fittings in the same material. Joints shall be cemented adopting procedures recommended by the manufacturer. Conduits shall be fixed and supported at regular centres to prevent impinging on other building elements.

Rigid screwed steel conduit and fittings shall comply with AS 2052 with heavy protection against corrosion.

Steel conduit is generally not permitted due to stray dc currents and corrosion issues, but may be permitted if PVC is not suitable. Refer to earthing and bonding section to specific nature of the railway environment.

Only heavy duty PVC conduit shall be installed underground.

For underground stations conduits shall be HFT (halogen-free flame retardant electrical conduit) in commercially available colour black.

19.3 Use of cable trays and ladders

For major non-underground cable runs consisting of multiple cables/conduits, including suspended cables, the use of cable trays or ladders is required. Any reference to cable trays shall equally apply to cable ladders.

Cable trays shall be perforated steel and hot dipped galvanised, have purpose made tees, bends etc., and be from the same manufacturer. These shall be sized to cater for the required cable runs, with an allowance of 30% spare space for future cabling.

Cable trays shall be appropriately earthed.

Where cable trays carry other than electrical conduits, the required separation distances or physical isolation shall be provided.

Where exposed to the outside environment, a cable tray shall have covers and appropriate insect and bird proofing to prevent bird and animal droppings becoming a *Work Health and Safety Act* (WHS) issue, as well as being a barrier to prevent damage to

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cables. Additionally, such provisions would also prevent infestations and nuisance above public areas.

Any vermin or bird proofing shall have appropriate hinged access gates with locks at appropriate centres to enable maintenance access.

Cable trays shall be run in such a manner as to follow the structural members of building. Tee-offs shall be implemented in a manner that has minimum visual impact on the building or facility in which they are installed.

The height and disposition of cable tray runs shall give due consideration to safe and easy accessibility by ladder, preferably located so access can occur outside a Possession.

Cables shall be neatly installed on cable trays, utilising proprietary straps and fixings. Cable spacing shall be in accordance with AS 3008 and de-rating shall be avoided. A 30% spare capacity shall be provided.

Segregation of cable systems is an important design issue that needs to be carefully considered (refer to Section 18.5).

Suitable cable tray and ladder supports shall be installed to manufacturer's recommendations and instructions, and shall adequately carry the anticipated cables load for the present and future, with minimum deflection.

19.4 Minimum conduit size and installation

Minimum conduit size shall be:

- 32mm PVC rigid heavy duty where installed underground
- 25mm PVC rigid heavy duty where installed in concrete
- 20mm elsewhere

Conduits shall be run vertically, horizontally or parallel with building members where exposed; however, whether exposed or concealed, conduits shall be accessible.

Cables run underground shall be either single core double insulated (SDI), or TPS cables, installed in conduit.

In situations where conduit and fittings are external to buildings and exposed to mechanical damage, i.e. less that 2.4m above ground or floor level, mechanical protection shall be provided comprising substantial galvanised steel guards or galvanised steel pipe sleeves.

Wiring within concrete slabs shall be enclosed by heavy duty rigid PVC conduit. The conduit shall be installed above lower reinforcement steel or directly below top reinforcement, with long sweeping bends.

To avoid weakening structural concrete slabs, ensure that in-slab conduits are not bunched together.

In all cases appropriate junction boxes, bends, cable access shall be provided.

19.5 Buried installations

Prior to commencing work on underground services, supply, erect and maintain warning signs, temporary fences, barriers and night lights around the work area. Ensure that the RailCorp services search includes investigation of both the location and status (i.e. live or dead) of cables.

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Safety shall be ensured by appropriate separation from the public and staff areas. Refer also to Section 7.8 regarding searching for in-ground services prior to undertaking any digging or trenching.

Ensure safety issues are adequately addressed, both during installation and in the final product.

Saw cut existing concrete and bitumen surfaces in a straight line to a depth of 75mm before excavation is commenced. Lift and store concrete paving slabs for later reinstatement. Ensure reinstatement is undertaken by appropriately experienced trade personnel to the levels and standards of new work.

Excavate the trench to the required depth and remove all sharp projections. Where rock is encountered obtain instructions regarding any changes to the specified requirements that may be appropriate. Variation can be measured against known geotechnical information.

Bed in conduits on a 150mm layer of compacted sand.

After cable laying has been completed, and the conduits inspected, the trench shall be backfilled with a further 150mm of sand. The remainder of the trench shall be filled to the level of the existing surface with sandy loam or other granular material free from stones or other objects liable to damage the conduits. Each successive 150mm layer of backfill shall be consolidated before installing the next layer.

Do not stockpile soil or excess materials on site. Minimise materials storage and review excess regularly.

Install marker tape directly over (75mm above, and overlapping the wiring system by 40mm on each side) buried service and accurately record details regarding location and depth of the buried service in the “As-built” documents. Refer to AS/NZS 3000, Clause 3.11.4.3 for more details.

Remove excess soil from the site unless otherwise directed. The trench shall be refilled, compacted and resurfaced to the original condition.

All LV underground services shall comply with Category A wiring system in accordance with Clause 3.11 of AS/NZS 3000.

Civil construction requirements may be referenced from Signalling Construction standard SPG 07 05 Construction of Cable Routes and Signalling Civil Works.

19.6 Use of flexible and corrugated conduit

The use of flexible conduit is not permitted without prior approval, except where used for the hard wiring of hot water tanks, stoves and equipment, and then only where bends are required.

The use of corrugated non-metallic conduit is not permitted without prior approval, except for the following applications:

- in lieu of non-metallic flexible conduit,
- for the interconnection of sections of *Unistrut* supporting light fittings,
- for the interconnection of rigid PVC conduits around structural members,
- in short lengths for the extension of rigid PVC conduit to light fittings.

20 Fixings

Positive, anti-vibration and anti-corrosion fixings are required to be used for all fixings. No friction fixings are to be used.

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The rail environment can have high levels of ongoing vibration, and all fixing methods chosen must prevent failure for this environment.

Fixings are to be suitable for the particular environment in which they are used.

Failure of fixings can be a danger to people, railway infrastructure and train running.

Where not fully supported on cable trays, fixings for cables, conduits and equipment shall be as follows:

20.1 TPS cables, surface fixed

Approved panel clips shall be used at suitable centres to prevent sagging and maintain cable run integrity without contact with other building elements. Fix to structurally sound elements only.

20.2 Saddling of conduits

Unless otherwise approved, conduit saddles shall be double-sided metallic type with heavy corrosion protection to AS2052. The use of spring-clip type saddles is not permitted.

Provide saddles at maximum 1.2m centres on horizontal runs and 2.0m centres on vertical runs. Saddles shall match conduits.

Where flexible couplings are used at structural expansion joints, provide saddles close to the flexible coupling on both sides.

Fixings to comprise 25mm galvanised clouts in woodwork, nylon, anchor plugs in brick and concrete work with not less than 38mm x No.6 galvanised wood screws, and round head 4mm diameter set screws and nuts into sheet metal.

20.3 Fixings for cable ladders and cable trays

Fixings for cable ladders and cable trays depend on the material used and the manufacturer's recommendations (refer to Section 19.3).

20.4 Fixings for switchboards and accessories

Galvanised metal thread screws (or better), bolts and nuts into steel and metal expanding plugs not less than 38mm x 6mm, into brick (not mortar) and concrete work.

When holes are drilled in switchboards subsequent to paint finishing, exposed steel shall be rust-proofed and finished to the same colour as the switchboard, prior to inserting fixtures or fittings.

20.5 Fixings for luminaires

In order to address issues of vandalism and vibration, luminaires shall be securely fastened to building structure or support members or purpose installed nogging.

- surface mounted fittings – fixings to comprise of 4 screws (2 at each end for fluorescent fittings).
  - into timber noggins – 38mm x No.6 round head wood screws
  - into brick and concrete (securing to mortar not permitted) – 6.5mm dia. expanding metal fixings
  - into cold rolled steel structural members – 4mm dia. round head set screws, "Locktite" or spring washers and nuts

  Do not drill into structural hot rolled sections.

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- light fitting mounted on *Unistrut* trunking or similar to be secured using two *Unistrut* nuts (Cat. P3016/M6) and M6 round head screws (at each end lock washer).
- bracket-mounted light fittings – brackets shall be proprietary brand cast aluminium type. Elsewhere, mounting bracket shall be fabricated from hot rolled MS angles utilising full depth fillet welds. Drill brackets to suit mounting arrangements and hot dip galvanise to AS1650 after fabrication. Ensure two fixings are used at each end, both to fitting and support bracket.

Fixing brackets, bolts, screws etc. shall be selected and sized to withstand external forces without deformation or damage.

Note: Use of explosive powered fixings is not permitted.

21 Accessories

21.1 Switches

Switches for lighting and small power circuits shall have a minimum rating of 10A and be single or multi-gang for architrave or wall mounting as appropriate and with white plates unless another colour is specified. Switches shall comply with AS3133.

No switches shall be located in public areas except where essential and then in locked enclosures.

21.2 General purpose outlets (GPOs)

General Purpose Outlets shall comprise a 10A switch, 10A, 3-pin flat pin receptacle and, where indicated, a neon indicator, all mounted under a common plastic flush plate, white in colour unless otherwise specified. Outlets shall comply with AS3112 and be arranged with the earth pin in the 6 o'clock position.

No GPOs shall be located in public areas, except where required for cleaning purposes. In such cases these shall be of the lockable type and located out of the reach of children i.e. greater than 1500mm above floor level.

21.3 Mounting arrangement

Unless specified otherwise, switches, GPOs, etc., shall be flush mounted and installed in wall boxes.

Generally, mounting heights shall be as follows:

Switches – 900-1100mm above finished floor level AFFL

GPOs
- 200mm above benches, or
- 300mm AFFL
- 900-1100mm AFFL in public areas and located where cleaning is not possible

Measurements shall be to the centre line of the switch or outlet.

Refer to AS1428.1 for heights for the disabled.

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22 Power

22.1 General

New installations require adequate quantities and suitable location of power outlets and circuits commensurate with the needs of the work areas.

The maximum number of General Purpose Outlets (GPOs) per final sub-circuit shall be less than or equal to the number allowed under AS/NZS 3000. Note that where a circuit contains a maximum number of outlets, additional outlets shall not be added to the circuit.

Three-phase and special outlets and, in general, fixed appliances and equipment shall each be provided with a separate final sub-circuit in order to ensure that if problems occur they are localised and do not affect other equipment or systems. Fixed appliances and equipment shall be provided with appropriate isolating switches, lockable in the “off” position, where required.

22.2 Circuitry

At least two power circuits for general use shall be provided in a Booking Office.

Additional circuits and outlets dedicated to special use may also be required, i.e. for Public Address systems, security systems, ticketing systems, air conditioners, SPI systems etc.

22.3 Emergency power supply

In certain circumstances there will a need for the utilisation of an emergency power supply. This would normally be provided in the form of a diesel-generator set of appropriate kVA rating that would cater for the requisite electrical load. Such a generator set should be able to be delivered to a site and connected to the target switchboard.

Large switchboards, such as the ISMSB, should incorporate tee-off busbars for easy connection of an emergency diesel-generator set (refer to Section 12.3).

23 Lighting

Illumination is required for a person to be able to see within an environment. The provision of lighting has to deal with a multi-faceted set of factors and parameters. These include interior and exterior lighting, which in turn need to address issues associated with work activities, security as well as issues such as surface reflectance, colour rendition, energy consumption and maintenance. This implies addressing capital expenditure, whole of life luminaire selection, technologies available and the means of controlling the lighting installation to further enhance performance and minimisation of energy usage. Refer also to Section 5.4.

Consequently, lighting Designers need to consider such issues as:

- the project/site environment
- nature of tasks or activities within the project site
- natural daylight – maximise its use
- artificial lighting and selection of lamp sources
- direct and/or indirect lighting
- lamp colour temperature (K)
- colour rendering index (CRI); generally not less than 65, for LEDs ≥ 80
- luminaire location
- luminaire light distribution with respect to site requirements
- the impact of luminaire glare on train drivers

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- surface colours
- surface reflectance
- disabling or veiling glare
- the operational environment and maintenance factor
- energy efficiency
- power factor (not to be less than 0.9 lag)
- longevity of luminaires and lamps
- maintenance, and associated costs
- life cycle costing

Dark colours give a perceived understated illumination level, whilst low reflectance surfaces absorb light and thereby reduce its general availability to light up surfaces. Note that both horizontal and vertical illuminances are important lighting considerations. Whilst horizontal illumination is the common focus of design (e.g. working surfaces, platforms, walkways etc) vertical illumination is important for reading wall mounted information (e.g. train time tables), visual recognition for security purposes and the like.

Lighting Designers shall provide isolux diagrams to demonstrate design compliance with relevant standards for both the horizontal and vertical planes. Notwithstanding applicable standards, Designers shall properly consider the working environment and design lighting in the site context.

Note that in certain areas such as from station platforms to commuter car parks, access paths to station lifts and similar, Designers need to consider lighting for the visually impaired. This lighting needs to comply with the requirements of the *Disability Discrimination Act*, in addition to the relevant Australian standards.

The colour temperature of lamps shall be 4,100 K +/-10%, for both internal and external lighting of tunnels and station platforms, including office lighting. Colour temperatures outside these limits shall only be entertained where it is demonstrated that higher efficiency is produced, without a reduction in lamp longevity.

23.1 Lighting - external

Lighting installations shall take into account the special requirements of the railway environment, which can be harsh in terms of deterioration and difficult in terms of access to maintain the equipment. An appropriate maintenance factor shall be chosen for design, based on the particular environment for which the design is required.

The effective maintenance of lighting is essential to its continuing efficiency. Lighting designs shall permit simple, safe and effective maintenance, avoiding the need for special equipment, track Possessions and isolations of electrification.

In accordance with AS 4282, ensure that spill lighting does not adversely impact on the surrounding environment e.g. neighbouring residents. As such, spill lighting shall be carefully considered and avoided wherever possible. Typical examples are lighting of commuter car parks, open footbridges and open area lighting such as stabling yards.

Note that some lighting or light limiting measures may be dictated by the project's Development Consent documentation.

23.2 Lighting – internal

The AS1680 series of standards apply to interior lighting which includes railway buildings. In addition, lighting requirements outlined in the *Station Design Standard Requirements* are also applicable, where relevant. Note the latter incorporates illumination values to meet the requirements of the Disability Discrimination Act (1992) Stabling yards, for example, include the provision of buildings that are central to the main activities together

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with those providing supporting facilities such as offices, meal rooms, other rooms and shower/toilet areas. Lighting in these areas differs greatly.

Lighting of covered or partially covered areas shall consider the impact of daylight and provide appropriate sensor to switch off lighting as well as in event of non-occupancy.

23.3 Lighting for security purposes

Lighting contributes as a visual deterrent as well as assisting in the detection stage of the defence in depth security strategy. Whether to support the operation of CCTV or to enhance the safety and security of staff, contractors and visitors, the lighting plan requires extensive skilled development and shall comply with the following: Refer to *RailCorp Security Standard RSS-001-Stations 2008*

23.4 Lighting for tunnels

Lighting of tunnels is required for a variety of purposes. These generally include but may not be limited to the following:

23.4.1 Provision of lighting in the event of an emergency

This is required:

a) to enable passengers and staff to detrain and make their way safely out of the tunnel

b) to facilitate safe access by emergency services as egress

This may be by purpose made walkways in new tunnels or via the Cess at track level in existing tunnels.

- emergency lighting shall be of the single point maintained type, permanently connected to the electrical supply and have adequate battery backup for 4 hours, after the loss of normal power.
- at the end of a four hours effective life, after loss of normal electrical power, the minimum illumination of Emin=3 lux (measured at ground level) must be achieved. In addition, the uniformity ratio of Emax/Emin shall not exceed 10. For example, if Emin is 3 lux, then Emax cannot exceed 30 lux. Refer also to Section 24.1.

23.4.2 Provision of adequate lighting for train operation

This applies where lighting is not provided by train headlights and adequate lighting is required to:

a) enable train drivers orientation

b) ensure track visibility to see objects on the track in front of the train in motion

c) provide adequate lighting for train drivers to climb safely out of their cabins in the event of train failure, breakdown or emergency.

Note: inspection of train or track will be undertaken by torch.

23.4.3 Provision of general lighting for maintenance access

The following are required to be provided::

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- lighting for maintenance access shall be switchable from appropriate point along the tunnel and/or remotely.
- maintenance access lighting should be such that the illumination provided on the walking floor areas is an average of E_{ave} = 40 lux, with a minimum of E_{min}= 20 lux. The Uniformity Ratio U1=E_{min}/E_{ave} = 0.5.

Note: portable lighting is required for particular work, tasks or inspections.

Maintenance access to luminaires and lamps in tunnels is restricted, and would normally require a track Possession. Care must be exercised in selecting long-life lamps as well as suitably located luminaires to facilitate maximum maintenance periods and ease of maintenance.

23.4.4 General considerations for the provision of lighting in tunnels

Any, or a combination of the abovementioned or other lighting, visible within tunnels must obviate:

A Health or discomfort issues to either or both drivers and passengers

Of particular importance is the stroboscopic (flickering) effect. The range of human effects caused by strobing may be characterised as follows:

- distraction, discomfort, unease or fatigue
- sickness, nausea or headaches
- inducement of serious physical symptoms in some predispose individuals, such as epilepsy

Stroboscopic frequencies most likely to cause problems are between 15 and 25Hz.

One or a number of the following design parameters can contribute to “strobing” or “flickering”:

a) luminaire and light source type and characteristics

b) luminaire horizontal spacing

c) luminaire vertical location

d) light level or intensity related to directionality

e) person’s location and field of vision

f) limits of train speed

g) characteristics of the train interior or cabin interacting with the above

h) duration of individual exposure may be a factor, particularly with drivers

B Glare or light intensity which prevents or distracts the driver’s vision and/or attention

A number of types of glare may be problematic and must be addressed.

a) contrast glare is glare caused by the stark juxtaposition of dark and light

b) discomfort glare

c) veiling or disabling glare

Appropriate orientation and shielding as well as appropriate choice of luminaires may be necessary in addressing each type of glare.

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The particular issue of glare at tunnel entry/exit to/from external light or highly artificially lit areas such as underground stations must be adequately addressed in design . An appropriate level of lighting transition must be achieved related to the adjustment and adaptation of the human eye and the field of vision for train drivers so that “flashover” causing veiling or disabling glare is obviated. This will also be related to possible train speed.

C Prevention of the driver’s clear comprehension of signals and signs

The driver must be clearly facilitated to see and comprehend:

a) Signals

Lighting must not interfere with the unambiguous reading of signals by drivers. Lighting should not provide undue distraction or interference and should not provide colour, in conjunction with reflection off tunnel walls or surrounding reflecting surfaces which could be confused with signals.

b) Signboards and speedboards

Lighting must facilitate the clear reading of signboards and speedboards as well as not interfering with clear vision of these signs by drivers.

Refer also to EP23 10 00 01 SP *Low Voltage Tunnel Services Board* and EP23 10 30 01SP *Tunnel Emergency Light Fittings*. and ESC 340 *Tunnels*.

23.5 Illumination levels

For information regarding illumination levels (lux) refer to RailCorp *Station Design Standard Requirements* for public areas on and leading to stations, and AS1158.3 for the lighting of roads and public areas where not subject to DSAPT. Interior lighting for office and associated service areas shall be in accordance with AS 1680.1, *Interior and Workplace Lighting*.

It is important to note that lighting illumination is required to comply with the requirements of the Disability Discrimination Act (1992), where applicable, to and between accessible facilities. Depending on tasks and activities, both horizontal and vertical illumination may need to be addressed.

Refer also to Appendix A for commonly referenced illumination levels for railway stations and the general precinct.

23.6 Circuitry and control

23.6.1 Lighting in other than underground and enclosed stations

Refer to Drawings A1-88496 and K-88525. Note that luminaires are connected to alternate circuits to provide half lighting in the event of failure of one circuit. Emergency and exit lighting shall also be consistent with this philosophy.

23.6.2 Lighting – city underground and enclosed stations

As underground stations have dual supply systems (from different HV feeders), luminaires are staggered over the two transformer supplies.

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23.6.3 Daylight switch control

Refer to Drawings A1-88496 and K-88525. Note that each daylight (photoelectric) switch is connected to one circuit breaker with no other load connected.

Daylight switch control shall be provided for all public outdoor and under canopy lighting.

Each daylight switch may control a number of contactors and each contactor may require more than one by-pass switch to achieve full control.

Control of open platform post luminaires shall be arranged such that these are not necessarily energised concurrently with under cover lighting. The philosophy being that the platform illumination could be adequate when that in the covered areas may not. The switching shall be available on a three-mode selection basis; time of day (adjustable or programmable), daylight switch and manual override facility. Both the daylight switch operation and manual override shall override the time of day setting. Daylight switches would need to be suitably set to achieve the required lighting differentiation between the open and covered areas.

Control circuit diagrams shall be provided with the design documents.

Maximise the potential effect of daylighting. For example, cost effective implementation of sensor control of lighting shall be considered e.g. zone switching in a manner such that the artificial lighting supplements the natural daylight.

23.7 Light fittings, lighting columns and equipment

23.7.1 Approved equipment

Only luminaires and lighting columns approved by RailCorp shall be used for station lighting, unless special approval is otherwise obtained from RailCorp. Refer to:

- Drawing D85221 Railway Station Lighting Standard, Single or Double Arm Support Details
- Drawing C88524 Railway Station Lighting, Platform Lighting Column Type 3g – General Arrangement
- “Standard” Lighting Columns as indicated on Drawing K-88525.
- Drawing B88557 Railway Station Lighting, lighting pole for Type 3f & 3g lighting column - Details

In addition to the above, tilt-poles (columns) shall be utilised in new installations. Where used, these shall be so designed such that they can be tilted down by one individual for easy maintenance. The tilt-pole shall incorporate a counterbalance design to facilitate the tilting operation. Suitable security fixings shall be provided to ensure the tilt-poles are not prone to vandalism.

With respect to luminaires, those that incorporate innovative technologies which provide reduced power consumption, longevity and other benefits shall also be assessed (e.g. LEDs) on their merits. Refer also to Section 5.4 regarding Life Cycle Costing. Note that it should not be assumed that only luminaires that appear in the above documents are acceptable or should be used.

A comparative justification for all/any design choice is necessary.

23.7.2 Luminaires

All luminaires shall be individually fused with a fused terminal block (Clipsal BP504F2, Pierlite F2 or equivalent), be high power factor corrected to not less than 0.85 lag with the capacitor complying with AS 2644 and, where applicable, use “low loss” type ballast.

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Where used, *Vandalux* luminaires (or equivalent) shall be fitted with a clear diffuser for maximum efficiency, except where glare is an issue. Typically, such luminaires are required in public areas and publically accessible areas, including fire escapes.

23.7.3 Innovative lighting

The use of new lamp sources and technologies such as light emitting diodes (LEDs) shall be considered alongside traditional light sources. Although this section deals mainly with LEDs, this would also apply to other lamp sources.

Luminaires incorporating LED technology have been shown to be cost effective in outdoor situations and shall be considered in terms of being technically acceptable and being capital and cost effective. A life cycle cost benefit approach (over 25 years, refer to Section 5.6) shall be utilised.

Note that LED luminaires are susceptible to ambient temperature, as well as internally generated heat, which must be exchanged with the surrounding environment by means of suitably designed cooling fins or other means.

LED luminaires shall be able to deliver the required lux levels utilising the low range driver current. This is to ensure longevity is maximised (i.e. high driver current reduces driver life and decreases overall lamp longevity) whilst the lumen output is still appropriate for the activity/task in the areas under consideration. Designers shall judiciously select the appropriate luminaire, light distribution, spacing, and mounting height. In addition, such parameters as lumen output and colour temperature need to be addressed for the project site and the activities/tasks required therein.

Note that for new technologies it is important that suppliers provide adequate data and warrantees for their products. Warrantees should be two to five years in duration, which would give substance and credibility to any supplier claims regarding longevity.

23.7.4 Blocking inductors

Where required by the Local Electricity Distributor, luminaires fitted with blocking inductors shall be used.

23.8 Insect proofing of luminaires

When installing or maintaining luminaires, care is to be taken to ensure penetration by insects does not occur, by:

- sealing cable entries
- ensuring diffusers have suitable seals which are correctly seated and fully tightened
- replacing any damaged/deformed diffuser

23.9 Illuminated “Station” sign

Illuminated “Station” signs shall be supplied by a dedicated circuit, controlled through one of the daylight switch contactors (on separate set of contacts).

Because of conduit limitations, signs may be connected to stair or ramp light circuits, providing they are both on similar lighting columns, if no other practical alternative is also provided.

Refer also to drawing A1-88496.

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23.10 Illuminated directional signs

Directional signs (not for emergency), where fitted, shall be connected to a dedicated circuit and shall NOT be connected via a daylight switch controlled lighting contactor.

24 Emergency lighting and exit signs

24.1 Underground stations

Refer to *Standard Requirements for Fire & Life Safety in Underground or Enclosed Railway Stations (April, 2009 as draft).*

Notwithstanding the requirements of AS 2293, the minimum horizontal illumination measured at pavement level shall be 3 lux with a maximum to minimum ratio not greater than 10 i.e. $E_{max}/E_{min} \leq 10$.

Single point exit and emergency maintained units, capable of 4 hours of illumination shall be used in preference to central UPS.

24.2 All other locations

For all other locations, refer to AS 2293. If single point units are used in above ground stations, battery back-up units shall be a minimum of 2 hours.

25 Station systems

25.1 Station Passenger Information (SPI) system

The SPI system shall be connected to dedicated circuit(s).

25.2 Public telephones

Public telephones shall be connected to a dedicated circuit.

A 2m clearance shall be provided to any OHW structure and any metal work in contact with the OHW structure (refer to Drawing A1-88496).

25.3 Commuter phones

Commuter phones are located in non-attended stations and connected to stations that are in control of the respective areas. These phones enable the public to communicate with the respective stations. Such phones shall be connected to a dedicated circuit (Public Phones are not to be connected to this circuit).

A 2m clearance shall be provided to any OHW structure or any metal work in contact with the OHW structure.

25.4 Public address systems

The GPO for the public address amplifier shall be a single GPO, red in colour, with a neon indicator to indicate whether or not the supply is available. This GPO shall be connected to a dedicated circuit. There is a preference for the PA system to also serve as a EWIS system (where a EWIS system is required).

For detailed information refer to C&CS Passenger Information, F2010/22647 *Enhanced PA System Design and Installation Guide*.

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Refer also to 27.5 for IHLs.

25.5 Induction hearing loops (IHL)

Induction hearing loops shall be installed where PA systems are installed in stations to assist those with hearing impairment. Coverage shall be equal to that provided by the PA system. The IHL system usually consists of a single cable run in a conduit, in a series of loops usually located near the platform edge and near the covered area external walls. Care shall be taken when excavating or cutting platform areas to ensure these induction loops are not inadvertently cut. Due to the nature of the IHL system, specialist contractors experienced in the diverse materials that impact on IHL performance shall be engaged to design, undertake and commission this work.

Note that, in general, the PA system amplifiers are not suitable for IHL purposes, the latter being a current driven system. Hence a separate amplifier would be required for the IHL. This would require an additional power outlet.

These systems shall be designed by someone with specific experience in hearing loop design.

25.6 Ticketing and automatic fare collecting equipment

Automatic Fare Collection (AFC) Equipment shall be connected to dedicated circuit(s).

For earthing requirements refer to the RailCorp .*Guideline on Earthing and Bonding at Railway Stations.*

Where necessary, install an approved light for the equipment (refer to “Station Lighting Standard”). Ensure lighting levels around ticketing equipment is in accordance with the *Station Design Standard Requirements.*

25.7 Clocks

Provide and install standard RailCorp digital clocks (if digital clocks are required), where indicated on the drawings, and connect to a dedicated 16A circuit via clock point sockets (Clipsal Cat. 408/3 or equivalent), or hard wire to the clock terminals via a flex lock (Clipsal 38TB or equivalent). In general, all clocks within stations shall be synchronised via modem.

25.8 Hand dryers

Where these are required, each hand dryer shall be supplied from a separate circuit. The intention being that a faulty dryer will be individually isolated.

Hand dryers installed in Public Toilets or Public Wash Rooms shall be permanently connected. This shall be achieved by mounting the hand dryer over the wall box and making hard wired connections to the hand dryer terminal block.

Do not connect hand dryers to GPOs in public areas.

In the case of staff amenities, the hand dryer shall be plugged into a GPO, connected to a separate circuit, and mounted beside the dryer. Ensure location is a suitable distance from wet areas (sinks etc) as defined by AS/NZS 3000.

Refer also to Drawing A1-88496

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25.9 Commercial vending machines and automatic teller machines (ATMs)

This Section is relevant for commercial vending machines, ATMs and other similar machines that dispense consumer goods and services.

25.9.1 Application for connection of vending machines

In accordance with the *NSW Service and Installation Rules*, before committing to time and expenditure, "application for supply" must be made to the Local Electricity Distributor, to check that there is sufficient spare electrical supply capacity to permit the connection of the vending machine.

DO NOT assume that there will be sufficient spare electrical supply capacity to allow the vending machine to be connected as on a number of stations the Local Electricity Distributor (RailCorp) has advised that no additional load can be connected. At other stations the situation could change at any time.

A new application must be submitted each time a vending machine is proposed to be installed.

The Local Electricity Distributor on railway property in the electrified area (currently bounded by Newcastle, Bowenfels, Glenlee and Kiama) is RailCorp.

25.9.2 Instruction for installation

For further details and assistance regarding power issues, infrastructure, design or search related matter the following may be contacted.

For Applications / Power Supplies, the District Installation Inspectors' as per page two of the *Application for Connection*.

For Station Electrical Infrastructure, the Infrastructure Facilities - Maintenance Team Managers Electrical, for the CBD 9379 4052, Metropolitan 9752 8742

For Design matters e.g. changing a Switchboard and other issues, Service Searches on Platforms etc, will need to be discussed with the project manager Roger Johnston.

All information provided by RailCorp is for assistance only and cannot be classified as being definitive in nature. Contractors are required to inform themselves of the true nature of site conditions and act accordingly.

Vending machines shall be separately metered unless otherwise approved in writing by RailCorp (Electricity Business Management Group).

25.9.3 Vending machine location restrictions

In addition to obtaining approval for the proposed location from the Station Master, the following clearances for electrical requirements must be achieved:

- 2 metres from Overhead Wiring Stanchion (required due to electric shock risk from 1500V DC touch and step potential under fault conditions).
- 2 metres from a water tap (required as leaking or left on then the pool of water increases the risk of electric shock if an electric fault occurs within the vending machine). For exemptions, e.g. for vending machines requiring water connection, please discuss specifics with RailCorp.

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25.9.4 Source distribution switchboards

The vending machine shall be connected to a nominated distribution board (DB).

Under no circumstances is a vending machine circuit to be connected to a distribution board which is connected to an “Essential Supply”.

Should a DB be fully loaded or have no spare spaces, then the switchboard would need to be replaced with a new DB incorporating a 30% spare capacity. A replacement switchboard would be required to incorporate circuit breakers with RCDs.

All circuits shall be verified.

25.9.5 Separate circuit required

A dedicated circuit shall be provided to each vending machine, or a group of no more than three (3) vending machines which are co-located (i.e. virtually touching). Note that for vending machines with heavy electrical load, this may not be feasible.

If additional vending machines are added to an existing vending machine circuit, the circuit must be upgraded to comply with the requirements contained herein.

25.9.6 Circuit breakers

Vending machines shall be protected by combination RCD circuit breakers (30mA type).

Ensure that the RCD circuit breaker is appropriately rated for the fault level at the distribution board.

“Duplex” type circuit breakers are not permitted.

25.9.7 Cables

All cables shall have stranded copper conductors.

Minimum cable size shall be 2.5mm^2.

Where any part of the cable run is in cable tray/ladder, steel conduit or metallic trunking (duct), the cable shall be double insulated. For underground or built over stations, concourses and subways where fumes and smoke from burning PVC will not be readily dispersed, the cable insulation and sheath shall be of the low smoke, low toxicity and halogen free type. The cable sheath shall also be fire retardant.

25.9.8 Cable support system

Mechanical protection (i.e. steel or rigid HFT conduit) is required below 2.5 metres.

The use of non-steel flexible conduit is not permitted.

The use of corrugated PVC conduit is restricted for use only above 2.5metres; elsewhere it requires specific approval from RailCorp on a case by case basis.

Where the cable support system is a duct running along the platform, the vertical drop to the key switch shall be by conduit exiting the **side** of the duct (using a RailCorp approved gland if in flexible steel conduit). An exception is where directly above the vending machine, and steel square column vertical dropper can be used as an alternative, if required to also support the key switch. The vertical dropper shall be securely fixed at the top and at the platform surface in a highly vandal resistant manner.

Any proposed change by the electrical contractor must be approved by RailCorp.

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For rigid screwed steel conduit, all sharp edges, burs etc shall be removed and the conduit ends painted with a rust-inhibiting metallic paint which maintains conductivity, prior to being screwed together.

Rigid PVC conduit (above 2.5m) shall be grey in colour.

When using cable trunking (duct) the duct shall be galvanised steel, minimum 1.2mm thick with screwed on type lid. Minimum duct size is 50x50mm.

The fixing of the cable support system shall be highly vandal and vibration resistant.

Conduits shall be fixed by means of double-sided, galvanised steel saddles. The exception to this may be in the use of a single-sided saddle for the first saddle at the very top of a tight bend, for the vertical drop to the vending machine key switch.

Saddles shall be spaced 1 metre apart for runs along the platform etc, 1 metre apart for runs across the platform, and 300mm apart for vertical drops.

For ductwork installation, RailCorp is to approve the proposed fixing system, including spacing of fixings.

Obtain RailCorp approval to drill steel and concrete members, for reasons of structural integrity.

Penetrations through walls, floors and ceilings shall be sealed with fire resistant material to provide a fire rating not less than the wall, floor or ceiling being penetrated. The penetration seal should also prevent the ingress of smoke and also prevent the entry of rodents and insects.

25.9.9 Keyswitch

Each individual vending machine shall be provided with its own key switch.

The key switch shall be located adjacent to the vending machine.

If mounting on a platform column, mount the key switch on the non-track side of the column.

Obtain RailCorp approval via the project manager (who will liaise internally with suitable structural engineers) to drill steel and concrete members for reasons of structural integrity.

Key switches shall be labelled as follows:

DB **X** CB **Y,** by means of engraved “Traffolyte” labels, with black lettering on a white background.

Vending machines are to be numbered on a per platform basis (including island platforms as the one platform). Starting at the City end of the platform and facing the City numbering left to right progressing down the platform away from the City.

25.9.10 Connection from keyswitch to vending machine

The vending machine shall be connected to the key switch using black or grey sheathed flexible steel conduit.

For underground or built over stations, concourses and subways where fumes and smoke from burning PVC will not be readily dispersed, the cable insulation and sheath shall be of the low smoke, low toxicity and halogen free type. The cable sheath shall also be fire retardant.

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The conduit shall be connected into the bottom of the key switch using an approved threaded gland with suitable nut on the inside of the key switch housing.

Ensure that the steel conduit is effectively earthed.

The conduit shall be secured to the platform column etc and to the back of the vending machine using double sided galvanised saddles spaced 300mm apart.

Obtain RailCorp approval to drill steel and concrete members for reasons of structural integrity.

25.9.11 Disconnection of vending machines

When disconnecting and removing a vending machine, the conduit from the vending machine to the key switch shall be removed from the bottom of the key switch and a threaded cap installed to seal the resultant hole in the bottom of the key switch.

If there is only the one vending machine on a circuit then the circuit breaker shall be turned off and suitably tagged to RailCorp approval.

25.10 Commercial advertising signs

Commercial advertising signage shall be separately metered unless otherwise approved in writing by RailCorp (Electricity Business Management Group).

A distance of 2m shall be allowed between the signs, including any access points and access to platforms, and any overhead wiring structure or other metal work in contact with an overhead wiring structure.

Advertising signs shall be supplied from a dedicated circuit.

Under no circumstances are these signs to be connected to emergency lighting circuits or other essential services switchboards.

26 Station areas

26.1 Concourse

The station concourse area is usually made up of the “paid” and “unpaid” areas. Concessions (refer to Section 26.2) are usually located in the “unpaid” areas. However, there are also concessions operating in the paid areas.

Ticketing is usually in the unpaid area with ticket gates often separating paid and unpaid areas.

26.2 Concessions

Concessions are businesses that operate within the RailCorp property areas. These usually lease space from RailCorp.

26.2.1 Sub-mains for concessions and commercial leases at stations

Separate sub-mains shall be run to each concession. Although desirable, separate metering of each concession may not always be practical or available in all existing concessions. In such cases the RailCorp Property Group arranges for a consultant to assess the electrical load for these concessions and incorporates a rate in the contract documents with the concession holder.

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26.2.2 Compliance for concessions and commercial electricity supplies

In addition to compliance with relevant Australian Standards, and RailCorp Standards, all work shall also comply with RailCorp *Service and Installation Rules* for the supply of electricity.

26.2.3 Tariffs for concessions and commercial leases at stations

General Supply and Process Heating are the two tariffs that generally apply to concessions.

26.2.4 Energy metering for concessions and commercial leases at stations

Station energy meters shall be located in the station main switch-room or meter room unless otherwise approved by RailCorp.

Energy metering shall be arranged through the Manager of Supply Agreements of RailCorp's Delivery Support Unit.

Large commercial leases at stations may require their own separate power supply.

26.3 Public toilets

26.3.1 Lighting in public toilets

Use of vandal resistant light fittings is required (e.g. *Vandalux*).

Light switches shall not be installed in toilet areas. Luminaires shall be controlled from separate light switches located on a switch plate (incorporating separate waiting room light switches) near the entrance to the booking office, suitably labelled.

Separate circuits shall be run for male and female toilets.

For underground stations, two light circuits shall be provided, one off each transformer.

26.3.2 Power provisions in public toilets

No General Purpose Outlet (GPO) shall be installed in Public Toilets.

26.3.3 Power operated door locks to public toilets

Where required, power operated door locks shall be connected to a dedicated circuit and shall not be connected to any other power or lighting circuit (refer to Drawing B88550). Separate remotely operated pushbutton facility shall be suitably located adjacent to the ticket office window, one each for male and female or unisex disabled toilets where these are available.

All components for the electric door lock control shall be readily accessible and shall not be located in the ceiling spaces, etc.

26.4 Passenger waiting rooms

Use of vandal resistant light fittings is required.

Light switches shall not be installed in Waiting Rooms.

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Luminaires shall be controlled from separate light switches located on a switch plate (incorporating separate toilet light switches) near the entrance to the Booking Office, suitably labelled.

No General Purpose Outlet (GPO) shall be installed in Waiting Rooms

26.5 Bus/rail interchanges or areas outside the station boundary

In general, lighting for Bus/Rail Interchanges shall be provided by the Local Electricity Distributor.

Particular attention shall be given to the isolation of OHW structures supporting the 1500 Vdc OHW and structures which are at earth potential (i.e. 2m clearance shall be provided between bus shelters/awnings and RailCorp structures supporting 1500 Vdc OHW).

27 Overhead wiring structures (OHWS)

A 2m clearance form metallic items shall be provided around any structure supporting the 1500V overhead wiring and to avoid the possibility of a person experiencing an electric shock. This clearance is to provide separation between OHWS and other metallic structures such as lighting poles, canopies, awnings, steel troughing, metal fences and rolling stock, in order to avoid an electric shock if these and an OHWS are concurrently touched, in the event that the latter experiences a potential rise above earth.

Only where separation cannot be achieved insulation may be approved.

Refer to Electrical Standards document *C-4501 Metallic Lineside Fencing in Electrified Areas*, which details requirements regarding the double air gap required in the fence.

Refer also to the RailCorp *Guideline on Earthing and Bonding at Railway Stations*.

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Appendix A Lighting of railway stations and adjacent precincts

Although basic information is found in other documents (e.g. *Station Design Standard Requirements)* the following lighting information has been extracted for convenience and is provided below (in reformatted table form) as a result of frequent reference to such information by Designers and others. Refer to appropriate documents and standards for full design requirements.

Table A1 - Illumination levels (lux) for public areas of stations

	Illuminance			Uniformity	
	Eav	E min	EV min	U1	U2
Enclosed & Covered Areas of Stations					
Entrance, Passageways, Walkways	150			0.5	
Ramps & Stairs	150			0.5	
Enclosed Footbridge	150			0.5	
Platform (accessible path full length of train)	160			0.5	
Yellow Line (Platform Edge)		150[a]			
Displays & Directional Signage (timetables, train movements etc)	200			0.5	
Public Counter Tops (ticket office windows)	250			0.5	
Telephones & Ticket Machines	200			N/A	
Public Toilets	200			0.5	
Subways	35	17.5	17.5*		7
Open Areas of Stations (not covered)					
Entrance, Passageways, Walkways	42[d,e]	21	14*		7
Ramps & Stairs	42	21	14*		7
Open Footbridge	42[d,e]	21	14*		7
Platform (accessible path full length of train)	42[d,e]	21	14*		7
Yellow Line (Platform Edge)		30[1]			
Displays & Directional Signage (timetables, train movements etc)	200			0.5	
Station Commuter Car Parks & Precinct					
Transport Interchange (open entrance walkway)	42		12*	0.25	
Accessible Path (station open entry to car park)[i]	42		8*	0.25	
Car Park – Open (disabled spaces)[i]	42		12*	0.25	
Car Park – Open (other)	20		8*	0.25	
Car Park - Covered	40		12*	0.25	

*Measured in the vertical plane 1.5m above ground level.

Note:

- Other RailCorp standards, such as *RailCorp Security Standard RSS 001-Stations 2008*, relevant Australian standards and statutory requirements are also required to be concurrently addressed. Note that the above table is extensive but not definitive.

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- The purpose for lighting must be carefully considered and minimum appropriate lighting in the horizontal and vertical planes, or both should be provided accordingly.

In above table, uniformity factors U1 and U2 refer to internal and external uniformity of illumination respectively, expressed as follows:

$U1 = E_{min}/E_{av}$

$U2 = E_{max}/E_{av}$

Where E_{max}, E_{min} and E_{av} respectively represent the maximum, minimum and average values of illumination.

Care shall be taken when utilising these ratios in calculations, to ensure they are properly used, particularly in software applications.

Notes on Table A1

The following notes refer to Table A1 and incorporate requirements for the visually impaired. Where there are discrepancies between standards with respect to particular applications, the higher illumination values shall be used.

a) Not specifically covered in any code. Recommended minimum level of illumination is higher than the minimum for the remainder of the platform.

b) Illumination level is approximately twice that recommended in AS 1158.3.1

c) Not specifically covered in any code. Recommended illumination level as per area with similar visible task.

d) Level of illumination not less than that of adjoining area.

e) Footbridge shall be considered the same as ramps and stairs.

f) Lighting shall be as uniform as possible. Any changes in lighting level shall be gradual. All uniformity factors are clarifications.

g) For the “Enclosed & Covered Areas of Stations” the illumination values are based on AS1428.2 (1992) required by the Disability Standard for Accessible Public Transport 2002 and Amendments, subsequently Premises Standard under the Commonwealth Disability Discrimination Act 1992 (DDA). These values have been confirmed to be interpreted as “enclosed” and “covered” areas by the Australian Human Rights Commission, with exemptions

h) Illumination values for “Open Areas of Stations (not covered)” were agreed enhancements for uncovered areas recommended by the Webb Report and accepted by the Human Rights and Equal Opportunity Commission (HREOC), now known as the Australian Human Rights Commission (AHRC).

i) Illumination for disabled car spaces and accessible paths to the station entry are derived from the requirement to provide a continuous path of travel between the station and other accessible facilities required by Clause 2.2 of the DSAPT which refers to AS1428.2 (1992) Clause 7. Lighting values for car parks are taken from the greater of requirements of AS1158, agreed AHRC values and RailCorp security standards.