Transport Asset Standards Authority

T HR SC 01000 SP

Specification

Common Signals and Control Systems Equipment Requirements

Version 2.0

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Standard governance

Owner: Lead Signals and Control Systems Engineer, Asset Standards Authority

Authoriser: Chief Engineer, Asset Standards Authority

Approver: Executive Director, Asset Standards Authority on behalf of the ASA Configuration Control Board

Document history

Version	Summary of changes
1.0	First issue 29 March 2017
2.0	Second issue – Specifications consolidated into this document are SPG 1013, SPG 1043, SPG 1432, SPG 1865 and SPG 1868. SPG 0712 is modified in accordance with TN 030:2018 as a result of changes to this document

Preface

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

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

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

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

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

About this document

This document contains common equipment requirements that are to be applied by specifications for particular equipment or this document is used on its own if no particular equipment specification exists.

This document is a second issue. The following specifications are consolidated into this document and are superseded by this document:

SPG 1013 *Cables for Railway Signalling Applications – Cable and Wire for Indoor Use* (V 1.3)

SPG 1043 *Fuses for Railway Signalling Applications* (V 1.2)

SPG 1432 *Non Vital Relays for Signalling Applications* (V 1.1)

SPG 1865 *Lightning and Surge Protection – Varistor-Arrestor Panel (VAP)* (V 1.1)

SPG 1868 *Lightning and Surge Protections – Power Inductors* (V 1.2)

The following specification is modified in accordance with the appended technical note as a result of changes to this document:

SPG 0712 *Lightning and Surge Protection Requirements* (V 1.4)

Alignment with ARA implementation guideline for GS1 identification for *equipment: Implementation Guideline for standardised Identification & Marking of parts and components in the Australian Rail Industry*.

Note: The implementation guideline is produced by GS1 Australia and the Australasian Railway Association (ARA)

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1. Introduction

Signals and control systems equipment is installed as part of the one integrated system for the railway. Most of the requirements for signals and control systems equipment are common. The common signals and control systems requirements are consolidated in this document. These requirements are based on Australian standards and international standards which provide the primary basis for the equipment requirements.

Signals and control systems equipment is typically installed alongside the railway track or in buildings.

The particular meaning of the word 'equipment' for this document is defined in the terms and definitions section.

2. Purpose

This document collates requirements that are common to multiple equipment types so that they are consistently set for each equipment type and its installation.

This document defines the set of common requirements for signals and control systems equipment and its installation arrangements. Particular Transport for NSW (TfNSW) signals and control systems equipment specifications produced by the Assets Standards Authority (ASA) can add to or amend this document.

2.1. Scope

This document covers the common requirements for all signals and control systems equipment and its installations arrangements for the heavy rail transport mode.

This document covers the requirements in the plan, acquire and operate/maintain life cycle phases in the heavy rail transport mode.

This document does not cover specific functionality for equipment which is covered in a particular specification for that equipment type.

2.2. Application

The requirements in this document apply to equipment supplied as a separate configuration item. Line replaceable units (LRU) provided for maintenance are considered as part of the original equipment and are not evaluated separately.

This document is used as part of the assessment criteria for suitability of equipment for general application based on T MU MD 00005 GU *Type Approval of Products*. The equipment generally needs to gain type approval for its application on a part of the TfNSW infrastructure.

Particular TfNSW signals and control systems equipment specifications produced by the ASA amend these common requirements to meet the performance required for the particular equipment type.

3. Reference documents

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

International standards

IEC 60050-161 International Electrotechnical Vocabulary – Part 161: Electromagnetic compatibility

IEC 60050-192 International Electrotechnical Vocabulary – Part 192: Dependability

IEC 60050-351 International Electrotechnical Vocabulary – Part 351: Control technology

IEC 60297 (all parts) Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482.6 mm (19 in) series

IEC 60364 (all parts) Low voltage electrical installations

IEC 60664-1 Insulation coordination for equipment within low voltage systems – Part 1: Principles, requirements and tests

IEC 60721 (all parts) Classification of environmental conditions

IEC 61984 Connectors – Safety requirements and tests

IEC 62236-4 Railway applications – Electromagnetic compatibility – Part 4: Emission and immunity of the signalling and telecommunications apparatus

IEC 62262 Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)

IEC 62278 Railway applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS)

IEC 62279 Railway applications – Communication, signalling and processing systems – Software for railway control and protection systems

IEC 62280 Railway applications – Communications, signalling and processing systems – Safety related communication in transmission systems

IEC 62425 Railway applications – Communication, signalling and processing systems – Safety related electronic systems for signalling

IEC 62443 (all parts) Industrial communication networks – Network and system security

IEC 62497-1 Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment

IEC 62498-3 Railway applications – Environmental conditions for equipment – Part 3: Equipment for signalling and telecommunications

IEC 61709 Electric components – Reliability – Reference conditions for failure rates and stress models for conversion

Note: The European standard equivalence to IEC standard with different standards numbers is provided in Appendix A.

ISO/IEC 25051 Software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – Requirements for quality of Ready to Use Software Product (RUSP) and instructions for testing

ISO/TS 22163 Railway applications – Quality management system – Business management system requirements for rail organizations: ISO 9001:2015 and particular requirements for application in the rail sector

Australian standards

AS 7722 EMC Management

Note: AS 7722 is produced and maintained by RISSB

AS 2756 Low voltage switchgear and controlgear – Mounting rails for mechanical support of electrical equipment

AS/NZS 4417.1 Regulatory compliance mark for electrical and electronic equipment – Part 1: use of the mark

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

AS 61508 (all parts) Functional safety of electrical/ electronic/programmable electronic safety related systems

AS 62040 (all parts) Uninterruptible power systems (UPS)

AS/CA S008 Requirements for customer cabling products

AS IEC 60300 (all parts) Dependability management – Application guide

AS/NZS 3080 Information technology – Generic cabling for customer premises (ISO/IEC 11801:2011, MOD)

AS/NZS 4268 Radio equipment and systems – Short range devices – Limits and methods of measurement

AS/NZS 60950.1 Information technology equipment – Safety – Part 1: General requirements (IEC 60950-1, Ed 2.2 (2013) MOD)

AS/NZS 60990:2002 Methods of measurement of touch current and protective conductor current

AS/NZS 61000 (all parts) Electromagnetic compatibly (EMC)

AS/NZS IEC 60947.1 Low voltage switchgear and controlgear – Part 1: General rules

AS/NZS IEC 60947.3 Low voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units

AS/NZS IEC 60947.5.4 Low voltage switchgear and controlgear – Part 5.4: Control circuit devices and switching elements – Method of assessing in the performance of low energy contacts – Special tests

AS/NZS IEC 60947.7.3 Low voltage switchgear and controlgear – Part 7.3: Ancillary equipment – Safety requirements for fuse terminal blocks

AS/NZS ISO 9001 Quality management systems – Requirements

AS/NZS ISO/IEC 18028 (all parts) Information technology – Security techniques – IT network security

AS/NZS ISO/IEC 24702 Telecommunications installations – Generic cabling – Industrial premises

AS ISO/IEC 27001 Information technology – Security techniques – Information security management systems – Requirements

AS ISO/IEC 27002 Information technology – Security techniques – Code of practice for information security controls

Transport for NSW standards

SPG 0706 Installation of Trackside Equipment

SPG 0707 Installation of Equipment Racks and Termination of Cables and Wiring

SPG 0708 Small Buildings and Location Cases

SPG 0712 Lightning and Surge Protection requirements

T HR EL 00001 TI RailCorp Electrical System General Description

T HR SC 02000 ST Mandatory Requirements for Signalling Safeworking Procedures

T MU AM 01001 ST Life Cycle Costing

T MU AM 01005 ST Asset Handover Requirements

T MU AM 02004 ST Management of Asset Information

T MU AM 04001 PL TfNSW Configuration Management Plan

T MU EN 00005 ST Ambient Environmental Conditions

T MU HF 00001 ST Human Factors Integration – General Requirements

T MU MD 00005 GU Type Approval of Products

T MU MD 00009 SP AEO Authorisation Model

T MU MD 20001 ST System Safety Standard for New or Altered Assets

Other reference documents

Implementation Guideline for standardised Identification & Marking of parts and components in the Australian Rail Industry

Note: The implementation guideline is produced by GS1 Australia and the Australasian Railway Association (ARA)

Protection of the Environment Operations (Noise Control) Regulation 2008

Radio communications (Low Interference Potential Devices) LIPD Class Licence 2015

4. Terms and definitions

The following terms and definitions apply in this document:

accelerated test a test in which the stress level, or rate of stress application, exceeds that occurring under specified operational conditions, to reduce the duration required to produce a stress response (IEC 60050-192, 192-09-08)

AEO Authorised Engineering Organisation

ARA Australasian Railway Association

CBI computer based interlocking

CE European conformity

COTS commercial off the shelf

DIN German Institute for Standardization

EMC electromagnetic compatibility (IEC 60050-161, 161-01-07)

EPR earth potential rise

equipment a physical item that provides functionality including its firmware and essential software

field test test carried out under user operational conditions (IEC 60050-192, 192-09-06)

functional safety part of the overall safety that depends on functional and physical units operating correctly in response to their inputs (IEC 60050-351, 351-57-06)

GS1 a global, neutral, non-profit standards organisation that brings efficiency and transparency to the supply chain (www.gs1.org)

hazardous state state that has the potential to cause harm to persons, significant material damage or other unacceptable consequences (IEC 60050-192, 192-02-26)

ISA independent safety assessor

IT information technology

IT power distribution system of earthing with live parts isolated from earth and exposed conductive parts earthed (IEC 60364)

ITE information technology equipment

laboratory test test made under prescribed and controlled conditions that may or may not simulate field conditions (IEC 60050-192, 192-09-05)

LRU line replaceable unit

LV low voltage

MACMT mean active corrective maintenance time (IEC 60050-192, 192-07-22)

MTBF mean time between failures, also known as mean operating time between failures (IEC 60050-192, 192-05-13)

> *Note: MTBF is used as the general term. Mean time to failure (MTTF) (IEC 60050-192, 192-05-11) is the applicable term if the equipment is not repairable.*

off line support tool tool only used during the plan or acquire asset life cycle phases to plan, design, construct, install or test and commission equipment

> *Note: Tools used for training during the operate/maintain life cycle are categorized as off line support tools as they are not used in association with the in service equipment.*
>
> *Note: Tools that are used during both acquire and operate/maintain life cycle phases in association with equipment before it is commissioned and while it is in service are considered to be on line support tools.*

on line support tool tool used during the operate/maintain asset life cycle phase in association with the in service equipment

PD pollution degree; classification according to the amount of dry pollution and condensation present in the environment as defined in the applicable standard IEC 60664-1 or IEC 62497-1

RAM reliability, availability and maintainability

RAMS reliability, availability, maintainability and safety

RCM regulatory compliance mark

redundancy provision of more than one means for performing a function (IEC 60050-192, 192-10-02)

RIM rail infrastructure manager

RISSB Rail Industry Safety and Standards Board

RSNL Rail Safety National Law

RTO rail transport operator

SFAIRP so far as is reasonably practicable

SSI solid state interlocking (a computer based interlocking (CBI) originally produced for British Rail)

TFM trackside functional module (a part of solid state interlocking (SSI) trackside equipment)

UPS uninterruptable power supply

WHS work health and safety

5. Quality management framework

The design, manufacture, supply and repair of the equipment shall be performed in accordance with a quality management framework audited for compliance with AS/NZS ISO 9001 *Quality management systems – Requirements*.

Railway specific equipment should either be produced in accordance with ISO/TS 22163 *Railway applications – Quality management system – Business management system requirements for rail organizations: ISO 9001:2015 and particular requirements for application in the rail sector* or a quality management system that covers the RAMS processes relevant to the equipment. The International railway industry standard (IRIS) group provides certification to ISO/TS 22163.

6. RAMS framework

The design, manufacture, supply and repair of railway specific equipment shall be performed in accordance with the following international standards:

- IEC 62278 *Railway Applications – Specification and demonstration of reliability, availability, maintainability and safety (RAMS)*
- IEC 62279 *Railway applications – Communication, signalling and processing systems – Software for railway control and protection systems*
- IEC 62425 *Railway applications – Communication, signalling and processing systems – Safety related electronic systems for signalling*

The generic safety case and generic application safety case produced for railway specific equipment in accordance with IEC 62278 shall be supported by an independent safety assessor (ISA).

> *Note: The generic safety case and generic application safety case ISA is not required to be an Authorised Engineering Organisation (AEO) that TfNSW has authorised for the provision of ISA engineering services.*

The railway specific equipment shall have documentation for its installation, commissioning, operation and maintenance in accordance with IEC 62278 to meet the nominated reliability, availability, maintainability and safety (RAMS) targets.

IEC 62278 does not include security issues in its scope. Section 21 of this document details security arrangement for equipment.

Commercial off the shelf (COTS) equipment for general application shall be supported by evidence of reliability and maintainability based on AS IEC 60300 (all parts) *Dependability management* or an equivalent standard. Equipment reliability and maintainability performance shall be defined. System safety of COTS equipment is managed as part of the safety assurance provided by the AEO for new or altered assets in accordance with T MU MD 20001 ST *System Safety Standard for New or Altered Assets*.

Non-railway specific equipment that provides functional safety shall comply with AS 61508 (all parts) *Functional safety of electrical/electronic/programmable electronic safety related systems* or the appropriate product specific safety standard.

Individual equipment reliability, availability and maintainability (RAM) performance shall satisfy the following requirements when installed in the defined environment unless varied by a particular requirement:

a. The theoretical mean time between failures (MTBF) for failures that would delay a train moving through the area covered by the equipment or impacts rail operations shall be more than 20 years.

b. The theoretical MTBF for failures that require corrective action by the maintainer or operator shall be more than six years.

c. Individual components shall fail less frequently than the failure rate defined in IEC 61709 *Electric components – Reliability – Reference conditions for failure rates and stress models for conversion* or an equivalent component reliability database.

d. The equipment shall function without functional degradation while any one redundant item that forms part of the equipment redundancy is in a faulty state.

e. The mean active corrective maintenance time (MACMT) shall be less than 40 minutes. This includes all configuration, verification and validation activities and start up time.

f. The accepted method for theoretical reliability prediction is the application of IEC 61709. The defined mission profile is 24 operating hours per day in the recommended reference conditions defined in IEC 61709.

g. The theoretical availability and reliability analysis shall be supported by in service reliability information that provides at least a 50% confidence level that the theoretical values have been achieved. If in service reliability information is not available then the type approval

reliability demonstration shall apply field tests, laboratory tests and accelerated tests to achieve an equivalent confidence level by reasonably practicable means.

h. The combined preventative maintenance and inspection or adjustment requirements shall be less often than once every six months assuming the defined mission profile with less than 30 minutes duration per visit.

i. Preventative maintenance tasks that affect operation of the rail system shall not be more frequent that once every two years for each item of equipment.

j. Equipment shall include traceability information to support configuration, maintenance and investigation of issues with hardware, software, configuration data, or application data.

7. Electromagnetic compatibility (EMC) framework

The electromagnetic compatibility (EMC) framework shall be in compliance with AS 7722 *EMC Management*. All recommendations by AS 7722 for the application of a standard to manage an issue shall be complied with unless justified by documented reasoning as to why it is not reasonably practicable to do so. An alternative standard shall be applied if application of the nominated standard is not reasonably practicable.

Note: Consideration is being given to the specific inclusion of AS/NZS IEC 61000.6.7 Electromagnetic compatibility (EMC) – Generic standards – Immunity requirements for equipment intended to perform functions in a safety related system (functional safety) in industrial locations as it covers a number of open areas in the existing standards. Newly developed products that provide functional safety should consider conformance with the standard.

T HR EL 00001 TI *RailCorp Electrical System General Description* provides a general description of the high voltage power distribution and electric traction system for trains.

Control of electrolysis from stray direct current (dc) electric traction currents constrains earthing of cable shields and metallic armour.

Cable locators are used to locate cables while equipment is in operational use. Coupling can occur from the cable locator signal onto circuits within cables.

Equipment should have evidence of immunity from alternating current (ac) traction generated interference where reasonably practicable to allow for the potential introduction of ac traction within the expected life of the equipment. Application design and installation should comply with equipment constraints for ac traction where reasonably practicable.

Equipment with radio transmitters compliant with the *Radio Communications (Low Interference Potential Devices) LIPD Class Licence 2015* are used as part of the signals and control systems infrastructure. AS/NZS 4268 *Radio equipment and systems – Short range devices – Limits and*

methods of measurement provides limits and methods for compliance with the LIPD Class Licence.

Test equipment attachment clips can contain magnets with magnetic fields stronger than 300 A/m. These attachment clips are used during installation and maintenance activities. Typically these fields are less than 100 A/m at 100 mm. Equipment that is potentially affected by these magnetic fields shall be identified for provision of warning signs. A special mention shall be provided in the installation and maintenance procedures of the effect of magnetic fields for equipment potentially affected by strong magnetic fields.

The operational use of radio transmitter devices by signals and control systems personnel is managed by T HR SC 02000 ST *Mandatory Requirements for Signalling Safeworking Procedures*.

Specific EMC requirements for the electric power interface to the equipment are defined in Section 14 of this specification.

8. Human factors framework

The human factors framework shall comply with T MU HF 00001 ST *Human Factors Integration – General Requirements*. The operate/maintain phase is generally the longest duration life cycle phase. So it requires significant attention in the management of human factors issues.

Equipment shall be designed so far as is reasonably practicable (SFAIRP) so that no single human error can result in a failure with a likely consequence of injuries or fatalities to people. Processes required to control human errors for moderate consequence risks (or more significant) shall provide multiple human factor defences to control the hazard.

9. COTS equipment framework

An AEO approved for all of the signals and control systems detailed life cycle activities for design is delegated authority to evaluate and manage the type approval of a subset of COTS equipment in accordance with the specified requirements for the equipment. The AEO shall consider how the equipment will be installed and practicality of the maintainer being able to perform a 'like for like' replacement of the equipment.

> *Note: The equipment requirements include recommendations and constraints from the supplier and type approval of the signals and control systems equipment the COTS equipment is being used with.*

This delegation is limited to the subset of COTS equipment that meets all of the following criteria:

a. The equipment is not specific to any particular industry.

b. The COTS equipment will not be used to control any functional safety related failure modes.

c. Similar equipment is available from three or more suppliers.

d. Replacement of one brand's equipment with another brand's similar equipment is able to be completed in 30 minutes by first line maintenance personnel with a design covering interface terminal wiring only. The equipment can be preconfigured and tested prior to the replacement.

   Note: This is typically called a 'like for like' replacement.

e. The equipment is made to the International standards applicable to the product or product family.

f. All of the equipment interfaces conform to International standards.

g. The equipment type is in widespread use.

h. The specific equipment item is in commercial production with delivery in less than six weeks from purchase request.

The AEO shall ensure that the COTS equipment meets the requirements for the engineering services being provided under the particular procurement contract.

The number of similar types of equipment used in the signals and control system needs to be managed to support efficiencies in the operation of the whole rail network over life cycle of a large number of individual assets. The AEO should review the type approval register when selecting equipment as part of the engineering service.

The initial consultation step in T MU MD 00005 GU should be used in the type approval of equipment under this framework.

AEO type approvals under this framework shall be provided for registration in accordance with T MU MD 00005 GU along with a copy of the supporting evidence.

10. Standardisation

Equipment shall be designed and manufactured to comply with Australian and international standards unless it is not reasonably practicable.

Systems shall use common modules with standardised interfaces.

Appendix B identifies appropriate standards and requirements for some common equipment types. The standards and requirements in Appendix B are mandatory for the equipment type. Equipment types identified as COTS equipment in Appendix B are accepted as one of the subset of COTS equipment meeting the delegation criteria defined in Section 9.

Innovative equipment is typically developed before the equipment is standardised. Concessions will be used to support the use of innovative equipment that provides a net benefit to stakeholders.

11. Physical form and fit

The equipment is installed in the arrangements as defined in SPG 0706 *Installation of Trackside Equipment* and SPG 0707 *Installation of Equipment Racks and Termination of Cables and Wiring*. Buildings and locations that house equipment are defined in SPG 0708 *Small Buildings and Location Cases*.

The physical form and fit of the equipment shall permit efficient use of the space while meeting human factors requirements and RAM requirements. Security requirements that can impact the physical form and fit are detailed in Section 21.

11.1. Form

Equipment shall be constructed and installed so that testing, inspection, configuration and replacement can be carried out to meet the RAMS targets using work practices that have been assessed for work health and safety (WHS) compliance. Considerations include, height, weight, accessibility, visibility, labels, lighting, manual handling and the physical work environment. Trackside locations are outdoors with uneven ground, exposed to weather. Installation is planned work that can be scheduled for any time of the day or night. Corrective maintenance is unplanned work that can occur at any time of the day or night.

Equipment with an expected life of less than that nominated in Section 19 or with an expected failure rate of more than once during its expected life shall be replaceable by one person within the MACMT requirement.

Equipment can generate audible noise as a by-product of its operation. Resonances in the installation arrangement can cause an increase in the sound level produced by the equipment. The equipment combined with its installation arrangement shall not produce audible noise that disturbs personnel performing prolonged work in the same location as the equipment.

11.2. Fit

Equipment is typically mounted on custom relay racks, mounting rails, mounting plates or 19 inch racks.

Equipment to be mounted on custom rack types or mounting plates shall be supported by an assessment demonstrating its suitability for the mounting arrangement. Suitability includes mechanical strength and ability to meet the RAMS requirements over the expected life in the environmental conditions.

AS 2756 *Low voltage switchgear and controlgear – Mounting rails for mechanical support of electrical equipment* defines mounting rails used for electrical equipment. G 32 (commonly known as G rail or TS 32 rail) and TH 35 (commonly known as TS 35 rail or DIN rail) are used. New equipment intended to be mounted on a mounting rail shall be suitable for mounting on TS 35 rail.

> *Note: EN 50022 and IEC 60715 are international standards that are equivalent to AS 2756.*

Equipment to be installed in 19 inch racks shall meet the requirements of IEC 60297 (all parts) *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482.6 mm (19 inch)*. The integrated equipment and 19 inch racking shall comply with IEC 60297.

12. Regulatory compliance

Equipment shall comply with relevant product standards and be marked accordingly. The European conformity (CE), Australian regulatory compliance mark (RCM) and standards marks are recognised markings. The RCM and its application are defined in AS/NZS 4417.1 *Regulatory compliance mark for electrical and electronic equipment – use of the mark*.

To meet oblations under the *Protection of the Environment Operations (Noise Control) Regulation 2008* equipment that regularly produces unintended noise as part of its operation shall have the noise level controlled so that the noise level is less than 35 dB(A) when measured from a distance of 10 m. This is done to make it unlikely that the noise will be heard at night from a habitable room in properties near to the railway line.

13. Environmental conditions

The ambient environment conditions are detailed in T MU EN 00005 ST *Ambient Environmental Conditions*. Equipment can be designed to operate in the given environmental conditions or it can be protected so that it experiences a narrower range of environmental conditions.

Railway specific equipment shall comply with IEC 62498-3 *Railway applications – Environmental conditions for equipment – Part 3: Equipment for signalling and telecommunications* with the following specific clarifications for the Sydney area:

a. The conditions detailed in T MU EN 00005 ST are expected to occur. Some of these conditions are outside the external ambient conditions defined in IEC 62498-3. This is likely to also affect conditions within housings without temperature or climate control.

b. Humidity can drop below 15% (~ 5%) in conjunction with the temperatures above 40°C.

c. Rain exposure for less than 30 minutes through an open door is expected once per year for equipment installed in cubicles and shelters.

d. Pollution in tunnel environments is high (3S3/4S3) for mechanical active substances.

e. Vibration and shocks for equipment installed more than 3 m from the rail can be significant due to typical installation arrangements. Equipment installed more than 3 m from the rail shall comply with the vibration and shock requirements for equipment installed from 1 m to 3 m from the rail.

f. The product design shall control 'fibre blooming' of material caused by UV exposure due to the solar radiation. 'Fibre blooming' should not occur in the first third of the expected life of the product.

Note: The equivalence of terms between IEC 62498-3 and SPG 0708 are considered to be a cubicle is a location case, a shelter is a bungalow and a building is a control centre or signal box.

COTS equipment shall have evidence of suitability for the intended environment in which it is to be used. The balance between equipment environmental requirements, installation requirements, compliance with RAMS requirements and ongoing maintenance costs shall be made in accordance with T MU AM 01001 ST *Life Cycle Costing*.

Classification of environmental conditions for COTS equipment shall be based on IEC 60721 (all parts) *Classification of environmental conditions*. Typical parameters for COTS equipment are given in Table 1.

Table 1 – Typical parameters for COTS equipment

Parameter	Value
Use	Stationary
Location	Weather protected
Summary of classes	3K5/3B2/3C2/3S2/3M2
Duration of use	In accordance with Section 19
Duration of significant vibration	One week in a year
Maximum duration of significant vibrations	Eight hours
Number of significant shocks	Once in 24 hours

Equipment locations and maintenance activities do not completely prevent rodents and ants from affecting equipment. Rodents can cause equipment failure due to gnawing or from urine entering equipment. Ant nesting can affect insulation and surface conductivity.

Equipment is installed in a variety of locations. Corrosion can occur for some materials; particularly if they are not protected from the environmental conditions present at the installed location. The equipment shall meet its expected life and RAMS requirements when installed in the proposed equipment locations and arrangements.

The equipment shall be designed for continuous operation in the defined environment.

14. Electrical power interface

The electrical power interface provides equipment power and can provide power for equipment inputs and outputs. Data communications interfaces are not considered as an electrical power interface. Interfaces that combine data communications and power are not specifically covered in this section.

14.1. All equipment

The equipment's electrical power interface shall comply with AS/NZS 60950.1 *Information technology equipment – Safety – General requirements (IEC 60950-1, Ed 2.2 (2013) MOD)* for the power distribution system that it is to be connected to or the equivalent applicable product standard that covers product safety requirements.

Equipment shall not require a warning label for 'high leakage current' or 'high touch current' based on an assessment in accordance with AS/NZS 60950.1.

The equipment shall be tested in accordance with item 4.2 voltage dips and item 4.3 voltage interruptions of Table 4 in AS/NZS 61000.6.2:2006 *Electromagnetic compatibility (EMC) Part 6.2: General standards—Immunity for industrial environments*. In assessing equipment performance, criteria B and criteria C should not require maintenance intervention to restore functionality. The equipment does not normally have a user in attendance. Performance criterion B for item 4.2 shall include the requirement to not cause a restart of the equipment.

> *Note: The tests in the previous paragraph only apply to the ac power inputs of equipment as defined in the referenced standard.*

Equipment shall have immunity from harmonics and have the mains signalling on the ac input supply. This immunity shall be based on test class 3 in AS 61000.4.13 with no loss of function. Harmonics from traction rectifiers and ripple control systems are found on the railway ac power supply.

> *Note: The railway power distribution system is moving toward compliance with AS 61000.2.2 for harmonics which will eventually reduce the requirement to test class 2.*

Equipment shall start operating and remain operating in the permanent voltage range. Expected voltage interruptions shall not cause equipment to lose functionality. Compliance tests shall be done in accordance with AS 61000 (all parts) *Electromagnetic compatibly (EMC)*.

Equipment with a current draw of more than 3 A shall have a method to power on and off the equipment.

> *Note: Typically used methods are an on/off switch as part of the equipment or the requirement to use either a dedicated on/off switch external to the equipment or circuit breaker for the equipment.*

All equipment shall be tested to determine the minimum current protection rating and the type required to prevent operation of circuit protection due to inrush currents. Inrush current scenarios shall consider short duration interruptions combined with supply phase changes. The minimum current protection rating and type shall be documented in the product documentation.

The minimum overcurrent protective device for equipment intended to be installed inside trackside locations shall be less than or equal to 20 A with a type C circuit breaker trip curve on the 120 V ac power distribution.

14.2. Power on, resumption, interruption

Equipment that is intended for unattended operation shall automatically start up or restart on restoration of power after loss of power to the equipment.

14.3. Railway specific equipment

Railway specific equipment shall comply with IEC 62497-1 *Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances*.

Overvoltage design shall at least meet OV2 for circuits internal to equipment housings and OV3 for circuits that can run external to equipment housings. PD3 (or more severe) is the pollution degree (PD) for the environment in which the indoor equipment will be used. PD4 (or more severe) is the pollution degree for the environment in which the outdoor equipment will be used.

Equipment intended for installation in trackside locations shall continue operating without disruption during and after a voltage interruption of 0% residual voltage for at least 10 cycles at 50 Hz. Compliance is tested in accordance with AS 61000.4.11.

14.4. Non-railway specific equipment

Non-railway specific equipment shall be at least rated for insulation coordination overvoltage category II in accordance with IEC 60664-1 *Insulation coordination for equipment within low voltage systems – Part 1: Principles, requirements and tests* in a PD2 (or more severe) environment.

14.5. Signalling 120 V ac

Signalling 120 V ac 50 Hz uses the IEC 60364 (all parts) *Low voltage electrical installations* IT ac power distribution system.

The signalling 120 V ac 50 Hz nominal power supply electrical characteristics are as follows:

a. be permanently at any voltage in the range of +10% and -20% from the nominal value

b. be interrupted with a voltage interruption with 0% residual voltage (of 120 V ac supply) for up to 5 cycles at 50 Hz

Equipment supplied at 120 V ac and intended to be protected by fuse shall have inrush current that is less than 20 A^2s when measured at 96 V and 132 V. Typically used fuses are rated at 34 A^2s.

Typical confirmation tests performed while testing equipment for an IT power distribution system power supply are as follows. Failure of these tests will result in the equipment being classified as faulty.

c. insulation resistance to earth > 100 MΩ at 500 V dc (both legs of two wire supply)

d. capacitance to earth < 100 nF for each leg of the supply with values less than 50% different from one to the other

Equipment to be installed on a 120 V ac supply that also provides power for SSI trackside functional module (TFM) signal modules shall be tested for conducted harmonic emissions in the range of 9 kHz to 150 kHz. The test arrangement shall be based on AS/NZS 60990:2002 *Methods of measurement of touch current and protective conductor current*. Sources that drive a touch current also drive currents that can cause conducted interference to sensitive equipment. The test is to measure currents that can circulate through parasitic capacitances and other paths intended or otherwise that might affect the signalling safety equipment. The power arrangement shall simulate a signalling 120 V ac supply based on a single phase IT power distribution system arrangement. The unweighted touch current measuring network, in accordance with AS/NZS 60990:2002 Figure 3 is used. The normal operating conditions limit value is 0.25 mA ac rms. The fault conditions limit value is 0.5 mA ac rms.

14.6. General 230 V ac

General 230 V ac low voltage (LV) power distribution uses the TN C S ac power distribution system in accordance with IEC 60364.

The general 230 V ac power supply does not provide any functional safety. Equipment shall only have power quality requirements for the general 230 V ac power supply.

14.7. Signalling dc

The signalling dc power supplies are unearthed (floating). Typically they are also unregulated and unfiltered. In this case the peak supply voltage will be 1.6 times the maximum dc voltage measured by a dc voltmeter.

The voltage range for an unregulated supply is typically +10% to -20% of the nominal voltage.

Equipment powered from the unfiltered signalling dc supply shall not filter the dc supply itself due to components fitted within the equipment.

Equipment shall meet its expected life and RAMS performance when connected to this electrical supply arrangement.

Equipment shall not provide a galvanic path to earth less than 500 MΩ unless it is providing earth leakage detection functionality.

14.8. General dc

No additional equipment requirements apply.

The general dc power supply does not provide any functional safety. Equipment shall only have power quality requirements for the general dc power supply.

15. Communications interface

All communications interfaces to equipment shall conform to a recognised Australian standard or international standard for the physical layer of the interfaces. This includes connector and electrical or optical aspects.

The communications interface shall comply with Section 7 and Section 21.

Communication interfaces between equipment that do not share a common earthing system shall pass an electric strength test between the telecommunication interface and equipment earth using a 1.5 kV ac test voltage. AS/NZS 60950.1 details a standard test method. A common earthing system has all elements bonded together with low resistance and low impedance connections. An earth bonding connection longer that 30 m is unlikely to provide a low impedance connection. Cable shield connections shall not provide the only conductive path between two earthing systems.

Note: Telecommunications interfaces include all communications interfaces. Not just the interfaces to a telecommunications network.

Note: The use of a separate item of equipment to meet the electrical strength test is the accepted practice for interfaces that do not inherently provide isolation. Galvanic isolation is typically used to achieve the isolation required to meet the electrical strength.

16. Maintenance

Equipment shall be designed to integrate into maintenance arrangements based on AS IEC 60300 (all parts).

The key features required for maintainers to meet the maintainability performance requirements are as follows:

a. labelling of indications, connections and test points that is consistent with documentation

b. built in tests, automated self-tests, test points and diagnostics

c. consistent processes for configuration of modules, replacement of modules and testing of modules

d. clear identification of firmware, software and application data for use by maintainer

e. a facility to determine which particular replaceable item has failed

f. restrictions on replacement or restart of redundant items that form part of the system redundancy while the system is operational are clearly identified and included in any MACMT analysis

17. Hazardous substances

No goods listed in the *Australian Dangerous Goods Code* shall be used as part of equipment.

The use of hazardous substances as part of equipment shall be minimised in accordance with Australian and international regulations for WHS.

Hazardous substances used as a part of the equipment shall be identified and managed as required by WHS regulations.

18. Fire properties

Equipment shall be designed and manufactured to minimise the likelihood of a fire starting within the equipment.

The equipment construction and properties of the materials used shall limit the spread of flames and the ability to sustain a fire within the equipment.

Equipment that is designed to be used in quantity with close spacing shall primarily use non-combustible material or self-extinguishing material.

Smoke hazard and toxic hazard limits due to fire are not specified based on the expected material quantities, fire resistance and usage in normally unattended locations. Some equipment will require specific controls for these hazards due to usage or installed location.

Equipment usage in confined spaces, underground locations and attended locations shall manage fire related hazards. In these cases equipment compliance with a standard for confirming ignition is unlikely or compliance of emissions from burning equipment with a low smoke and halogen free standard or both shall be demonstrated.

Evidence for compliance shall be based on the results from tests in accordance with an International Electrotechnical Commission (IEC) standard, International Standardization Organization (ISO) standard or equivalent Australian standard.

19. Equipment life

Railway specific equipment shall have a minimum operational life of 20 years in the defined environment unless justified by a life cycle costing process as stated in T MU AM 01001 ST.

COTS equipment life shall be assessed based on the installed environment, usage and proposed maintenance. If the expected equipment life is less than 10 years in the proposed environmental conditions then this shall be justified by life cycle costing in accordance with T MU AM 01001 ST.

Data storage mediums shall have a minimum life of seven years without data loss with a 99.9% confidence level when stored in the nominated operational environment in a non-powered state.

20. Software

Software for railway applications and software for non-railway specific equipment that provide functional safety is covered in Section 6.

All ready to use software product (not covered by Section 6) that is provided as part of signals and control systems equipment shall be supported by either a conformity evaluation report or a supplier's declaration of conformity to ISO/IEC 25051 *Software engineering – Systems and software Quality Requirements and Evaluation (SQuaRE) – Requirements for quality of Ready to Use Software Product (RUSP) and instructions for testing*.

21. Security framework

The security framework is made up of physical security and cyber security. These are detailed in Section 21.1 and Section 21.2 respectively.

21.1. Physical security

Equipment and cable installed within a housing, location or building that provides physical security of the equipment does not itself require protection against intentional physical threats from people.

Equipment that is to be installed in a manner that is open to direct access shall have its own physical security. This physical security shall meet the following requirements:

a. The equipment shall be protected against vandalism when the physical security is in place by achieving an IK10 rating for external mechanical impacts in accordance with IEC 62262 *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*. After testing, the equipment shall be operational and not present a hazard to health and safety or the environment.

b. Access to the equipment internals or its wiring plus action to cause a hazardous state shall take longer than 10 minutes for one person using common hand tools.

c. Equipment open to direct access is normally locked by a padlock provided by the rail infrastructure manager (RIM). Padlock hasp external measurement is 36 mm wide and 32 mm high. Internal maximum measurement is 23 mm wide and 25 mm high. Typical diameter of the hasp is 6 mm. This equipment shall be capable of being securely locked using the nominated padlock or require the use of tools for access to equipment internals.

d. Tests to confirm the effectiveness of the equipment physical security shall be carried out by physical test, by detailed analysis or detailed simulation on the installed arrangement.

21.2. Cyber security

The cyber security requirements are described in Section 21.2.1 through to Section 21.2.4.

21.2.1. Aim

Cyber security shall be provided for the following equipment and configuration:

a. products/equipment including hardware, firmware and software

b. support tools – on line and off-line support tools for design, configuration and maintenance

c. data – design, configuration, transient and historical

d. transmission system – if required as part of the cyber security for products, tools and data

This shall be done so that they are robustly protected against the following hazards due to deliberate acts as a minimum:

e. unauthorised access to products, tools and data by local access, remote access or interception/monitoring at an intermediate location

f. data unintentionally left behind on products, in tools or in a transmission system

g. monitoring or recording data contrary to *Rail Safety National Law (RSNL)* requirements 'not to publish', 'train safety recordings' or for planning a future attack

h. denial of service

i. malicious code

j. exploitation of design, installation or maintenance errors

k. unintended introduction of vulnerabilities or configuration changes

l. repetition, deletion, insertion, re sequencing, corruption, delay and masquerade of transmitted (transient) data in accordance with IEC 62280 *Railway applications – communications, signalling and processing systems – Safety related communication in transmission system*

m. deletion, alteration or corruption of firmware, software or data (design, configuration and historical)

This shall occur while supporting the following:

n. required functionality

o. meeting RAMS performance targets including MTBF, MACMT and preventative maintenance effort

p. the full range of corrective and preventative diagnostics necessary for the particular maintenance personnel to complete their tasks in a timely manner

q. meeting data transmission performance criteria – errors rate, latency, jitter, throughput, and so on

r. continuous change and improvement of the system

s. condition monitoring of the system

21.2.2. Context

Rail system products inherently lag behind current information technology (IT) equipment due to the extended product assurance processes and development costs. Rail system products range from custom embedded equipment with proprietary interfaces designed in the 1980s to current standardised COTS equipment running railway specific applications.

Current cyber security solutions are not always relevant or able to be applied to rail system products. Rail system products may be inherently protected or significantly more vulnerable to cyber security issues.

International standards IEC 62278, IEC 62279, IEC 62425 and IEC 62280 provide a safety management framework that is likely to have been applied to rail system products. Exported hazards, safety related application constraints and assumptions associated with the products form residual hazards that either could not be or are not managed as part of the product.

Rail system products that have a different safety management framework will also have hazards, constraints and assumptions identified prior to use.

A significant proportion of cyber security hazards for rail system products are residual hazards that the rail transport operator (RTO) manages.

21.2.3. Hazard management

Cyber security management shall be embedded into the current hazard management framework; otherwise the assurance framework will not be complete.

Residual hazards relating to cyber security due to the integration of a rail system into the RTOs infrastructure and operations are a subset of the hazards that need to be identified to the RTO and managed by the RTO.

The hazard identification process for equipment shall include the identification of cyber security hazards for the whole of the rail system's life cycle. These include currently known threats, emerging threats and potential threats by technical means. One or more formal hazard identification techniques shall be used to identify these hazards.

Cyber security hazard controls shall be integrated as part of the equipment as far as practical.

The equipment supplier shall have a process to identify, manage and advise emerging and potential cyber security hazards for the equipment while the equipment is supported.

Generic controls for known or unknown or future hazards are as follows:

a. prevent unintended or unauthorised access through an authorised client device

b. prevent unauthorised access through a network connection accessed from outside of authorised locations

c. prevent where possible or otherwise limit potential denial of service traffic from network connections located outside authorised locations

d. prevent configuration changes of the network and client devices from a network connection located outside of authorised locations

e. prevent both unintended access to and unauthorised access to monitoring of data traffic

f. configuration management of cyber security hazard controls for safety related systems managed by those responsible for the safety related system

g. physical security of authorised locations including access to equipment, patching locations, terminations and cabling

h. regular training of authorised personnel in their role in providing system security by both physical and cyber measures

i. application of strong configuration control processes to control RAMS and security hazards

j. detection and investigation of anomalies in system operation

k. processes to control potential for malicious code on equipment

l. restrict distribution of safety related software, firmware and data

m. regular review of system security

n. use of a combination of controls to prevent the hazard supported by controls to mitigate the consequence should the hazard occur

21.2.4. Cyber security standards

The following standards are used as a basis for addressing cyber security for information technology configurations and products. They can also be applicable to signals and control

systems equipment. These standards identify threats which may form hazards that should be controlled to manage the safety and reliability of the particular rail system.

- AS ISO/IEC 27001 *Information technology – Security techniques – Information security management systems – Requirements*
- AS ISO/IEC 27002 *Information technology – Security techniques – Code of practice for information security controls*
- AS/NZS ISO/IEC 18028 *(all parts) Information technology – Security techniques – IT network security*
- IEC 62443 *(all parts) Industrial communications networks – Network and system security*
- NIST Framework for Improving Critical Infrastructure Cybersecurity

  Note: the IEC 62443 (all parts) is considered the most appropriate standard to cover cyber security for signals and control systems equipment. A future version of this document is likely to mandate compliance with IEC 62443 for signals and control systems equipment.

22. Connecting devices

Connecting devices are components used for electrical or optical connections for equipment inputs, outputs, power and communications connections. Interface terminals include two part arrangements (plug and socket) and parts mounted separately.

22.1. General requirements

Connecting devices shall comply with an IEC standard that is appropriate for the intended usage in the defined environmental conditions.

Connecting devices shall be conservatively rated for the proposed application. The conservative rating shall consider the particular duty cycle, power supply and load characteristics, range of operating currents, conductors and termination methods, environmental conditions, expected life, and standardisation of equipment and spare parts when selecting a connecting device.

Equipment electrical interface terminals for power, input and output circuits (excluding communication circuits) shall meet the requirements for connecting devices defined in this document and in accordance with AS/NZS IEC 60947 *Low voltage switchgear and controlgear*.

Rated impulse voltage shall meet the requirements of IEC 60664-1 overvoltage category II for circuits within a location and overvoltage category III for circuits that run outside a location. Applied to 120 V ac circuits used for functional safety applications (see Section 22.2) this results in a rated impulse voltage of 6 kV for general use. Alternatively a 4 kV impulse voltage rating can be used if the connecting device is limited to internal circuit applications only.

Note: Management of human factors and maintenance issues is likely to require adoption of the higher rating so that the device is suitable for general usage.

The majority of conductors connected to equipment are from 0.2 mm² to 4 mm² cross sectional area. These conductors are normally terminated with pin lugs, flat blade crimps or ferrules. Some types of wires used have thicker than normal insulation. The majority of conductors for power supply wiring are from 4 mm² to 16 mm². Refer to Appendix B for details on the type of wire used. Terminals shall be suitable for use with the conductor sizes, insulation thickness and termination method used.

Continuous service temperature for connecting devices shall be rated for the maximum temperature in the environment defined for the equipment that they form part of, or if separate items the cubicle defined in IEC 62498-3. Connecting devices shall comply with IP2X in accordance with AS 60529 *Degrees of protection provided by enclosures (IP code)*.

Small parts (that is, less than 5 mm^3 volume) shall be held captive during normal usage to prevent loss of the parts.

Connecting devices shall have a compatible range of labelling and colour coding designed for use over the expected life without preventing the compliance with other requirements. Connecting devices used as separate terminals shall have a compatible range of bussing.

The maintainer uses test equipment with 2 mm diameter test probes. Connecting devices that are not sealed shall provide for maintenance testing at connections.

22.2. Functional safety application

Connecting devices for functional safety applications use the inherent physical properties for insulation, robustness and design of the device as part of the functional safety of an electrical circuit.

Connecting devices used as part of a functional safety application shall meet the following requirements:

a. Be rated for at least three times the nominal voltage with a 250 V ac minimum voltage rating. As a result 360 V ac is the minimum rated voltage for use on the 120 V ac signalling power supply.

b. Have a maximum rated voltage rating based on IEC 60664-1 pollution degree (PD2) or higher for more severe requirements.

c. Have a current rating at least four times the nominal maximum current or twice the fuse rating with a minimum 4 A current rating. Circuit fusing is typically 4 A or more. Fuses used for functional safety applications typically only provide short circuit protection.

d. The combination of the connecting device and wire termination shall be designed to prevent failure of the connection due to exposure to the environmental conditions over the

expected installation life without any maintenance action. Screwless type clamping units with direct pressure (also known by as CAGE CLAMP®, tension clamp or spring-cage) are an accepted arrangement.

e. Have a connecting device design to make it unlikely that one loose conductor will be able to make a connection to another electrical circuit.

f. Use the connecting device design combined with the conductor termination method to prevent stray conductor strands from causing a connection to another circuit.

22.3. Communications connecting devices

Terminals for communications electrical circuits shall meet the requirements for connecting hardware in accordance with AS/CA S008 *Requirements for customer cabling products*.

Environmental conditions are medium for mechanically active substances (4S2) like dust in accordance with IEC 62498-3.

Connecting hardware shall be protected to prevent failure of data communications due to the ingress of mechanically active substances while in situ or during maintenance action.

Communications connector's hardware shall comply with AS/NZS ISO/IEC 24702 *Telecommunications installations – Generic cabling – Industrial premises* or alternatively AS/NZS 3080 *Information technology – Generic cabling for customer premises (ISO/IEC 11801:2011, MOD)*. Modified connectors that provide additional protection against the environmental conditions to comply with the specified environmental conditions and maintenance arrangement are accepted.

22.4. Disconnect application

Typical application of a disconnect terminal is as a disconnector (isolator) in accordance with AS/NZS IEC 60947.3 *Low voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units*. Utilization category is typically AC 20 or DC 20 or both in accordance with AS/NZS IEC 60947.1 *Low voltage switchgear and controlgear – Part 1: General rules*.

The connecting device for the disconnect function shall be tested for compliance with AS/NZS IEC 60947.3. After compliance testing the device shall meet its original performance requirements.

Leakage current shall be less than 100 µA at 132 V ac when the disconnect function is operated when used in a functional safety application on a nominal voltage of 120 V ac or less.

The disconnected state shall be easily visible from 2 m. The disconnected state shall provide for attaching a label for the reason for disconnection. If the connection part is removable then a storage location shall be provided for the connection part.

Connecting devices with a disconnect function for general application shall be suitable for use in low energy circuits. Conformance for low energy operation of disconnect shall be based on AS/NZS IEC 60947.5.4 *Low voltage switchgear and controlgear – Part 5.4: Control circuit devices and switching elements – Method of assessing in the performance of low energy contacts – Special tests*. The disconnection and reconnection shall be tested using a 1 V dc supply and a 10 kΩ resistor. The current drawn through the connecting device shall not vary by more than ± 10% during the connected time from the average current drawn while performing 100 connect and disconnect cycles.

22.5. Fuse terminals

Fuse terminals shall comply with the general connecting device requirements defined in Section 22.1.

Fuse terminals shall also meet the requirements for fuse terminals in accordance with AS/NZS IEC 60947.7.3 *Low voltage switchgear and controlgear – Part 7.3: Ancillary equipment – Safety requirements for fuse terminal blocks*.

Requirements for fuses are defined in Appendix B of this document.

22.6. Two part arrangements

Two part arrangements (plug and socket) shall be rated for the greater number of both 100 insertions and removals or the likely number of insertions and removals during the expected equipment life.

Two part arrangements shall be rated for disconnect and connect under load conditions unless the design arrangements, operating instructions, maintenance instructions and labelling include turning off the equipment while disconnecting and reconnecting.

Two part arrangements shall meet the conformance test for low energy operation as defined in Section 22.4 unless they comply with a suitable alternative standard or are only for applications using greater than 24 V nominal.

Plug arrangements shall not be able to be broken apart by moderate hand force.

All non-communications two part connectors shall comply with IEC 61984 *Connectors – Safety requirements and tests*.

23. Time

Equipment fitted with time functionality shall support time synchronisation from common source of time and date. The common time source may automatically adjust for daylight savings changes. The equipment shall manage time changes without disruption of any functionality for timing, data recording and event record interrogation. The equipment time shall not require manual adjustment due to drift of an internal time source or daylight savings changes.

Note: Manual adjustments due to abnormal changes to daylight saving dates are accepted.

Internal time sources in the equipment shall drift by < 2 s per day from the actual time when a time source is not available for synchronisation.

24. Work health and safety

The equipment is used in the environment defined in the TfNSW standards. This is the operational context for the operator and maintainer of the rail network. The work health and safety risks for the equipment shall be identified and controlled in this context.

25. Documentation

The supplier shall provide documentation covering the use, maintenance and operation of the equipment. Generic documentation shall be supplemented by specific documentation for TfNSW as required.

Documentation supplied shall be provided in a document file format for display by computer. The document shall be in English language. T MU AM 01005 ST *Asset Handover Requirements* details the documentation required to be supplied.

26. GS1 application

The GS1 specifications provide functions for identify, capture, share and use information about physical and non-physical items.

GS1 Australia and ARA have partnered to produce the document *Implementation Guideline for standardised Identification & Marking of parts and components in the Australian Rail Industry for the application of identify, capture and share functionality in the rail industry*.

Railway specific items shall have the GS1 functions for identify, capture and share applied in accordance the implementation guideline for the rail industry. Other items shall have the GS1 functions for identify, capture and share applied in accordance with GS1 specifications.

Note: Suppliers of existing approved equipment will be contacted to review the practicability of the application of GS1 specifications.

Note: The use of GS1 product recall and traceability functionality is likely to become a requirement for functional safety equipment in a future revision of this document.

27. Spare parts

Spare parts shall be provided in packaging that is suitable for storage and transportation. Spare part packaging shall be suitable to keep the spare part in functional condition in the storage

environment for the expected life of the associated equipment when stored in an environment less severe than 1K5/1Z2/1B2/1C2/1S3/1M3 or IE11 based on IEC 60721-3-1.

The spare part transportation environment is planned to be less severe than 2K2/2B2/2C2/2S2/2M3 or IE22 based on IEC 60721-3-2. Transportation from a logistics location to the usage location may occur in storage packaging. In this case the transportation duration will be less than two hours.

Identification requirements for equipment, spare parts and packaging are detailed in Section 26.

Any maintenance actions required prior to operational use of the spare part shall be fully detailed in the equipment documentation.

28. Through life support

The supplier shall demonstrate the capability to provide the following support during the first 75% of the expected life of the equipment:

a. new or refurbished LRU

b. support tools required by the operational equipment or advise of a suitable supplier of support tools

c. training for users and maintainers

d. support for the disposal or recycling of retired items if the equipment has particular disposal requirements

e. enhance the products to correct identified deficiencies either by incremental improvement or replacement with a product that can be installed during corrective or preventative maintenance activities

f. technical support for onsite maintenance personnel

g. ongoing support for GS1 functionality detailed in Section 26

The supplier shall advise the expected end of support for railway specific equipment two years prior to terminating the support.

In accordance with T MU MD 00005 GU suppliers of railway specific equipment shall advise the equipment type approver of any alterations and RAMS issues identified for the equipment as soon as practical.

The maintenance support contact for the equipment shall be at a location in Australia.

The supplier shall keep records on the repaired items and on the replacement items. The supplier shall on request provide information based on these records so that the performance of the equipment can be assessed.

29. On-line support tools

An on-line support tool is equipment used as part of the operation and in service maintenance of operational equipment.

A lack of availability of this equipment does not directly cause an operational impact but may result in more significant operational impacts if an incident occurs relating to operational equipment. On-line support tools include hardware, software and data.

Control, operation and use of an on-line support tool that can make configuration changes to operational equipment shall be included in the relevant RAMS framework and security framework.

29.1. Computers

Computers for general use as an on-line support tool shall comply with the requirements for COTS equipment defined in this document. Computers are a form of the information technology equipment type detailed in Appendix B.

Computers shall also comply with Section 29.2 if they are used for maintenance at trackside locations.

29.2. Portable equipment

Portable on-line support tools used by installation or maintenance personnel to support the operational equipment shall be designed for the 'transportation' and 'portable and non-stationary use' classes of environmental conditions defined in IEC 60721. The severity condition 2 is typical for the environment.

Usage will occur in the 'portable and non-stationary use' environmental conditions. Short term more severe conditions are expected for one hour twice per year when the equipment is likely to be exposed to rain while being used.

Portable equipment designed to operate without an external power supply shall operate for at least six hours without external power supply.

30. Off-line support tools

An off-line support tool is used as part of the design, testing and configuration of new operational equipment or systems or alteration of existing operational equipment or systems. An off-line support tool can be used as part of a training facility. Non-availability of an off line support tool may delay the introduction changes to the operational railway but not affect the operation of existing railway infrastructure.

Off-line support tools are not deliverable equipment that becomes a maintained asset in the operational railway. They are part of the tools and processes used by an AEO to provide

engineering services under the AEO framework. Therefore off-line support tools are outside the scope of type approval. Any assurance required is provided by the AEO as part of the engineering service provided.

Off-line support tools shall provide all of the facilities required by the AEO to meet their responsibilities under T MU MD 00009 SP *AEO Authorisation Model*.

The AEO using the off-line support tool shall assure that they are appropriate for the AEO to meet the requirements of T MU MD 20001 ST for the engineering service they are providing.

An AEO applies T MU AM 04001 PL *TfNSW Configuration Management Plan* when providing engineering services related to signals and control systems equipment. Off-line support tools shall not prevent an AEO from complying with T MU AM 04001 PL.

The configuration information repository owner and custodian for signals and control systems railway asset configuration information shall be an AEO authorised for the design life cycle of signalling and control systems in engineering services matrix.

Requirements for railway asset configuration information are set by T MU AM 02004 ST *Management of Asset Information*. Off-line support tools shall not prevent the AEO providing the engineering service in compliance with T MU AM 02004 ST.

In addition to complying with T MU `AM 02004 ST the off-line support tools for application data shall include functionality for the following:

a. version management

b. data comparison

c. application data and configuration backup, restore and archive

d. protection from cyber security hazards as defined in Section 21.2

e. import and export data to a format that complies with the RailML format

An off-line support tool shall be available to enable comprehensive testing of the application data and system operation in a factory acceptance test environment. This off-line support tool for testing shall provide a capability to automated repetitive testing activities.

Appendix A EN and IEC standard equivalence

Table 2 identifies the EN standard that is equivalent to an IEC standard with different standard numbers.

Table 2 – EN standard equivalent to an IEC standard

EN standard	IEC standard
EN 50121-4 *Railway applications – Electromagnetic compatibility – Part 4: Emission and immunity of the signalling and telecommunications apparatus*	IEC 62236-4
EN 50124-1 *Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment*	IEC 62497-1
EN 50125-3 *Railway applications – Environmental conditions for equipment – Part 3: Equipment for signalling and telecommunications*	IEC 62498-3
EN 50126-1 *Railway applications – The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) – Part 1: Basic requirements and generic process*	IEC 62278
EN 50128 *Railway applications – Communication, signalling and processing systems – Software for railway control and protection systems*	IEC 62279
EN 50129 *Railway applications – Communication, signalling and processing systems – Safety related electronic systems for signalling*	IEC 62425
EN 50159 *Railway Applications – Communications, signalling and processing systems – Safety related communication in transmission systems*	IEC 62280

Appendix B Equipment types

This appendix details the applicable standards for equipment types commonly used as part of signals and control systems. The applicable standards are supported by requirements for selection and application to the particular equipment type.

B.1. Equipment for installation in danger zone

Equipment to be installed in the danger zone of the rail corridor as defined in SPG 0706 shall comply with requirements for class II electrical equipment. This is part of the risks control measures for electrical traction faults.

The applicable base standard for class II electrical equipment is IEC 61149 *Protection against electric shock – Common aspects for installations and equipment*

B.2. Cable and wire

Signalling cables are specified for their inherent physical properties as part of the functional safety of the signalling system. The other cables and wire are specified for reliability, availability and electrical safety.

The applicable standards for cable and wire are as follows:

- AS/ACIF S008 *Requirements for customer cabling products*
- AS/NZS 5000.1 *Electric cables – Polymeric insulated – For working voltages up to and including 0.6/1 (1.2) kV*
- IEC 60228 *Conductors of insulated cables*
- Military Specification Mil-W-22759 *Wire, electrical, fluoropolymer-insulated, copper or copper alloy*

  Note: MIL-W-22759 is a USA Military specification.
- SPG 1010 *Cables for railway signalling applications – General requirements*

Section B.2.1 through to Section B.2.5 of this specification details the application of the standards.

B.2.1 Internal wire for safety applications

The minimum requirements for internal wire for safety applications are:

- Copper conductor in the range of 0.75 mm² to 1.5 mm².
- Conductor arrangements shall be either class 2 (stranded conductors), class 5 (flexible conductors) in accordance with IEC 60228.

- Conductor strand size ≥ 0.2 mm diameter.
- Overall insulated cable diameter of greater than 1.9 mm (2.6 mm preferred) and less than 3.2 mm.
- Minimum voltage rating of 600 V.
- High temperature rating ≥ 90ºC.
- Provide robust insulation for the cable that can be demonstrated to withstand physical damage and abuse during installation and alteration of wiring.
- Flexible with high abrasion resistance.
- Stable insulation ensuring that movement of insulation away from cable ends is minimal due to environmental and installation factors.
- Normal insulation colour is black with other colours such as white and yellow available.
- Identification markings on the cable insulation.
- Manufactured to a standard.

Two types of internal wire for safety applications have been type approved. The wire types are specified in Section B.2.1.1 and Section B.2.1.2.

Teflon wire is for use in Computer Based Interlocking (CBI) applications. The Teflon wire can also be used for general applications in CBI installations.

The Nylon Jacketed PVC wire is preferred for use in Relay Based interlocking's and can be applied for general use in Computer Based Interlocking installations.

B.2.1.1 Internal wire with PVC insulation and nylon jacket

Internal wire with PVC insulation and a nylon jacket for use as part of railway signalling interlocking's is legacy RailCorp equipment.

Note: Equivalent products will be considered on a cross acceptance basis.

The specific requirements for internal wire with PVC insulation and nylon jacket are as follows:

- The conductor shall consist of 7 x 0.4 mm plain annealed copper conductors.
- The insulation shall be PVC-V90HT with a flame retardant incorporated.
- Voltage rating shall be 0.6/1.0 kV.
- The insulation and nylon jacket shall be considered as a combined insulation.
- The nominal radial thickness of the combined insulation shall not be less than 0.8 mm. However the maximum radial thickness shall be such that the overall diameter of the finished cable, including nylon jacket, does not exceed 3.2 mm at any point.

- The average radial thickness of the nylon jacket shall be 0.15 mm (+0.15 mm, -0.05 mm).
- The formulation of the insulation shall minimise the potential for plasticiser to seep out from the cable ends. The nylon jacket, plus high storage temperatures (up to 80°C) are believed to trigger the seeping of the plasticiser.
- Wire for normal use shall have insulation coloured white or off white (neutral colour), with a black coloured nylon jacket.
- Wire for stage work wiring use shall have insulation coloured yellow, with a clear nylon jacket.
- The wire shall be supplied on drums with nominal length of 1000 m ±10 m.
- Markings shall be in accordance with Specification SPG 1010 *Cables for Railway Signalling Applications – General requirements*. The additional information shall be as follows:
    - The following identification shall be printed on the insulation under the nylon covering, in a size as large as practical, repeated at intervals of not greater than 150 mm.
    - Manufacturer's name or identification, year and RailCorp NSW
    - Example: SKCables Pty Ltd, 1992 RailCorp NSW

B.2.1.2 Internal wire using Teflon insulation

M22759/16-16-000 Wire, ETFE Insulated, 600 V, Medium Weight, Tin Coated Copper Conductors, 150°C, 16 AWG in accordance with USA Military specification Mil-W-22759 is approved for use as wire for the signalling safety system.

The particular wire is rated for 600 V using 19/29 AWG stranded conductors giving a 1.23 mm² cross section area resulting in 15.8 Ω/km resistance.

The wire is also available as black and white twisted pair. Part Mil-W-22759/16-16-0+9 twisted at greater than 15 twists per metre.

B.2.2 General application cable and wire

Cable and wire for general application is COTS equipment. The cable or wire shall have certification to a standard.

Cable and wire for general application shall have a minimum voltage rating of 250 V to earth and 250 V between conductors.

Stranded conductor shall be 0.3 mm² or more. The individual conductor strand size shall be 0.2 mm diameter or more.

Single strand conductor size shall be 0.6 mm diameter (#24 AWG) as part of a multi-conductor cable and 0.9 mm diameter when used as an individual conductor wire.

The environmental conditions detailed in Section 13 can be met with insulation rated for a continuous conductor temperature of 75ºC or higher. Trackside installations should use wire rated for 90ºC temperature or higher. A higher insulation temperature rating will be required if the application increases the insulation temperature beyond its limit given the environmental conditions for the installation.

The typical insulation colour used is light blue. Other colours can be used for special applications.

B.2.3 Equipment specific cable and wire

Some equipment nominates particular cable and wire for use in the installation of the equipment.

Equipment specific cable and wire is approved for use with the particular equipment as part of the type approval of the equipment.

Equipment specific cable and wire detailed in equipment manuals may be used in accordance with the equipment manuals unless restricted by type approval conditions.

B.2.4 Communications cable and wire

Communications cable and wire is COTS equipment.

Cable and wire used for communications applications shall comply with the ACIF requirements when used as part of a telecommunications network as defined in AS/ACIF S008 *Requirements for customer cabling products*.

Cable and wire for data communication links used within an installation that are not in the scope of AS/ACIF S008 shall use cable and wire selected based on either AS/ACIF S008, Section B.2.2 or Section B.2.3 as appropriate to meet requirements in the EMC environment defined in Section 7.

B.2.5 Power conductors for internal use

Power conductors for internal use are COTS equipment for use inside cubicles, shelters, equipment locations or buildings with the environmental conditions defined in Section 13.

Power conductors may be used from power supply to power supply bus, earthing in equipment room or locations, and power supply bus to equipment when fuse is greater than 4 A.

Power conductors for internal use shall comply with AS/NZS 5000.1 for a rated insulation temperature of 90°C or higher.

Single insulated power conductors can be used in ducts, cable trays, conduits, equipment housings, and switchboards.

Power conductors to be installed below floor level, or left exposed shall have additional protection when compared to single insulation. Power cables for external use complying with Section B.2.1 can be used for this application.

Conductor arrangements shall be either class 2 (stranded conductors), class 5 (flexible conductors) or class 6 (flexible conductors which are more flexible than class 5) in accordance with IEC 60228.

Conductor insulation colours should be:

- Red for positive dc power or Bx ac power supply wiring.
- Black for negative dc power or Nx ac power supply wiring.
- Blue can be used for Bx, Nx or both for ac power wiring in an installation. This arrangement should only be used for compatibility with existing installations.
- Green/yellow for earth wiring. Green can be used for installations that cannot use two colour combinations, such as fire safe or fire resistant applications.

B.3. Fuses

This section applies to fuses used as part of the signalling safety system and for other applications in the signals and control system. Fuses are COTS equipment.

The applicable standard for fuses for new applications is IEC 60127-2 *Miniature fuses – Part 2: Cartridge fuse-links.*

Applicable legacy standards for fuses that are in ongoing usage with type approved terminals are as follows:

- DIN 41576-2 *Miniature fuses; indicating cartridge fuse-links 250 V, interchangeable, medium time-lag (M)*

  Note: These fuses are suitable for Weidmuller SAK S1, Wago 282-126 and Pivot Electronics DATT-100 fuse terminals using 25 mm x 5 mm size, 250 V medium time-lag characteristic, with coloured indicating cap.

- Defence standard 59-96 *Fuse links electrical* (part 1 and part 2)

  Note: These fuses are suitable for SAK S3 and Pivot Electronics DATT-101 fuse terminals using 32 mm x 6.35 mm (1 ½" x ¼") size, 440 V medium time-lag characteristic.

  Note: Defence standard 59-96 is a NATO defence standard.

- DIN 49522 *D-type fuse-links D 01, D 02, D 03, 380 V~ 250 V*

  Note: These fuses are suitable for SAK S5 fuse terminal using D 02 size, 400 V ac/250 V dc Neozed.

Fuses and associated fuse holder or base for use as part of the signalling safety system shall be selected based on the following:

a. compliance with applicable standard

b. the requirements in the main part of this document; with particular attention to the following:

   i. Section 8 provision of a human factor control to support the use of the correctly rated fuse in the fuse holder

   ii. Section 22.2 safety application with the exception that the rated breaking capacity of fuse at least twice the nominal voltage of the circuit

   iii. after the fuse has operated then the leakage current is less than the leakage current for a disconnect application detailed in Section 22.4

   iv. Section 22.5 fuse terminals

c. facilities for the maintainer to identify fuse status

d. have a fuse characteristic that causes the fuse to operate before any of the protected circuit and equipment may be damaged due to overcurrent

e. co-ordination with other circuit protection, surge protection and equipment turn-on

f. no self-resetting or self-healing capability

g. minimisation of fuse types to reduce logistics demands and meet mean time to repair (MTTR) targets for signals and control systems

B.4. General relays

This section applies to relays used for non-functional safety applications. Relays for this application are COTS equipment. Historically these relays have been called 'non-vital' relays to identify that they do not provide specific failure modes associated with functional safety.

The applicable standards for relays that do not provide functional safety are as follows:

- IEC 60255 (all parts) *Measuring relays and protection equipment*
- AS/IEC 60947.5.1 *Low-voltage switchgear and controlgear – Control circuit devices and switching elements – Electromechanical control circuit devices*
- IEC 61810 (all parts) *Electromechanical elementary relays*
- IEC 61812-1 *Time relays for industrial and residential use*

Legacy general purpose relays use NEMA terminal numbering. The legacy general purpose relays have a variety of terminal numbering arrangements. Legacy general purpose relay terminal arrangements shall comply with Table 3.

Table 3 – Legacy general purpose relays

Type	Coil	C/O contact 1	C/O contact 2	C/O contact 3
8 pin	2, 7	1 Common 4 NC 3 NO	8 Common 5 NC 6 NO	N/A
11 pin	2, 10	1 Common 5 NC 4 NO	3 Common 7 NC 6 NO	11 Common 8 NC 9 NO

Alternative contact arrangements for legacy general purpose relays shall only be used as spare parts for existing infrastructure.

New relays shall be selected based on the following:

a. compliance with applicable standard for the function to be provided

b. the requirements in the main part of this document

c. particular load considerations in selecting relays are as follows:

   i. load is within minimum switching capacity and maximum switching capacity

   ii. load is energised within the loads limits given the voltage drop on switching elements in the circuit

   iii. switching element OFF state current is at least an order of magnitude less than a current that may energise the load (including any load status indicator) or allow it to remain energised

   iv. A conformance test shall be used to confirm that the relay contact type is suitable for low energy operation. The disconnect application test defined in Section 22.4 can be applied.

   Note: Relays are often used in applications that switch low energy circuits.

   Note: Twin contact (also known as bifurcation) and gold plating of contacts are typically used to improve switching of low energy circuits.

   Note: Wetting current is another term used to characterise operation of contacts in low energy circuits.

d. Energisation duration of dc relays.

   Note: Many signals and control systems applications have relays energised with only occasional de-energisation. Residual magnetism may result in the relay not opening normally open contacts after prolonged energisation.

e. Relays shall be capable of being secured against becoming dislodged due to shock or vibration.

f. Minimise variety of equipment types to support maintainability and logistics for the signalling and control systems as a whole.

g. Relay status indicators having similar on/off characteristics as the relay.

Note: Typical LED indicators can indicate that the relay is energised when is not.

B.5. Surge protection equipment

Surge protection equipment is made up of equipment for lightning protection earthing, and equipment used as surge protection devices.

The applicable standards for surge protection equipment are as follows:

- SPG 0712 *Lightning and Surge Protection requirements*
- AS 7708 *Signalling Earthing and Surge Protection*

  Note: AS 7708 is produced and maintained by RISSB
- IEC 62561 *Lightning protection system components (LPSC)* (all parts)
- IEC 61643-11 *Low-voltage surge protective devices – Part 11: Surge protective devices connected to low-voltage power systems – Requirements and test methods*
- IEC 61643-21 *Low-voltage surge protective devices – Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods*

SPG 0712 sets the system level requirements for the application of the signalling earthing and surge protection.

Surge protection equipment made to superseded standards is now legacy equipment. Legacy surge protection equipment is made up of an arrangement of items mounted on an insulated back plate with specific sizes. Legacy surge protection equipment defined in Section B.5.3 and Section B.5.4 is only required for minor upgrades or replacements as part of existing installations. Legacy surge protection equipment arrangements are not required for new installations.

B.5.1 Earthing equipment

Earthing equipment is COTS equipment. SPG 0712 applies IEC 62561 for lightning protection system components with some application criteria. Earth electrodes, equipotential bonding bars, bonding braids, isolation spark gaps (potential earth clamp), connections, earth enhancing compound and inspection pits are covered by IEC 62561. Lighting protection system components are classified as either class H for heavy duty or class N for normal duty by manufacturer testing in accordance with IEC 62561. Normal duty components are suitable for most applications.

Insulated green/yellow earthing cables shall comply with Section B.2.5.

The applicable standard for earth leakage detector equipment is applied by AS 7708 and by SPG 0712.

The applicable standard for earth resistance testers is applied by SPG 0712.

B.5.2 Surge protection devices

Surge protection devices (SPD) for application on general 230 V ac electrical power as defined in Section 14.6 are COTS equipment. The applicable product standard is IEC 61643-11.

Surge protection devices (SPD) for the communications interfaces on equipment powered from general dc electrical power as defined in Section 14.8 are COTS equipment. The applicable product standard is IEC 61643-21. These SPD shall be applied in accordance SPG 0712.

Surge protection devices for application on signalling 120 V ac electrical power as defined in Section 14.5, signalling dc electrical power as defined in Section 14.7, and signalling equipment input and output ports can have safety related failure modes or multiple devices failures as a result of a single event.

Earth Potential Rise (EPR) due to 50 Hz high voltage faults to earth can damage SPDs. Two different parameters are provided to assess SPD performance in the event of a 50 Hz EPR. SPDs only need to comply with one of the 50 Hz EPR withstand parameters defined in the particular Table 4, Table 5 or Table 6.

Type approval is required for any SPD used as part of the signalling safety system. The applicable standard for type approval of these SPD is SPG 0712 in conjunction with the requirements in this document.

B.5.3 Primary power supply SPD

IVAP and PRF are legacy names for primary power supply surge protection equipment installed at power supply locations. Voltage ratings are for the 120 V ac nominal power supply. Primary electrical power supply surge protection equipment is a multipole SPD that does not include a short-circuiting type SPD for indoor use with fixed mounting in an inaccessible location.

The primary power supply SPD shall have five terminals:

a. 'Line 1' suitable for one external wire of 4 mm² to 95 mm² size

b. 'Line 2' suitable for one external wire of 4 mm² to 95 mm² size

c. 'Equipment 1' suitable for one external wire of 4 mm² to 95 mm² size

d. 'Equipment 2' suitable for one external wire of 4 mm² to 95 mm²size

e. 'Signalling Earth' suitable for one wire of 4 mm² to 16 mm² size

Note: The terminal names for item a through to item e use the legacy naming convention.

Note: Cable sizes up to 95 mm² are in common use. Legacy applications have used cable sizes up to 240 mm². Larger terminals to match the particular application are accepted.

The primary power supply SPD shall be tested to IEC 61643-11 with the following class I and class II performance:

- Suitable for installation on an IT-system of earthing.
- Voltage drop shall be less than 1 V between line and associated equipment terminal at rated current.
- Nominated parameters in accordance with Table 4.
- The test of I_{PE} shall be carried out using the maximum supply voltage defined in Section 14 for the supply applied from Line 1-to-Earth and Line 2-to-Earth. The highest measured current shall be nominated as the performance value.
- The reference voltage (U_{REF}) for the 120 V ac signalling supply is 132 V ac.
- Typical failure modes of components shall not result in increased residual current to earth when measured by means of the I_{PE} test.

  Note: Typical failure modes of voltage-dependent resistors and protective diodes include low resistance. Connection of these devices from any line or equipment terminal to earth does not meet this requirement.

  Note: An earth leakage detector is used to detect power supply faults to earth and initiate the need for corrective action by maintenance.

Table 4 – 120 V ac primary power supply SPD

Protection mode	Parameter	Value
line-to-line	U_C	150 V rms
line-to-line	I_{imp}	≥ 25 kA
line-to-line	I_n	≥ 20 kA
line-to-line	U_P	≤ 0.8 kV
line-to-line	I_{fi}	≥ 500 A
line-to-equipment	I_L	≥ 75 A and ≤ 300 A
either line-to-earth	I_{imp}	≥ 50 kA
either line-to-earth	I_n	≥ 40 kA
either line-to-earth	U_P	≤ 1.5 kV
either line-to-earth	I_{fi}	≥ 100 A
either line-to-earth 50 Hz EPR withstand	U_C	440 V ac

Protection mode	Parameter	Value
either line-to-earth 50 Hz EPR withstand	U_T	≥ 1200 V / 200 ms withstand
either line-to-earth	I_{PE}	< 0.1 mA

Note: Legacy equipment has been approved with U_C 355 V ac for line-to-earth.

Note: Compliance with only one of the 50 Hz EPR withstand parameters is required.

Primary power supply SPD shall meet the physical form and fit as defined in Section 11 or the legacy form factor of the IVAP and PRF equipment.

IVAP and PRFs used a back panel size of 230 mm by 460 mm. Items mounted on the back panel projected no more than 200 mm from the mounting surface. Mounting bolts holes of 8 mm in diameter were located in each of the four corners 20 mm from the edges.

Primary power supply surge SPD shall be capable of replacement in the time defined in Section 9 by a compatible SPD.

B.5.4 Secondary power supply SPD

VAP and VAPL are legacy names of the secondary power supply surge protection. The VAP was a surge protection arrangement with protection modes for each line-to-earth. Line-to-line protection mode was added and the name was changed to VAPL.

The secondary electrical power supply SPD are used for protection of signalling 120 V ac IT power supply. It is intended to be installed at locations that are not the origin of the signalling power supply. Secondary power supply SPD is a multipole SPD with no series impedance that does not include a short-circuiting type SPD for indoor use with fixed mounting in an inaccessible location.

Note: Secondary power supply SPD are typically installed in a location that is remote (> 200 m) from the location with the primary SPD installed.

Secondary power supply SPD shall have three independent terminals:

a. Line 1/Equipment 1 suitable for two external wires of 4 mm² to 16 mm² size

b. Line 2/Equipment 2 suitable for two external wires of 4 mm² to 16 mm² size

c. Signalling earth suitable for one external wire of 4 mm² to 16 mm² size

Note: Line 1 and equipment 1 are directly connected together within the VAP/VAPL. Line 2 and equipment 2 are directly connected together within the VAP/VAPL.

Note: The terminal names for item a to item c use the legacy naming convention.

Secondary power supply SPD shall be tested to IEC 61643-11 with the following class I and class II performance:

- Suitable for installation on an IT-system of earthing.

- Nominated parameters in accordance with Table 5.
- The test of I_{PE} shall be carried out using the maximum supply voltage defined in Section 14 for the supply applied from Line 1-to-Earth and Line 2-to-Earth. The highest measured current shall be nominated as the performance value.
- The reference voltage (U_{REF}) for the 120 V ac signalling supply is 132 V ac.
- Typical failure modes of components shall not result in increased residual current to earth when measured by means of the I_{PE} test.

  Note: Typical failure modes of voltage-dependent resistors and protective diodes include low resistance. Connection of these devices from any line or equipment terminal to earth will not meet this requirement.

  Note: An earth leakage detector is used to detect power supply faults to earth and initiate the need for corrective action by maintenance.

Table 5 – 120 V ac secondary power supply SPD

Protection mode	Parameter	Value
line-to-line	U_C	150 V rms
line-to-line	I_{imp}	≥ 12.5 kA
line-to-line	I_n	≥ 10 kA
line-to-line	U_P	≤ 0.8 kV
line-to-line	I_{fi}	≥ 100 A
line-to-equipment	I_L	≥ 32 A and ≤ 80 A
either line-to-earth	I_{imp}	≥ 25 kA
either line-to-earth	I_n	≥ 20 kA
either line-to-earth	U_P	≤ 1.5 kV
either line-to-earth	I_{fi}	≥ 100 A
either line-to-earth 50 Hz EPR withstand	U_C	440 V ac
either line-to-earth 50 Hz EPR withstand	U_T	≥ 1200 V / 200 ms withstand
either line-to-earth	I_{PE}	< 0.1 mA

Note: Legacy equipment has been approved with U_C 355 V ac for line-to-earth.

Note: Compliance with only one of the 50 Hz EPR withstand parameters is required.

Secondary power supply SPD shall meet the physical form and fit requirements defined in Section 11 or the legacy form factor of the VAP and VAPL equipment.

VAP and VAPL used a back panel size of 190 mm by 130 mm. Items mounted on the back panel projected no more than 200 mm from the mounting surface. Two mounting bolts holes of 6 mm in diameter were located 10 mm from each side and along the midpoint of the 190 mm distance.

Secondary power supply surge SPD shall be capable of replacement in the time defined in Section 9 by a compatible SPD.

B.5.5 Tertiary power supply SPD

Tertiary electrical power supply SPD are used for protection of signalling equipment powered from the signalling IT power supply. The nominal supplies are 120 V ac, 50 V dc, 24 V dc and 12 V dc to 18 V dc (for level crossings).

One port or two port SPD can be used for tertiary protection on the power supply bus or individual signalling equipment after the particular fuse or circuit breaker. Tertiary power supply surge protection equipment should not be short-circuiting type SPD.

Tertiary power supply SPD are for installation on mounting rails as defined in Section 11.2 or on connecting devices defined in Section 22. This will be indoor use with fixed mounting in an inaccessible location.

Tertiary power supply SPD for ac power shall be tested to IEC 61643-11.

Tertiary power supply SPD for dc power shall be tested to either IEC 61643-11 or IEC 61643-21.

Tertiary power supply SPD performance shall meet the following requirements:

- Suitable for installation on an IT-system of earthing.
- One port SPD shall be voltage limiting type.
- One port SPD used on a power supply bus shall have a thermal disconnect and a status indicator.
- Meet the IEC 61643-11 class II and class III performance parameters in accordance with Table 6, Table 7 or Table 8 as applicable. SPD tested to IEC 61643-21 for category C2 that are designed for dc power applications and provide equivalent performance to Table 7 or Table 8 are accepted for those applications. The line to earth parameter only applies when that protection mode is provided by the SPD.

  Note: Two types of SPD are used. The commonly used type does not provide line to earth protection mode and the other type provides line to earth protection mode. Both types provide the line to line protection mode.

  Note: Legacy equipment has been approved with a lower performance values. These values have been aligned to the international standards.
- The I_{PE} test defined in IEC 61643-11 shall be carried out using the maximum supply voltage as defined in Section 14 for the supply applied from Line 1-to-Earth and Line 2-to-Earth. The highest measured current shall be nominated as the performance value.

- The reference voltages (U_{REF}) are 132 V ac for the 120 V ac nominal, 88 V dc (peak) for the 50 V dc and 20 V dc for the 12 V dc to 18 V dc (level crossing).
- Typical failure modes of components shall not result in increased residual current to earth when measured by means of the I_{PE} test.

  Note: Typical failure modes of voltage-dependent resistors and protective diodes include low resistance. Connection of these devices from any other terminal to the earth terminal will not meet this requirement.

  Note: An earth leakage detector is used to detect power supply faults to earth and initiate the need for corrective action by maintenance.

  Note: The SPD with line-to-earth protection mode for use on dc power supplies defined by these requirements are not suitable for applications where a path to a remote earth exists due to the likelihood of damage due to 50 Hz EPR faults.

  Note: The SPD with line-to-earth protection mode for use on dc power supplies defined by these requirements do not provide protection aligned with equipment compliant to AS 61000-6-1 or AS 61000-6-2. Equipment to those standards requires $U_P \leq 0.5$ kV for line-to-earth protection mode.

Table 6 – 120 V ac tertiary power SPD

Protection mode	Parameter	Value
line-to-line	U_C	150 V rms
line-to-equipment	I_L	≥ 6 A and ≤ 32 A
line-to-line	I_n	≥ 5 kA
line-to-line	U_{oc}	≥ 4 kV
line-to-line	U_P	≤ 0.8 kV
either line-to-earth and line-to-line	I_{fi}	≥ 50 A
either line-to-earth	I_n	≥ 10 kA
either line-to-earth	U_{oc}	≥ 6 kV
either line-to-earth	U_P	≤ 1.5 kV
either line-to-earth 50 Hz EPR withstand	U_C	440 V ac
either line-to-earth 50 Hz EPR withstand	U_T	≥ 1200 V / 200 ms withstand
either line-to-earth	I_{PE}	< 0.1 mA

Note: Compliance with only one of the 50 Hz EPR withstand parameters is required.

Table 7 – 50 V dc tertiary power SPD

Protection mode	Parameter	Value
line-to-line	U_C	≥ 75 V ac or ≥ 100 V dc and ≤ 120 V dc
line-to-line	I_n	≥ 2.5 kA
line-to-line	U_{oc}	≥ 2 kV
line-to-line	U_P	≤ 0.4 kV
line-to-equipment	I_L	≥ 4 A and ≤ 20 A
either line-to-earth and line-to-line	I_{fi}	≥ 50 A
either line-to-earth	I_n	≥ 5 kA
either line-to-earth	U_{oc}	≥ 4 kV
either line-to-earth	U_P	≤ 1.5 kV
either line-to-earth	I_{PE}	< 0.1 mA

Note: Table 7 line-to-earth protection mode parameters only apply when that protection mode is provided. Equivalent SPD to IEC 61643-21 for category C2 are accepted as detailed in this section.

Table 8 – 12 V dc to 18 V dc (level crossing) tertiary power SPD

Protection mode	Parameter	Value
line-to-line	U_C	≥ 17 V ac or ≥ 22 V dc and ≤ 36 V dc
line-to-equipment	I_L	≥ 4 A and ≤ 20 A
line-to-line	I_n	≥ 1 kA
line-to-line	U_{oc}	≥ 2 kV
line-to-line	U_P	≤ 0.22 kV
either line-to-earth and line-to-line	I_{fi}	≥ 50 A
either line-to-earth	I_n	≥ 2 kA
either line-to-earth	U_{oc}	≥ 4 kV
either line-to-earth	U_P	≤ 1.5 kV
either line-to-earth	I_{PE}	< 0.1 mA

Note: Table 8 line-to-earth protection mode parameters only apply when that protection mode is provided. Equivalent SPD to IEC 61643-21 for category C2 are accepted as detailed in this section.

B.5.6 Input output port SPD

SPD for input ports, output ports or combined input and output ports of equipment shall comply with IEC 61643-21 and the additional requirements as defined in Section B.5.6.1 and Section B.5.6.2 of this document.

Note: Legacy equipment input and output ports need individual analysis to determine the specific parameters required to protect the port. They are likely to need lower U_P values. The requirements set below assume that the equipment meets IEC 62236-4 or other applicable EMC standard.

B.5.6.1 Safety related requirements for SPD

a. SPD configuration shall be either a two, three, four and five terminal SPD. The multi-terminal SPD configuration defined in IEC 61643-21 shall not be used for circuits that provide functional safety.

   Note: Four-terminal and five-terminal configurations are only for use on the one balanced circuit. Independent functional safety circuits are not to be connected through the one SPD.

b. If the internal arrangement of the SPD is not symmetrical then any additional connection to the common terminal shall be connected to the X2 or Y2 leg of the circuit.

   Note: This allows the single switched circuits to use the X1, Y1 leg of the circuit as the switched leg of the circuit.

c. SPD used for single switched circuits shall not have components from the line terminal or protected terminal used for the switched leg of the circuit to the common terminal that have low resistance as a typical failure mode.

d. SPD used for double switched circuits should not have components from line terminals or protected terminals to the common terminal that have low resistance as a typical failure mode.

   Note: Typical failure modes of voltage-dependent resistors and protective diodes include low resistance.

e. Protection against direct contact from live parts shall be provided irrespective of the SPD's voltage or accessibility.

   Note: This is part of the insulation coordination between independent circuits.

f. The overstressed fault mode shall be either IEC 61643-21 mode 1 or mode 3.

g. Insulation resistance from any line terminal to the common terminal or general earth is > 10 MΩ as measured at U_c.

h. SPD for different functions or performance shall be visually distinctive or physically not compatible to meet the requirement defined in Section 8.

i. The SPD current rating shall meet the requirement defined in Section 22.2.

B.5.6.2 Performance related additional requirements for SPD

The additional requirements related to the performance of the SPD are as follows:

a. An SPD meeting the extended range of service conditions is accepted as meeting the requirements of Section 13 when used in weather protected installations.

b. U_c for digital inputs or outputs should be the same value as used to protect the associated power supply. Refer to Section B.5.5 for values of U_c for commonly used power supplies.

c. U_c for ports other than digital inputs or outputs shall be the value nominated by the protected equipment manufactures requirement.

d. U_P between line terminals shall be < 0.8 kV for both C2 and B2 category waveforms.

e. U_P between any line terminal and common terminal shall be < 1.6 kV for both C2 and B2 category waveforms.

f. Series resistance requirement is based on the particular application.

Note: Typical applications require < 10 Ω loop for a circuit.

g. Capacitance from any line terminal to the common terminal shall be < 1 nF.

Note: A lower value than that specified in AS 7708 is nominated due to the quantity that may be installed on the one power supply.

h. AC durability shall have been tested using 20 A for 1 s with five applications.

i. SPD used on fused circuits shall include current limiting components that can prevent the fuse blowing during normal SPD operation.

B.6. Cable management equipment

Cable management equipment is COTS equipment. Cable management equipment life shall be equal to or greater than the expected life of the installation. The installation life is typically greater than the railway specific equipment life detailed in Section 19.

Cable management equipment that can be regularly exposed to solar radiation shall have evidence that it will meet the expected life with the solar radiation and UV radiation levels as defined in Section 13.

Cable management equipment that is likely to be directly exposed to solar radiation for more than four hours per day shall include measures to limit internal temperature rise due to solar radiation.

Cable management equipment installed outdoors is subject to bushfire risk as defined in T MU EN 00005 ST. Outdoor cable management equipment shall be designed and tested to provide sufficient insulation to protect cabling for up to 30 minutes against the identified bushfire.

The applicable standards for cable management equipment are as follows:

- AS/NZS 2648.1 *Underground marking tape – Non-detectable*
- AS/NZS 4296 *Cable trunking systems* or associated international standard IEC 61084 *Cable trunking and ducting systems for electrical installations*
- AS 4702 *Polymeric cable protection covers*
- AS/IEC 61386 *Conduit systems for cable management* (all parts)

  Note: AS/IEC 61386 is superseding AS 2053.1.
- IEC 61537 *Cable management - cable tray systems and cable ladder systems*

B.7. Uninterruptable power supply

Uninterruptable power supplies are normally provided as part of the electrical discipline infrastructure. The TfNSW electrical discipline standards apply when the UPS is provided as part of the electrical discipline infrastructure.

If an uninterruptable power supply (UPS) is provided as part of the signalling 120 V ac (or derived voltage) power supply then the signals and control systems discipline requirements apply.

The applicable standard for signals and control systems discipline UPS equipment is AS 62040 (all parts) *Uninterruptible power systems (UPS)*.

The signals and control systems discipline additional requirements are as follows:

a. comply with the requirements defined in the other sections of this document

b. have an external bypass arrangement that provides power to the load automatically on complete failure of the UPS or by maintainer operated manual control

c. use replacement of batteries that do not require more than two people for an average of four hours labour every five years for replacement

d. external signalling circuits to provide maintenance information from the UPS shall be provided

B.8. Information technology equipment

General purpose information technology equipment (ITE) is COTS equipment.

The applicable standard for general purpose information technology equipment (ITE) is: AS/NZS 60950.1.

Supporting equipment standards for EMC and environmental performance are as follows:

- AS/NZS CISPR 24 *Information technology equipment – Immunity characteristics – Limits and methods of measurement*
- AS/NZS 61000 (all parts) *Electromagnetic compatibly (EMC)*
- IEC 62236-4 *Railway applications – Electromagnetic compatibility – Part 4: Emission and immunity of the signalling and telecommunications apparatus*
- EN 50121-4 *Railway applications – Electromagnetic compatibility – Part 4: Emission and immunity of the signalling and telecommunications apparatus*
- IEC 62498-3 *Railway applications – Environmental conditions for equipment – Part 3: Equipment for signalling and telecommunications*
- EN 50125-3 *Railway applications – Environmental conditions for equipment – Part 3: Equipment for signalling and telecommunications*
- IEC 60721 (all parts) *Classification of environmental conditions*

AS/NZS 60950.1 only covers safety aspects of information technology equipment. ITE functional requirements are outside the scope of this document and AS/NZS 60950.1. The AEO selects ITE COTS equipment to meet the requirements for the engineering service being provided under the particular procurement contract.

ITE COTS equipment for signals and control systems applications is considered for use based on its power supply arrangement.

ITE COTS equipment for use on general 230 V ac or general dc power supply can be accepted as compliant with the requirements in Section 5 to through to Section 19 and Section 22 based on the following:

a. a regulatory compliance mark (RCM) on the equipment

b. a quality assurance statement from the manufacture

c. a statement of compliance with AS 60950.1 or one of the other equivalent standards based on IEC 60950.1

d. a manufacture's statement that the equipment's MTBF is greater than that specified in Section 6 item a or item b as applicable for the application

e. the equipment does not have a high leakage current to earth disclosed in the equipment manual or installation instructions

f. EMC immunity test certification to AS/NZS CISPR 24 or AS/NZS 61000-6-1 or AS/NZS 61000-6-2 or IEC 62236-4 or EN 50121-4

g. evidence of compliance with either IEC 62498-3 or EN 50125-3 or IEC 60721 for the environment in which the equipment is to be installed in

h. power-on, resumption, interruption functionality in accordance with Section 14.2

i. either, only for use in an installation that is protected from voltage dips and interruptions or ac powered equipment is supported by evidence that meets AS/NZS 61000.6.2 with the amendments given in Section 14.1

ITE COTS equipment for use on signalling 120 V ac or signalling dc power supply can be accepted as compliant with the requirements in Section 5 through to Section 19 and Section 22 based on the following:

j. meeting item a through to item i

k. the equipment is confirmed as suitable for use on an IT power distribution system in the equipment installation instructions if it is to be powered from a signalling ac or dc power supply

l. communication ports and other non-power ports meet the 1.5 kV electrical strength to earth test requirement detailed in Section 15

m. either the ac powered equipment is supported by evidence that it is immune from the power supply variation and interruptions detailed in Section 14.5 or is only for use in an installation that is protected from voltage dips and interruptions

n. evidence that ac powered equipment meets test class 3 for AS 61000.4.13 or is inherently immune from these harmonics or only for use in an installation that limits the harmonics to less than AS 61000.4.13 test class 2 levels

o. specific tests given in Section 14.5 or Section 14.7 as appropriate