TS 05258:2.0

T HR SC 01000 SP

Specification

Common Signals and Control Systems Equipment Requirements

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Document information

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Document history

Revision	Effective date	Summary of changes
1.0	29/03/2017	First issue as T HR SC 01000 SP.
2.0	1/11/2018	Second issue as T HR SC 01000 SP.
1.0	19/11/2024	Renumbered as TS 05258:1.0. Version number recommenced in line with new designation. Changes to previous content include cyber security requirements and COTS products, clarification of non-railway specific equipment requirements, and applicable ESG 008 requirements moved to this standard.
2.0	23/06/2025	Removal and transfer to TS 05268 Cables for Railway Signalling Applications – General Requirements of B2 internal wire for safety applications.

Preface

This specification is a second issue as TS 05258.

This document contains generic common signalling and control systems 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. Requirements detailed in this document are based on Australian standards and international standards which provide the primary basis for the equipment requirements.

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 generic common signals and control systems requirements are consolidated in this document and are applicable to all signalling and control system equipment. But the specific equipment specification can alter the requirements specified in this document. If not specified, the requirements specified in this document are the default requirements.

The site-specific application of the equipment is not part of this document.

The particular meaning of the word ‘equipment’ for this document is defined in the terms, definitions and abbreviations section. In general, railway specific equipment performs safety related functions, whereas non-railway specific equipment does not.

The terms ‘normative’ and ‘informative’ are used in asset standards to define the application of the appendices to which they apply. A ‘normative’ appendix is an integral part of an asset standard, whereas an ‘informative’ appendix is only for information and guidance.

The change from the previous version is internal wire for safety applications (single core wire) has been removed from Appendix B to TS 05268 (a consolidated standard for signal cables which covers internal wire).

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1 Scope

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

This document specifies the set of generic common requirements for all signals and control systems equipment and its installation arrangements for the heavy rail transport mode.

This document covers the requirements for all asset life cycle phases.

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

2 Application

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

A specific equipment specification can override or alter the generic requirements specified in this document. If the requirements detailed in this document are not covered within the specific equipment specification, the requirements specified in this document are assumed the default requirements.

If the requirements specified in this document cannot be fulfilled or innovative equipment is developed before the equipment is standardised the process detailed in TS 00003.1 is applicable.

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

This document does not cover non-compliant equipment or installation which is already at the site and used for the like-for-like replacement. In this case, the process detailed in TS 00004.1 is applicable.

This document does not cover equipment or product using cloud hosting or cloud storage.

3 Referenced 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

CLC/TS 50701 *Railway applications – Cybersecurity*

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

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

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

EN 50022 (withdrawn) *Low Voltage Switchgear And Controlgear For Industrial Use – Mounting Rails – Top Hat Rails 35mm Wide For Snap-On Mounting Of Equipment*

EN 50121-4 *Railway applications – Electromagnetic compatibility – Part 4: Emission and immunity of the signalling and telecommunications apparatus*

EN 50124-1 *Railway applications – Insulation coordination – Part 1: Basic requirements – Clearances and creepage distances for all electrical and electronic equipment*

EN 50125-3 *Railway applications – Environmental conditions for equipment – Part 3: Equipment for signalling and telecommunications*

EN 50126-1 *Railway applications – The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) – Part 1: Generic RAMS process*

EN 50128 *Railway applications – Communication, signalling and processing systems – Software for railway control and protection systems*

EN 50129 *Railway applications – Communication, signalling and processing systems – Safety related electronic systems for signalling*

EN 50159 *Railway Applications – Communication, signalling and processing systems – Safety-related communication in transmission systems*

EN 62264-1 *Enterprise-control system integration – Part 1: Models and terminology*

IEC 60050-161 *International Electrotechnical Vocabulary (IEV) – Part 161: Electromagnetic compatibility*

IEC 60050-192 *International Electrotechnical Vocabulary (IEV) – Part 192: Dependability*

IEC 60050-351 *International Electrotechnical Vocabulary (IEV) – Part 351: Control technology*

IEC 60127-2 *Miniature fuses – Part 2: Cartridge fuse-links*

IEC 60228 *Conductors of insulated cables*

IEC 60255 (all parts) *Measuring relays and protection equipment*

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 supply systems – Part 1: Principles, requirements and tests*

IEC 60715 *Dimensions of low-voltage switchgear and controlgear – Standardized mounting on rails for mechanical support of switchgear, controlgear and accessories*

IEC 60721 (all parts) *Classification of environmental conditions*

IEC 60721-3-1 *Classification of environmental conditions – Part 3-1: Classification of groups of environmental parameters and their severities – Storage*

IEC 60721-3-2 *Classification of environmental conditions – Part 3-2: Classification of groups of environmental parameters and their severities – Transportation and handling*

IEC 61084 (all parts) *Cable trunking systems and cable ducting systems for electrical installations*

IEC 61140 *Protection against electric shock – Common aspects for installations and equipment*

IEC 61537 *Cable management – Cable tray systems and cable ladder systems*

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*

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

IEC 61810 (all parts) *Electromechanical elementary relays*

IEC 61812-1 *Time relays and coupling relays for industrial and residential use*

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 – Communication, 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 62561 (all parts) *Lightning protection system components (LPSC)*

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

ISO 22163 *Railway applications – Railway quality management system – ISO 9001:2015 and specific requirements for application in the railway sector*

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*

Australian standards

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

AS 4702 *Polymeric cable protection covers*

AS 7702 *Rail Equipment Type Approval*

AS 11801.1 *Information technology – Generic cabling for customer premises Part 1: General requirements (ISO/IEC 11801-1:2017, MOD)*

AS 11801.2 *Information technology – Generic cabling for customer premises Part 2: Office premises (ISO/IEC 11801-2:2017, MOD)*

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

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

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 IEC 60990:2018 *Methods of measurement of touch current and protective conductor current*

AS/NZS 2648.1 *Underground marking tape – Part 1: Non-detectable tape*

AS/NZS 3820 *Essential safety requirements for electrical equipment*

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

AS/NZS 4296 *Cable trunking systems*

AS/NZS 5000.1 *Electric cables – Polymeric insulated – Part 1: For working voltages up to and including 0.6/1 (1.2) kV*

AS/NZS 60947.1 *Low-voltage switchgear and controlgear Part 1: General rules (IEC 60947-1:2020 (ED. 6.0) MOD)*

AS/NZS 61000 (all parts) *Electromagnetic compatibility (EMC)*

AS/NZS 61000.4.11 *Electromagnetic compatibility (EMC) – Part 4.11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests (IEC 61000-4-11, Ed. 2.0 (2004) MOD) (Reconfirmed 2016)*

AS/NZS 61000.6.1 *Electromagnetic compatibility (EMC) – Part 6.1: Generic standards – Immunity for residential, commercial and light industrial environments*

AS/NZS 61000.6.2:2022 *Electromagnetic compatibility (EMC) – Part 6.2: Generic standards – Immunity standard for industrial environments (IEC 61000-6-2:2016 RLV (ED. 3.0) MOD)*

AS/NZS 61386 (all parts) *Conduit systems for cable management*

AS/NZS 62368.1 *Audio/video, information and communication technology equipment – Part 1: Safety requirements (IEC 62368-1:2018 (ED. 3.0), MOD)*

AS/NZS CISPR 24 *Information technology equipment – Immunity characteristics – Limit and methods of measurement*

AS/NZS IEC 60947.5.1 *Low-voltage switchgear and controlgear – Control circuit devices and switching elements – Electromechanical control circuit devices*

AS/NZS IEC 60947.5.4 *Low-voltage switchgear and controlgear – Part 5.4: Control circuit devices and switching elements – Method of assessing 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 IEC 61000.2.2 *Electromagnetic compatibility (EMC) – Part 2.2: Environment – Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems*

AS/NZS IEC 61000.4.13 *Electromagnetic compatibility (EMC) – Part 4.13: Testing and measurement techniques – Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests*

AS/NZS IEC 61000.6.7 *Electromagnetic compatibility (EMC) – Part 6.7: Generic standards – Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations*

AS/NZS ISO 9001 *Quality management systems – Requirements*

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

AS/NZS ISO/IEC 27001 *Information security, cybersecurity and privacy protection – Information security management systems – Requirements*

AS/NZS ISO/IEC 27002 *Information security, cybersecurity and privacy protection – Information security controls*

AS/RISSB 7708 *Signalling Earthing and Surge Protection*

AS/RISSB 7722 *EMC Management*

Transport for NSW standards

TS 00003.1 *Concessions to Transport Standards Part 1 – Concession Procedure*

TS 00004.1 *Nonconformances to Transport Standards Part 1 – Nonconformance Process*

TS 00026 *Ambient Environmental Conditions*

TS 00031.1 *OT10 Threat-Based Cyber Security Controls – Part 1: Controls and Implementation Requirements*

TS 00096 *Redundant or Staged Signalling Assets Management Requirements*

TS 00123 *Signals and Control Systems Register of Type Approved Products*

TS 01471 (T MU AM 06006 ST) *Systems Engineering* (standard)

TS 01505 (T MU AM 01001 ST) *Life Cycle Costing*

TS 01508 *Asset Handover Requirements*

TS 01515.1 *Asset Information – Part 1: Management of Asset Information*

TS 03739 (T HR EL 00001 TI) *RailCorp Electrical System General Description*

TS 04978 (T MU HF 00001 ST) *Human Factors Integration – General Requirements*

TS 04981 *System Safety Standard for New or Altered Assets*

TS 04990 (T MU SY 10010 ST) *Cybersecurity for IACS – Overview*

TS 04991 (T MU SY 10012 ST) *Cybersecurity for IACS – Baseline Technical Cybersecurity System Requirements and Countermeasures*

TS 04992 *Surface Transport Fixed Infrastructure Physical Security Standard* (available on request from standards@transport.nsw.gov.au)

TS 04993 (T MU SY 10013 PR) *Cybersecurity for IACS – Cyber Risk Management Procedure*

TS 05165 *Installation of Trackside Equipment*

TS 05166 *Installation of Equipment Racks and Termination of Cables and Wiring*

TS 05167 (SPG 0708) *Small Buildings and Location Cases*

TS 05169 (SPG 0712) *Lightning and Surge Protection requirements*

TS 05268 *Cables for Railway Signalling Applications*

TS 05368 (T HR SC 02000 ST) *Mandatory Requirements for Signalling Safeworking Procedures*

TS 05377 *Telecommunication Transmission Systems for Signalling and Control Systems*

TS 06178 (T MU MD 00005 GU) *Type Approval of Products*

TS 06208 *Time Synchronisation of Industrial Automation and Control Systems*

Legislation

Gas and Electricity (Consumer Safety) Act 2017 (NSW)

Protection of the Environment Operations (Noise Control) Regulation 2008 (NSW)

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

Rail Safety National Law (NSW) 2012 (NSW)

Work Health and Safety Act 2011 (NSW)

Other referenced 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)

National Transport Commission, *Australian Dangerous Goods Code*

State Archives and Records Authority of New South Wales, *Functional Retention and Disposal Authority: FA403*

4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations 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)

AMB Asset Management Branch

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

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

FMECA failure mode, effects, and criticality analysis

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)

IVAP inductor/varistor/arrestor panel

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

OTE operational technology 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

PRF primary rail filter

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

SIL safety integrity Level

SPD surge protection device

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

TAO Technically Assured Organisation

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

UPS uninterruptable power supply

WHS work health and safety

5 General requirements

5.1 Lifecycle management

The requirements set in TS 01471 and TS 04981 shall be applicable for whole equipment life cycle.

TS 00003.1 shall be applicable when equipment can not comply with the requirements set in this specification.

TS 00096 shall be applicable when the equipment becomes redundant or needs to be disposed or is part of the staged deployment process.

5.2 Quality management

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

Railway specific equipment should either be produced in accordance with ISO 22163 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 22163.

5.3 Type approvals

All railway specific and non-railway specific signalling and control systems equipment detailed in this document shall be type approved as detailed in TS 06178, which is based on AS 7702.

Equipment requiring type approval shall be identified during the planning or design stage of the asset life cycle. The equipment type approval shall include the harmonisation and interoperability assessments detailed in AS 7702, applicable TfNSW policies and frameworks, as well as TfNSW's asset management requirements.

The type approval shall comply with the processes detailed in TS 06178 and AS 7702. Artefacts used as type approval supporting evidence should be the outcomes of the applicable system and safety engineering processes.

Normally type approvals are generic product type approvals. In order to use the type approved equipment in the operational network, a site-specific system assurance report shall be generated. This report shall be based on the site-specific functional, operational, performance, human factor, maintenance, and cyber requirements as well as hazards and conditions.

If an equipment is part of the system and the system needs to be type approved, the individual equipment does not need to be type approved, but the equipment shall be part of the system

configuration. As such, if there are any equipment configuration changes, the system level type approval shall be updated as a variation or the system assurance shall be updated. The individual equipment type approved as part of the system shall not be used in other configurations or systems unless there is a site-specific assurance for the new configuration or an update to the existing system level type approval so that it includes the new configuration.

If the configuration of operational equipment is changed and there is no equipment type approval, the equipment shall be type approved based on its grandfather rights as detailed in AS 7702. Otherwise, the existing type approval shall be updated according to the changed configuration.

Note: TS 00123 lists all type approved signals and control system equipment and their certificates.

5.4 Categorisation of equipment

The signalling and control system equipment and its components shall be classed as ‘industrial automation and control systems’ in line with IEC 62443 (all parts). This classification shall apply to all signalling and control systems components whether located remotely or in the cloud hosting or cloud storage.

The signalling and control system equipment and its components shall be classed as a level 1 or a level 2 or a level 3 system according to EN 62264-1.

Note: As detailed in IEC 62279, the safety is assigned to a function with a safety integrity level (SIL), not to the equipment or (sub)system. It is also possible that the safety function can be performed on more than one piece of equipment. If the equipment performs a safety function as detailed in Section 6, it is recommended to refrain from denoting the equipment or function as ‘vital’ since this concept is not part of the international standards referenced in this document. Similarly, if the equipment or (sub)system does not perform a safety function as detailed in Section 6, it is recommended to refrain from denoting the equipment or function as ‘non-vital.’

If they are used, ‘vital’ is assumed equivalent to SIL 4 and ‘non-vital’ is assumed equivalent to ’basic integrity’, which has been called SIL 0 previously.

6 Reliability availability maintainability safety (RAMS)

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

- IEC 62278
- IEC 62279
- IEC 62425.

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), if it is identified that an ISA is required.

> Note: The generic safety case and generic application safety case ISA is not required to be a TAO 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 RAMS targets.

Non-railway specific equipment that provides functional safety shall comply with AS 61508 (all parts) or the appropriate product specific safety standard. It is also acceptable if the non-railway specific equipment complies IEC 62278.

Non-railway specific equipment application shall be supported by evidence of reliability and maintainability based on AS IEC 60300 (all parts) or an equivalent standard. Equipment reliability and maintainability performance shall be defined. System safety of non-railway specific equipment is managed as part of the safety assurance provided by the TAO or Asset Steward for new or altered assets in accordance with TS 04981.

Individual equipment 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 that 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. The common cause failures and single point failures shall be identified and eliminated or mitigated.

d. Individual components shall fail less frequently than the failure rate defined in IEC 61709 or an equivalent component reliability database.

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

f. 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.

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

h. 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.

i. 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.

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

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

If the equipment has no allocated safety functions, the integrity of the equipment and allocated functions shall be based on IEC 62278 requirements identified as ‘Basic Integrity’.

Note: As detailed in IEC 62278, the reliability assessment should include ‘all possible system failure modes in the specified application and environment’ and safety assessment should include ‘all system failure modes that could lead to a hazard’. These failure modes should include random failures as well as systematic failures of ‘ready to use software’ as detailed in Section 18.

7 Electromagnetic compatibility (EMC)

The electromagnetic compatibility (EMC) shall be in compliance with AS 7722. All recommendations by AS 7722 for the application of a standard to manage an issue shall be complied with. 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 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.

TS 03739 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. If this occurs, the equipment shall not create hazardous situations.

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 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 magnetic 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 TS 05368.

Specific EMC requirements for the electric power interface to the equipment are defined in Section 12 of this specification.

8 Human factors

The human factors shall comply with TS 04978. 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 Physical form and fit

9.1 General

The equipment is installed in the arrangements as defined in TS 05165 and TS 05166. Buildings and locations that house equipment are defined in TS 05167.

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 19.

The type approval requirements detailed in Section 5.3 are applicable.

9.2 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 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 17 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 as specified in Section 10.

9.3 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 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.

Twist is a common issue that exists with TH 35 rail. Risks related to twist impacting the mounting of equipment on the rail shall be assessed with mitigating controls put in place.

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). The integrated equipment and 19 inch racking shall comply with IEC 60297.

10 Regulatory compliance

To meet obligations under the *Gas and Electricity (Consumer Safety) Act 2017* and related fact sheets, the following process shall be followed:

- Any equipment which is identified as ‘declared articles’ as detailed in the Act, shall have ‘electrical safety approval mark’.
- Any equipment which is identified as ‘non-declared articles’:
    - The supplier or contractor shall provide evidence that the equipment is safe to use. The supplier or contractor shall comply with minimum safety requirements as set out in the Act and the requirements of selected clauses of Australian and New Zealand standard AS/NZS 3820.
    - If the CE mark is used, there shall be a gap analysis conducted against the minimum safety requirements. This shall include required mitigations and competencies, if there are discrepancies.

    Note: The *Gas and Electricity (Consumer Safety) Act 2017* covers consumer safety in relation to gas and electrical products and services.

As a guideline, most of the signalling and control systems related equipment are used for the enterprise and they are not used by the customer directly. Thus, they can be identified as ‘non-declared articles.’

To meet obligations 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.

The following laws are applicable to all equipment:

- *Rail Safety National Law (NSW) 2012*
- *Work and Health Safety Act 2011* as detailed in Section 22.

11 Environmental conditions

The ambient environment conditions are detailed in TS 00026. 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 with the following specific clarifications for the Sydney area:

a. The conditions detailed in TS 00026 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. Pollution in tunnel environments is high (3S3/4S3) for mechanical active substances.

d. Vibration and shocks for equipment installed more than 3 m from the rail which is measured from the toe of the nearest sleeper to the nearest edge of the location case or equipment housing for stand alone equipment, shall be assumed as negligible. Equipment installed less than 3 m from the rail shall comply with the vibration and shock requirements detailed in IEC 62498-3.

e. 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 TS 05167 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.

Non-railway specific 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 TS 01505.

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

Table 1 – Typical parameters for non-railway specific equipment

Parameter	Value
Use	Stationary
Location	Weather protected
Summary of classes	3K5/3B2/3C2/3S2/3M2
Duration of use	In accordance with Section 17
Duration of significant vibration	One week in a year
Maximum duration of significant vibrations	Eight hours
Number of significant shocks	Once in 24 hours

The flora and fauna where equipment will be used, shall be considered and all identified risk mitigated. 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.

12 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.

12.1 All equipment

The equipment's electrical power interface shall comply with AS/NZS 62368.1 for the power distribution system that it is to be connected to or the equivalent applicable product standard that covers product safety requirements.

As a default, none of the signalling and control system equipment shall have high leakage current or high touch current accordance with AS/NZS 62368.1. If a requirement can be only fulfilled with the equipment which has high leakage current or high touch current, the equipment shall be labelled for 'high leakage current' or 'high touch current' based on an assessment in accordance with AS/NZS 62368.1, and all required mitigations identified and implemented. 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 61000.6.2.2022. 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/NZS IEC 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/NZS IEC 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/NZS 61000 (all parts).

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.

For 120 V ac power distribution, the minimum over current protective device shall be no less than 20 A with a type C circuit breaker trip curve.

12.2 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.

12.3 Railway specific equipment

Railway specific equipment shall comply with IEC 62497-1.

Overvoltage design shall at least meet OV2 for circuits internal to equipment housings and OV3 for circuits that can run external to equipment housings. Equipment shall be rated to meet the pollution degree (PD) of the environment the equipment is expected to operate in. An assessment of the environment shall be conducted to determine the PD level as described in IEC 62497.

Where an assessment cannot be conducted, then the environment shall be considered to be as follows at minimum:

- PD3 for equipment used indoor
- PD4A for equipment used outdoor
- PD4A for equipment used in a tunnel environment (indoor or outdoor).

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, which is 200 milliseconds. Compliance shall be tested in accordance with AS/NZS 61000.4.11.

12.4 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.

12.5 Signalling 120 V ac

Signalling 120 V ac 50 Hz uses the IEC 60364 (all parts) 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.

1. insulation resistance to earth > 100 MΩ at 500 V dc (both legs of two wire supply)
2. 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 IEC 60990:2018. 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 IEC 60990:2018 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.

12.6 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.

12.7 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.

12.8 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.

13 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 19.

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 62368.1 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 than 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.

All transmission systems shall comply with the requirements detailed in Section 19.

14 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.

15 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.

16 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.

17 Equipment life

Railway specific equipment shall have a minimum operational life of 20 years after its commissioning in the defined environment unless justified by a life cycle costing process as stated in TS 01505.

Non-railway specific equipment life shall be assessed based on the installed environment, usage, and proposed maintenance. If the expected equipment life is less than 10 years after its commissioning in the proposed environmental conditions then this shall be justified by life cycle costing in accordance with TS 01505.

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.

If the equipment life is smaller than the design life of the system, the total cost of the system shall include the upgrade of the equipment into the life cycle costing in accordance with TS 01505.

18 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) such as device drivers, operating system, 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.

All failures of ‘ready use software’ components shall be included into the equipment or system reliability assessments such as FMECA. These failures should only be considered if they affect the equipment or system RAMS directly, such as crashes or unplanned shutdowns due to software issues. If such data is not available, nature of failures, consequences and rates can be estimated and used based on industry acceptable evidence by competent technical experts.

19 Security

19.1 Physical security

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

A risk-based analysis shall be performed to prevent, detect, and respond to any vulnerabilities and threats to the equipment, as required by TS 04992.

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 signalling and control equipment specific requirements:

- 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. After testing, the equipment shall be operational and not present a hazard to health and safety or the environment.
- 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.
- Equipment open to direct access is normally locked by an electronic or key padlock provided by the RIM.
    - If the padlock is the key padlock, 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.

- If the padlock is the electronic padlock, its requirements will be set by the RIM which should be similar to the existing key padlock's requirements if they exist. The electronic padlock shall comply with the cyber security requirements detailed in Section 19.2.

- Tests to confirm the effectiveness of the apportioned equipment's physical security requirements shall be verified by physical test, by detailed analysis, or detailed simulation on the installed arrangement. This shall be part of the type approval process.

19.2 Cyber security

Normally, a system contains more than one equipment and all system requirements including the cyber security requirements are apportioned to each equipment. Thus, each individual equipment may not fulfil all cyber security requirements detailed within the standards listed in this section. But the equipment shall comply with all apportioned cyber security requirements within the system which the equipment is part of.

If the equipment is part of the system which does not fully comply with the cyber security requirements, such as legacy systems, the apportioned cyber security requirements for the equipment shall be based on the fully cyber security compliant system's cyber security requirements, not based on the legacy system.

The signalling and control system equipment shall comply with the following cyber security standards:

- TS 04990
- TS 04991
- TS 04993
- TS 00031.1.

The signalling and control system equipment shall also comply with CLC/TS 50701 which integrates and fully complies with IEC 62443 (all parts) and IEC 62280 for the rail applications.

19.3 Transmission systems

The transmission systems connected to signalling and control system equipment shall be assessed as detailed in TS 05377. If there is no such assessment, the transmission system shall be assumed as 'category 3 and open transmission system' and there shall be risk analysis in order to determine the required mitigations.

Diversity and redundancy of the transmission systems connected to signalling and control system equipment shall comply the requirements specified in TS 05377.

20 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.

20.1 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.

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 20.2) 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. For example, directly connecting terminals to a supply transformer should meet the requirements of overvoltage category IV.

If the overvoltage category is not identified, then it shall meet the minimum requirements of category IV unless assessed otherwise.

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. Where it is identified that connecting devices present a risk of electric shock due to accidental contact, then the connecting device shall comply with IP2X in accordance with AS 60529.

When assessing the risk, consider factors such as but not limited to the following:

- physical separation between different voltage potentials
- accessibility
- barriers
- enclosures.

  Note: Extra low voltage circuits do not require touch protection.

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.

20.2 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 2 (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 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.

20.3 Communications connecting devices

Terminals for communications electrical circuits shall meet the requirements for connecting hardware in accordance with AS/CA S008.

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 or alternatively AS 11801.1 and AS 11801.2. Modified connectors that provide additional protection against the environmental conditions to comply with the specified environmental conditions and maintenance arrangement may be used.

20.4 Disconnect application

Typical application of a disconnect terminal is as a disconnector (isolator) in accordance with AS 60947.3. Utilization category is typically AC 20 or DC 20 or both in accordance with AS/NZS 60947.1.

The connecting device for the disconnect function shall be tested for compliance with AS 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. 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.

20.5 Fuse terminals

Fuse terminals shall comply with the general connecting device requirements defined in Section 20.1.

Fuse terminals shall meet the requirements for fuse terminals in accordance with AS/NZS IEC 60947.7.3.

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

20.6 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 20.4 unless they comply with a suitable alternative standard or are only for applications using less than or equal to 24 V nominal.

Plug arrangements shall not be able to be unintendedly disconnected by moderate hand force.

All non-communications two part connectors shall comply with IEC 61984.

21 Time

Equipment fitted with time functionality shall support time synchronisation from common source of time and date as detailed in TS 06208. 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 regardless of whether the common time source automatically adjusts for daylight savings changes or not.

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

A drift in the internal time sources for equipment shall not exceed 2 seconds per day from actual time when a common time source is not available for synchronisation.

22 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.

23 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. TS 01508 details the documentation required to be supplied.

24 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.

25 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 24.

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

26 Through life support

26.1 General

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. product enhancement 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 24

h. cyber security support

i. tools to support analysis of logs and failures.

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

In accordance with TS 06178 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.

26.2 Updates

The supplier shall have a mechanism to inform TfNSW in 14 calendar days when:

- new field notices are available
- existing field notices are updated or removed
- new patches or software or firmware versions are available for update
- new or updated equipment configurations are available including maintenance plans.

26.3 Logging and storage

The equipment shall have capability to generate adequate event logs and alarms for analysis, training, maintenance, and juridical purposes. Generated events and alarms shall be stored for the period of time mandated by State Archives and Records Authority of New South Wales, *Functional Retention and Disposal Authority: FA403* . If the equipment can not fulfil the mandated storage period, there shall be a mechanism to store the logged information externally for the mandated period. The integrity of creation of the event and alarms as well as the stored logs shall be assured.

27 On-line support tools

27.1 General

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 can result in more significant operational impacts if an incident occurs relating to operational equipment. On-line support tools include hardware, software, and data. On-line support tools shall be part the scope of type approval.

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

All local and remote access equipment shall comply with the security requirements detailed in Section 19.

All operational technology equipment such as computers, servers shall have a defined, tested, and approved standard operating environment which shall be managed according to the configuration and change management principles.

27.2 Computers

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

Computers shall also comply with Section 27.3 if they are used for maintenance at trackside locations.

27.3 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.

Portable equipment usage shall be based on environmental condition as described as ‘portable and non-stationary use’ as defined in IEC 60721.

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

28 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 of changes to the operational railway but shall not immediately affect the operation of existing railway infrastructure. The usage and outcomes of offline tools can impact on the future safety, performance, and operations of systems. Thus, offline tools shall be considered and be part of the system and safety assurance process. An offline tool might not require type approval based on the assurance content and coverage.

All local and remote access equipment shall comply with the security requirements detailed in Section 19.

In addition to complying with TS 01515.1, the off-line support tools for application data shall include functionality for the following:

a. version and configuration management

b. data and configuration comparison

c. application data and configuration backup, restore, and archive

d. protection from cyber security hazards as defined in Section 19.2

e. import and export data to a format that complies with the acceptable international standards format such as RailML.

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. The off-line support tool for testing shall provide a capability to automate repetitive testing activities.

Appendix A EN and IEC standard equivalence (normative)

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: Generic RAMS 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 (normative)

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 TS 05165 shall comply with requirements for class II electrical equipment. This is part of the risk control measures for electrical traction faults.

The applicable base standard for class II electrical equipment shall be IEC 61140 as well as within the relevant equipment standards.

B.2 Cable and wire

B.2.1 Rail signalling specific cable and wire

Requirements for cable and wire for railway signal applications are set out in TS 05268. Cable and wire forms part of the rail safety system.

B.2.2 General application cable and wire

Cable and wire for general application is non-railway specific 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 in cross-sectional area. 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 11 can be met with insulation rated for a continuous conductor temperature of 75°C or higher. Trackside installations should use wire rated for 90°C temperature or higher. A higher insulation temperature rating shall be used 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 non-railway specific 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/CA S008.

Cable and wire for data communication links used within an installation that are not in the scope of AS/CA S008 shall use cable and wire selected based on either AS/CA 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 non-railway specific equipment for use inside cubicles, shelters, equipment locations, or buildings with the environmental conditions defined in Section 11.

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 may 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 TS 05268 may 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 non-railway specific equipment.

The applicable standard for fuses for new applications is IEC 60127-2.

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:

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

2. Section 20.2 safety application with the exception that the rated breaking capacity of fuse be at least twice the nominal voltage of the circuit
3. after the fuse has operated then the leakage current is less than the leakage current for a disconnect application detailed in Section 20.4
4. Section 20.5 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 non-railway specific 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)
- AS/NZS IEC 60947.5.1
- IEC 61810 (all parts)
- 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:

    1. The load is within minimum switching capacity and maximum switching capacity.

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

    3. 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.

    4. 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 20.4 may 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:

- TS 05169
- AS/RISSB 7708
- IEC 62561 (all parts)
- IEC 61643-11
- IEC 61643-21.

TS 05169 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 non-railway specific equipment. TS 05169 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. Lightning 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/RISSB 7708 and by TS 05169.

The applicable standard for earth resistance testers is applied by TS 05169.

B.5.2 Surge protection devices

Surge protection devices (SPDs) for application on general 230 V ac electrical power as defined in Section 12.6 are non-railway specific equipment. The applicable product standard is IEC 61643-11.

SPDs for the communications interfaces on equipment powered from general dc electrical power as defined in Section 12.8 are non-railway specific equipment. The applicable product standard is IEC 61643-21. These SPDs shall be applied in accordance with TS 05169.

Surge protection devices for application on signalling 120 V ac electrical power as defined in Section 12.5, signalling dc electrical power as defined in Section 12.7, and signalling equipment input and output ports can have safety related failure modes or multiple device 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 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 SPDs is TS 05169 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 may be used.

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

- Shall be 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 shall be in accordance with Table 4.
- The test of IPE shall be carried out using the maximum supply voltage defined in Section 12 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 (UREF) 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 IPE 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
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 UC 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 9 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.

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:

- Shall be suitable for installation on an IT-system of earthing.
- Nominated parameters shall be in accordance with Table 5.
- The test of IPE shall be carried out using the maximum supply voltage defined in Section 12 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 (UREF) 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 IPE 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 UC 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 9 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.

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 9.3 or on connecting devices defined in Section 20. 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:

- Shall be 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.
- Shall 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 lower performance values. These values have been aligned to the international standards.
- The IPE test defined in IEC 61643-11 shall be carried out using the maximum supply voltage as defined in Section 12 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 (UREF) 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 IPE 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/NZS 61000.6.1 or AS/NZS 61000.6.2. Equipment to those standards requires UP ≤ 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

Protection mode	Parameter	Value
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 UP values. The requirements set in Section B.5.6.1 and Section B.5.6.2 assume that the equipment meets IEC 62236-4 or other applicable EMC standard.

B.5.6.1 Safety related requirements for SPD

SPD for input output ports shall meet the following additional safety related requirements:

a. SPD configuration shall be either a two, three, four, or 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 shall 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 shall be > 10 MΩ as measured at Uc.

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 20.2.

B.5.6.2 Performance related additional requirements for SPD

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

a. An SPD meeting the extended range of service conditions is accepted as meeting the requirements of Section 11 when used in weather protected installations.

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

c. Uc for ports other than digital inputs or outputs shall be the value nominated by the protected equipment manufacturer's requirement.

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

e. UP 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/RISSB 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 non-railway specific 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 17.

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 11.

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 TS 00026. 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
- AS/NZS 4296 or associated international standard IEC 61084
- AS 4702
- AS/NZS 61386 (all parts)
- IEC 61537.

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

The applicable standard for signals and control systems discipline UPS equipment shall be AS 62040 (all parts).

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

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

b. shall 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. shall 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 Operational technology equipment

The information technology and operational technology equipment are converging and merging most of the cases such as servers, networking equipment. This section covers both types of technologies. General purpose operational technology equipment (OTE) is non-railway specific equipment.

The following standards are appliable:

- AS/NZS 61000 (all parts)
- IEC 62236-4
- EN 50121-4

- IEC 62498-3
- EN 50125-3
- IEC 60721 (all parts)
- AS/NZS CISPR 24
- AS/NZS 62368.1.

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

OTE equipment for use on general 230 V ac or general dc power supply can be accepted as compliant with the requirements in Section 5 through to Section 17 and Section 20 based on the following requirements:

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

b. shall have a quality assurance statement from the manufacture

c. shall have a statement of compliance with AS/NZS 62368.1

d. shall have 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

   Note: if the manufacturer cannot provide such information, competent technical experts can calculate and verify the theoretical MTBF based on evidence.

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

f. shall have 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. shall have 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. shall have power-on, resumption, interruption functionality in accordance with Section 12.2

i. shall be 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 12.1.

OTE 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 17 and Section 20 based on the following requirements:

1. shall meet item a through to item i in the other list in this section

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

3. communication ports and other non-power ports shall meet the 1.5 kV electrical strength to earth test requirement detailed in Section 13
4. either the ac powered equipment shall be supported by evidence that it is immune from the power supply variation and interruptions detailed in Section 12.5 or is only for use in an installation that is protected from voltage dips and interruptions
5. shall have evidence that ac powered equipment meets test class 3 for AS/NZS IEC 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/NZS IEC 61000.4.13 test class 2 levels
6. specific tests given in Section 12.5 or Section 12.7 as appropriate.