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ARISO Contact details:

Head office:

Phone:

(07) 3724 0000
+61 7 3724 0000

Email:

info@ariso.org.au

Web:

www.ariso.org.au

Standard Development Manager:

Name:

Crispian Fitzhardinge

Phone:

0497 919 619

Email:

cfitzhardinge@ariso.org.au

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SDM name	Crispian Fitzhardinge
SDM phone	0497 919 619
SDM email	cfitzhardinge@ariso.org.au

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Preface

This standard was prepared by the Signalling Testing Process Development Group, overseen by the ARISO Train Control Systems Standing Committee.

Objective

The objective of this Standard is to outline requirements that describe types of testing and methods for testing typical signalling apparatus and systems that form part of the signalling systems, in Australian railway corridors. This Standard excludes mechanical signalling testing.

The Standard covers the testing through the construction and testing phases, including testing processes and performance requirements for individual items of apparatus and systems.

The Standard provides a set of testing requirements to support the completion of the testing required by AS 7717 and to manage the hazards associated with the signalling testing process. This standard does not diminish the obligation of the verification, validation engineers and test engineers to decide what should be tested and how it should be tested respectively.

Compliance

There are four types of provisions contained within Australian Standards developed by ARISO:

- (a) Requirements.
- (b) Recommendations.
- (c) Permissions.
- (d) Constraints.

Requirements – it is mandatory to follow all requirements to claim full compliance with the Standard. Requirements are identified within the text by the term 'shall'.

Recommendations – do not mention or exclude other possibilities but do offer the one that is preferred. Recommendations are identified within the text by the term 'should'.

Recommendations recognize that there could be limitations to the universal application of the control, i.e. the identified control is not able to be applied or other controls are more appropriate or better.

For compliance purposes, where a recommended control is not applied as written in the standard it could be incumbent on the adopter of the standard to demonstrate their actual method of controlling the risk as part of their WHS or Rail Safety National Law obligations. Similarly, it could also be incumbent on an adopter of the standard to demonstrate their method of controlling the risk to contracting entities or interfacing organisations where the risk may be shared.

Permissions – conveys consent by providing an allowable option. Permissions are identified within the text by the term 'may'.

Constraints – provided by an external source such as legislation. Constraints are identified within the text by the term 'must'.

ARISO Standards address known hazards within the railway industry. Hazards, and clauses within this Standard that address those hazards, are listed in Appendix A.

Appendices in ARISO Standards may be designated either "normative" or "informative". A "normative" appendix is an integral part of a Standard and compliance with it is a requirement, whereas an "informative" appendix is only for information and guidance.

Commentary

Commentary C Preface

This Standard includes a commentary on some of the clauses. The commentary directly follows the relevant clause, is designated by 'C' preceding the clause number and is printed in italics in a box. The commentary is for information and guidance and does not form part of the Standard.

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Section 1 Scope and general

1.1 Scope

This document is intended to be applied to railway signalling works and covers the following:

- (a) Function testing.
- (b) Principles testing.
- (c) Use of design simulators for testing.
- (d) Verification testing.
- (e) Integration (including correspondence) testing.
- (f) Trackside apparatus testing.
- (g) Cable testing.
- (h) Aspect sequence testing.
- (i) Systems testing.
- (j) Operation validation.
- (k) Testing and validation after minor works, accidents or incidents.

NOTE:

Minor works are considered projects that do not involve major resources or extensive planning. Examples include points conversions, track circuit conversions, addition and removal of a signal or aspect and non-complex stage-work.

- (l) Competencies of testing personnel.

This document is intended to be used by RIMs, RSOs, and suppliers.

The document is intended to be applied to new installations, recertification after incidents, and upgrades.

This document is intended to be used in conjunction with AS 7717

Signalling design is not within the scope of this document. Refer to AS 7718

This document specifies the accepted processes that can be employed when testing of all types of signalling apparatus, that form part of the signalling systems, on the Australian railway network.

This document applies to all railways in Australia with the exception of the following infrastructure:

- (a) Heritage railways, unless there is an interface with a non-heritage railway.
- (b) Light railways and tramways, with the exception of an interface with a railway.

1.2 Normative references

The following documents are referred to in the text in such a way that *some* or all of their content constitutes requirements of this document:

- AS/NZS 3000:2018, *Wiring Rules*
- AS 7708:2017, *Signals Earthing and Surge Protection*
- AS 7717:2016, *Signal Testing and Commissioning Management*
- AS 7631:2024, *Railway Infrastructure – Sighting*
- *Rail Safety National Law (2012)*

NOTE:

Documents for informative purposes are listed in a Bibliography at the back of the Standard.

1.3 Defined terms and abbreviations

For the purposes of this document, the following terms and definitions apply:

1.3.1

circuit

arrangement of conductors and electrical apparatus

1.3.2

circuit function test

energization of each circuit, or part of a circuit, and verifying by operation, or through disconnection of the fuse and link, that each and every control device is effective in controlling the circuit function in accordance with the circuit diagram

Note 1 to entry: The specific contacts on control devices such as relays are not verified.

1.3.3

computer based interlocking

computerized software-based system for providing interlocking functions between signalling equipment and associated controlled elements, including support for in-cab signalling system

1.3.4

continuity test

process whereby the wiring is checked to see that it is in conformity with the design detail and that all wires are continuous from termination point to termination point

Note 1 to entry: This test is generally carried out simultaneously with a wire count and insulation test.

1.3.5

executive software

core operating software that manages hardware, timing and security in signalling systems

1.3.6

insulation test

test of the resistance of the insulation between an electrical circuit conductor and earth or directly between the conductors of two separate electrical circuits

Note 1 to entry: The test is made at a specified voltage which is high compared to the circuit voltage.

1.3.7

null count

check against the circuit book analysis sheets to verify that there are no wires terminated on spare contacts of relays and other operating mechanisms, nor on spare fuses, links, terminals and all other spare termination points

1.3.8

rail infrastructure manager (RIM)

As defined by Rail Safety National Law.

1.3.9

rolling stock manager (RSO)

As defined by Rail Safety National Law.

1.3.10

stage works

phased installation and commissioning of signalling apparatus, as part of a large re-signalling scheme, often of a temporary nature as alterations proceed

Note 1 to entry: Stage work is usually labelled to clearly define the stage to which that work applies.

1.3.11

stop enforcement devices

equipment used to ensure that a train does not proceed past its authorized section

1.3.12

strap and function test

in-depth circuit function test

Note 1 to entry: The strap and function test is the energization of each circuit, or part of circuit, and verifying by operation or disconnection that each and every control contact, fuse and link is effective in controlling the circuit function in accordance with the circuit diagram. As each control contact is operated to open the circuit, a strap is applied across the contact and re-energization of the circuit is verified by observation of the circuit function or indicating device.

Note 2 to entry: There are methods of strap and function testing which vary from this definition. This document covers the most common method used in Australia.

1.3.13

through function test

circuit function test of a circuit or series of related circuits running between locations such as signal boxes, relay room, etc., to ensure the fuses, links and control devices effectively control the final function

Note 1 to entry: The through function test includes through function testing from a signaller's control at the operator interface to the operation of the trackside signalling apparatus, and to its change-of-state indication back to the signaller's indicator diagram.

1.3.14

validation

confirmation that the particular requirements for a specific intended use are fulfilled

1.3.15

verification

testing and evaluation of an item of apparatus or a system to assure compliance with its specification or other requirements

1.3.16

wire count

count of the number of conductors terminated on each wire termination point and at every wire termination point

Note 1 to entry: The wire count is certified against the circuit design detail and cross checked against the analysis sheets.

General rail industry terms and definitions are maintained in the ARISO Glossary. Refer to:

<https://www.ariso.org.au/glossary/>

Section 2 General requirements

2.1 General

Signalling testing is a lifecycle process commencing with the factory testing of signalling apparatus and systems, to site testing and validation of application specific requirements and commissioning. The objective of the tests shall be to provide a framework to provide assurance that the signalling apparatus and systems conform with:

- (a) approved design;
- (b) standards and specifications;
- (c) defined functional requirements; and
- (d) safety integrity requirements as specific for a system or product.

The development and implementation of the signalling testing and commissioning management shall comply with the requirements and recommendations in AS 7717:2016, which provides a common framework for RIMs to plan and execute the inspection, testing and commissioning of new and altered signalling infrastructure.

The detailed test processes and performance requirements for all types of signalling apparatus and system shall comply with the requirements and recommendation specified in this document, and other application specific local requirements and guidelines.

Application specific requirements define the expected outcome based on local and site, RIM and manufacturer specifications and requirements. Test specifications shall be defined by a competent test engineer with reference to the particular requirements for the specific application.

Where there are pre-defined test specifications, these shall be verified as appropriate for the specific application and adapted as necessary. In all cases, the test specifications shall be approved by a competent engineer in the context of the application specific test plan.

Any measurement and test equipment shall be approved and calibrated to meet project specific and RIM requirements.

2.2 Safety

All signalling apparatus and systems shall be assessed, tested and certified, in accordance with the RIM requirements, to be in an appropriate condition and configuration to meet operational, safety and functional requirements. Consideration to the age and condition of adjacent infrastructure, the operating regime, traffic tasks and seasonal climate conditions should form part of the assessment.

The testing of the signalling apparatus and system must manage the risks associated with testing activities in accordance with the obligations of the *Rail Safety National Law*, and the Work Health & Safety legislation and include, as far as is reasonably practicable, all safety considerations associated with the full life cycle of each stage of the testing process.

2.3 Testing personnel, competency management and documentation

Competency management procedures shall be established by the RIMs to ensure all testing works are application specific.

Staff shall be approved by the RIM, deemed competent, and suitably qualified to undertake testing work.

Any test apparatus used shall be approved by the RIM.

All phases of testing shall be undertaken by persons qualified to undertake such tests and by persons independent of the wiring and design process.

Testing personnel, competency management and documentation requirements shall comply with the requirements and recommendations in AS 7717:2016

Application specific competency and documentation requirements are based on the combination of location, risks, RIM and manufacturer requirements and any special controls or operational requirements.

Section 3 Test methods and procedures

3.1 General

This section sets out the minimum requirements for the inspection, testing methods and procedures for certifying new and altered signalling works and the standard procedures and practices for carrying out and recording inspection testing.

Detailed requirements for signalling testing methods may be based on local standards, guidelines and procedures but in all cases, tests shall be traceable back to the design requirements they are verifying or validating.

Independence shall be maintained between design, construction and testing activities.

Temporary wiring shall be distinctively coloured and labelled.

The types of testing procedures contained within this document are:

- (a) installation testing; and
- (b) system function testing and validation.

Installation testing shall verify that the system is built in accordance with the design documentation.

Installation testing shall include the following:

- (d) Detailed circuit testing.
- (e) Cables testing.
- (f) Apparatus testing
- (g) Equipment verification.
- (h) Wire continuity test.
- (i) Wire and null count.

System function testing and validation shall include the following:

- (j) Function testing.
- (k) Testing to control tables.
- (l) Aspect sequence testing.
- (m) Principles testing.
- (n) Integration testing.
- (o) Contact proving testing.

3.2 Detailed circuit test

3.2.1 General

Circuits shall be tested to ensure that they perform according to specific application requirements.

Detailed circuit tests of all new or upgraded signalling apparatus and system should include the following:

- (a) Documentation check.
- (b) Correlation check.
- (c) Apparatus inspection.
- (d) Wire count.
- (e) Null count.
- (f) Continuity test.
- (g) Insulation test.
- (h) Strap and function test.
- (i) Changeover procedure.
- (j) Factory acceptance testing (FAT).

Wireless communications links shall be tested to ensure they comply with the design.

3.2.2 Documentation check

An approved closure list and design detail shall be provided that confirm the design parameters and required system performance, upon which the testing will be based.

The closure list shall be checked and verification made that the design documents, plans and standards specifications, are the latest approved versions including amendments and modifications.

3.2.3 Changeover procedure

Independence shall be maintained between design, construction and testing activities.

Wherever wiring alterations are required to existing in service circuits, these alterations shall be prepared in advance of the changeover as follows:

- (a) New wires are run, labelled at each end, stripped and crimped, continuity tested and then insulated and secured. New wires to go on are identified with distinctly coloured tape.
- (b) Wires to be removed are identified, hand traced and clearly identified with differently coloured tape to that used for new wires, ready for removal.
- (c) After wires have been prepared, they are independently checked against the design and marked off.

On changeover, at the point of connection of new and existing circuits, a wire count, continuity test and strap and function test, inclusive of at least one contact clear in all paths, from the point of connection shall be undertaken. The wire count shall include both sides of each clear contact.

The requirements for the one contact clear test shall be defined by the RIM.

Testing should not commence until all wires for removal have been disconnected and removed.

3.2.4 Correlation check

Correlation checking shall include the following:

- (a) Verify that each conductor is continuous and runs directly between two (2) wire termination points.
- (b) Wire count existing portions of the altered circuit/s sufficiently to verify that the design is a true representation of the actual circuits.
- (c) Verify that there are no unused contacts/fuses/terminals shown to be in use in the circuit book analysis sheets that are without connected wires.

3.2.5 Apparatus inspection

An apparatus inspection is a visual inspection to verify the signalling apparatus conforms to the approved and issued design documents, plans and standards specifications.

Application specific requirements define the expected outcome based on local and site, RIM and manufacturer specifications and requirements.

The inspection of signalling apparatus shall include the following:

- (a) Verify that configuration and positioning of trackside apparatus conforms to the latest approved design documentations, plans and standard specification.
- (b) Verify that installed apparatus items and cables are the correct type, quantity, rating, colour, labelling, with no loose wires and appropriate quality workmanship.
- (c) Verify that the apparatus mounting layout conforms to the profile drawings.
- (d) Verify that labels, core numbers and colours are in accordance with design and documentation.
- (e) Verify that signalling apparatus physically conforms to approved plans and signal sighting forms.
- (f) If the signalling apparatus is fitted with a security lock, verify that the correct security lock is fitted.
- (g) Verify that extraneous items/apparatus are removed, that any loose wires are secured with ends insulated, that temporary wiring is removed and that stage work is removed.

3.2.6 Wire count

Wire count is a visual inspection that examines the apparatus termination points to confirm that the number of wires on each termination point corresponds with the number of wires shown on the wiring diagram and/or design detail.

The wire count shall be undertaken to ensure the installation wiring conforms to the approved design detail.

Wire count inspection shall include the following:

- (a) Verify the number of conductors terminated at a particular point is as shown on the approved wiring diagram and/or design detail.
- (b) Identification of all conductors connecting to terminals, busbars, links or other strapping.
- (c) Verify the wiring identification labels correctly identify the termination point of the wire.
- (d) Check terminations and crimps are correctly made, wires are not trapped under adjacent terminals, and crimps are correctly locked into plug boards or terminal blocks.
- (e) Verifying that the correct number of wires is attached to each termination point marks the individual ends of each wire on the circuit plan and/or design detail in accordance with application specific approved standards.

All termination links, including any rail-mounted fuses, should be closely checked to verify the presence or absence of common connections.

3.2.7 Continuity test

As part of the installation, a continuity test shall be performed. A continuity test is a method to support assurance that the wire runs from point to point, forming part of an overall circuit and is terminated as per the circuit and/or design detail.

Continuity testing is also used to confirm that a wire is connected as per the design documentation. The best way to do this is to hand trace it. When that is not practical then a continuity tester may be used. When using a continuity tester, there shall be an additional method of verifying the integrity of the wires.

A continuity test shall be carried out before termination or with all links, fuses and apparatus removed, using a calibrated and RIM-approved device that is capable of detecting a resistance greater than the cable resistance of the wire under test.

The continuity tester shall be low voltage, preferably with an audible indicator, that sounds when the test leads are connected across a continuous electrical path between termination points.

The continuity tester shall have its own independent power supply. A high resistance or open circuit between the terminated ends of the wire under test shall prevent the alarm sounding.

Where the wire cannot be terminated immediately it shall be checked as being present and ready for termination, suitably insulated and identified by a permanent label. Its subsequent termination shall be rechecked to ensure that the number of wires terminated is in accordance with the circuit and/or wiring diagram.

Continuity testing shall include:

- (a) ensuring that wiring is compliant with approved design detail and electrical continuity is verified;
- (b) ensuring that all loose wire ends are suitably insulated; and
- (c) a check to verify that all labelling is correct as per the design detail.

3.2.8 Null count

This is a visual inspection of all termination points against the documentation sheets to ensure there is no wiring surplus to that specified.

The null count should be carried out after the continuity test and wire count has verified the wiring connecting to the respective terminals and marked up on the test copies.

The documentation to be used shall be the relevant completed analysis sheets that were checked/marked up from the documentation check.

Null count inspection shall include the following:

- (a) Verify that there is no conductor connecting to terminals shown as spare in the contact/fuse/terminal analysis sheets in the circuit book.
- (b) On the analysis sheets, mark the spare contact, fuse or terminal, with a standard marking to indicate the test is successfully completed.

3.2.9 Insulation test

The insulation testing of all wiring and apparatus associated with signalling installations shall be carried out prior to bringing into use in any new work with an approved insulation testing instrument with a voltage output in accordance with the requirements of AS/NZS 3000:2018

The RIM shall specify the minimum acceptance values of insulation resistance.

Insulation tests shall be made on all lineside signalling cables, including local and power cables.

The test earth connection shall be tested immediately prior to performing this series of tests and immediately after the last test to ensure it provides a low resistance to earth.

Cable insulation tests shall be carried out with a proven effective reference earth. The integrity of the earth is essential for insulation resistance tests to be valid and earth leakage detectors to be effective.

Insulation testing is performed to determine the following:

- (a) Insulation resistance to earth of electrical apparatus, wire conductors, cable cores and cable sheaths.
- (b) Insulation resistance between cable cores.
- (c) Insulation resistance between each cable core and the cable sheath.

Insulation testing for individual wires shall include insulated resistance testing to the frame of the housing or rack for all individual wires run.

It is desirable to test the complete circuit as a single test. Testing of a complete circuit, with all other circuits connected and working, has the added advantage of possibly detecting an insulation breakdown between circuits and not via earth.

Prior to testing, all lightning protection devices and electronic devices shall be disconnected or removed to prevent incorrect readings and/or damage.

The cable cores can hold a static charge which could cause damage to equipment if connected prior to being discharged. All cores tested shall be discharged to earth before reconnecting any pins, fuses, surge protection, etc.

The values of insulation resistance in each core tested shall be recorded as a one-line entry on the cable test certificate and be certified. If a cable fails the electrical tests, details of the failure(s) including the actual insulation resistance values shall be reported for further direction.

3.2.10 Strap and function test

Strap and function testing shall be performed on all modified installations with all relays in place on their bases.

There are accepted variations to the process described below, however the general process and requirements detailed in this section should be followed.

The strap and function test of a circuit assumes that the contacts and terminals shown are the only ones in the circuit. This test verifies the wiring arrangements of these contacts by:

- (a) closing each series path in turn through the circuit, with all other paths open, to energize the function proving that none of the open contacts are in that series path; and
- (b) opening each contact in turn, in the series path, to de-energize the function, proving that the contact being opened is in the circuit and not in parallel with any other closed contact in that path.

Strap and function testing during train movement shall only be undertaken with the approval of the RIM.

If a strap and function test is prescribed, the test plan shall define the limits of approach and departure, method of control of the trains, and who is notified of the approach and departure. For each circuit:

- (c) connect a reliable indicating device which places a load on the circuit and draws current to mitigate false indication readings across the end function of the circuit (e.g., relay coil, lever lock coil) or the outgoing terminals of the circuit. Where the

circuit is double cut, both the positive and negative (or active and common) paths of the circuit shall be tested independently;

- (d) set up all conditions within the circuit with control levers in the correct position. This could involve temporary feeding of relays;
- (e) apply an appropriate fused power supply to the start of the circuit or part circuit and observe voltage and polarity of the reliable indicating device;
- (f) prove, in turn, each fuse, contact, link and terminal by breaking down the condition, strapping the contact where appropriate, removing the strap and reinstating the condition observing the response of the reliable indicating device, and where possible, the end function at each stage;
- (g) where controls are wired in parallel, each path shall be selected in turn and all the conditions in that path tested, with all other paths broken; and
- (h) the rating of each fuse shall be verified against the value on the circuit diagram.

When strap and function testing:

- (i) test straps to be used shall be registered with the TIC;
- (j) disconnection of any wiring should be avoided unless absolutely necessary;
- (k) testing shall be done one terminal at a time; and
- (l) connections shall be reverified.

Strap and function testing when using false feeds, shall comply with the following:

- (m) Only test straps registered with the TIC are permitted on site.
- (n) When testing near working circuits, strict care is taken to ensure that any false feed cannot accidentally or inadvertently be applied to affect the working circuits.
- (o) Where additional security is required, a false feed isolated supply is used, through a separate transformer or transformer rectifier unit.

Where temporary false feeds have been used and they are left in place prior to testing being completed, a record of those false feeds may be required to ensure they are removed at the conclusion of the testing.

Voltage readings when false feeding may be recorded. Any false feed voltage readings taken shall not be recorded as the final voltage.

Test straps (leads and jumper) shall:

- (p) have brightly coloured insulation, and be different to any stage colours used;
- (q) be of sufficient length not to be concealed within looms of wiring;
- (r) be uniquely named and numbered; and
- (s) be counted and recorded before the start and at the end of each day's testing work to ensure that no straps have been inadvertently left in position.

3.2.11 Factory acceptance test (FAT)

The FAT stage involves the testing of new signalling apparatus and systems to verify that they achieve the proposed operational and functional outcomes and are in accordance with the design and the overall project requirements.

Where possible, a FAT should be undertaken. Where a FAT is undertaken, this shall be completed prior to locations and associated equipment being transported to site.

FAT requirements shall include the following:

- (a) Prior to commencement of the FAT, a FAT test plan is produced defining the test configuration, apparatus configuration, test apparatus required and the test methods to be used.
- (b) A FAT test specification is produced defining the tests required, procedure to carry out the tests, test record sheets and acceptance criteria.
- (c) FAT test is carried out by a suitably qualified person, with the RIM reserving the right to witness and approve the testing.
- (d) At completion of the FAT, a report containing all the FAT results is provided to the RIM for final approval.

FAT shall include:

- (e) physical inspection;
- (f) wire count and bell test to confirm compliance with the approved signalling designs;
- (g) serial and part numbers of all equipment checked off and recorded on test copies;
- (h) power wiring and operation tests (where applicable);
- (i) data and communication link testing and correspondence (where applicable);
- (j) train control and diagnostic link operation and correspondence (where applicable); and
- (k) comprehensive function tests to confirm correct operation to the approved design (where applicable).

Simulation devices may be used where it is impractical to use the actual apparatus at a factory test.

3.3 Cable and earth tests

3.3.1 General

Cable testing shall be carried out in accordance to RIM requirements.

The testing of modified locations and SERs earths shall be performed prior to the commencement of cable and earth testing.

Cable testing shall be carried out on each core of the cables to check the:

- (a) continuity of conductors;
- (b) insulation resistance; and
- (c) correct termination, in sequence.

Cable test results shall be recorded on the cable test certificate and be certified.

If test results are outside of the defined acceptance criteria, then this shall be highlighted .

3.3.2 Earth tests

Testing shall be carried out prior to commissioning to ensure that commissioning activities are not placed at risk. This requirement applies to both existing and new cable.

All earthing grids/stakes installed at equipment box and control room locations shall be tested to assure they conform to the requirements of AS 7708:2017

3.3.3 Electrical signalling and power cables

Installation checks of electrical signalling and power cables shall include the following:

- (a) Inspect to ensure:
 - (i) the cables are of the correct type;
 - (ii) DC circuit polarity remains consistent;
 - (iii) where multiple cable joints exist, cables have not be transposed;
 - (iv) the installation resistance between all cores, cable sheath/drain wires/screens and between earth conforms to the relevant signalling installation instructions; and
 - (v) that cables are correctly and securely terminated in the correct core numbering and/or colour sequence.
- (b) Fault loop impedance is measured in accordance with the application specific requirements, to ensure the correct discrimination and operation of protection devices.
- (c) The tests to be made are for:
 - (i) insulation between each core and earth;
 - (ii) insulation between each core and all other cores in the cable;
 - (iii) insulation between metallic screens, shields and drain wires; and
 - (iv) earth and cable cores.

Electrical testing shall include the following:

- (d) Each conductor in each multicore cable is tested for continuity.
- (e) Insulation tests on multi-core and power cables is made after their permanent installation and termination has been completed.

For local cables, in cases of difficulty (e.g., where apparatus is not fitted with plug couplers or isolation type terminals), the test may be carried out with the cable in position and only the location end terminated.

For each cable, a cable test certificate shall be completed to certify that the minimum acceptance values of insulation resistance have been obtained.

The minimum acceptable values of insulation resistance shall be the values specified by the RIM.

If the applicable minimum values cannot be obtained, the cable shall be regarded as faulty and not be commissioned without RIM approval.

Where polarity sensitive apparatus is installed, all power distribution and data link cables shall be tested for the correct polarity, using a DC source connected to one end of the cable and a DC voltmeter applied to the other end and at all intermediate terminations.

3.3.4 Fibre optic testing

Testing of the fibre optic cable is to be undertaken in accordance with the RIM requirements and should determine if the cabling meets the RIM specifications. This could include the following tests/observations:

- (a) Inspect installation to ensure conformance with the relevant manufacturers and signalling installation plans and instructions and cables are correctly and securely terminated in the correct core numbering sequence.
- (b) Insertion loss testing (optical loss).

NOTE:

Insertion loss is the standardized measurement of optical power loss in a fibre link. The term optical loss is commonly used informally to describe the same measurement but is less precise.

- (c) End-face inspection and mechanical integrity check.
- (d) Continuity testing.
- (e) Polarity testing.
- (f) Labelling.
- (g) Limit of testing accuracy.
- (h) Test lead performance and losses.
- (i) Optical time domain reflectometer testing.

Where any part of the signalling system relies on digital communications, inspection and testing shall verify the performance and safety of the communications interface across the communication layers used by the system as below:

- (j) Layer identification.
The test plan shall identify the communication layers applicable to each safety-related interface, including as a minimum:
 - (i) physical/transmission layer;
 - (ii) data link layer; and
 - (iii) application or end-to-end layer.
- (k) Physical and data link layers.
Testing shall verify, as applicable:
 - (i) establishment and loss of the communication link;
 - (ii) correct detection of loss, corruption, or interruption of data; and
 - (iii) defined system behaviour following link loss or restoration.
- (l) Network and transport layers (where used).
Where routing, switching, or transport protocols are used, testing shall verify:
 - (i) correct addressing and connection management; and
 - (ii) system behaviour under delay, congestion, or interruption conditions relevant to the signalling function.
- (m) Application/end-to-end safety layer.
Testing shall verify that safety-related communication mechanisms correctly detect and respond to:
 - (i) message corruption;
 - (ii) loss, duplication, or re-ordering of messages;
 - (iii) excessive delay or timeout conditions; and
 - (iv) invalid or unauthorized messages.
- (n) Fail-safe behaviour
Testing shall demonstrate that failure or abnormal behaviour at any applicable communication layer results in the signalling system transitioning to, or maintaining, a defined safe state.
Where optical transceivers are used, inspection and testing shall verify that installed transceivers operate correctly with the connected optical fibre and equipment.

3.3.5 Data link and communications testing

3.3.5.1 General requirements

Where any part of the signalling system relies on communication interfaces, inspection and testing shall verify the correct performance and safety of the communications path supporting the signalling function.

Testing shall address both the data link and the communications infrastructure used to convey safety-related information.

3.3.5.2 Identification of communication scope

The test plan shall identify each safety-related communication interface and describe, as applicable:

- (a) the physical transmission medium (e.g., copper, fibre, radio); and
- (b) any communication or application protocols relied upon by the signalling system.

3.3.5.3 Physical and transmission layer testing

Inspection and testing shall verify, as applicable:

- (a) continuity and integrity of the transmission medium;
- (b) correct establishment and loss of the communication link;
- (c) correct detection of link loss, interruption or degradation; and
- (d) defined system behaviour following loss or restoration of the communication path.

3.3.5.4 Data link layer testing

Testing shall confirm the installation conforms to the relevant signalling installation plans, instructions and standards, and that the data link cables are correctly and securely terminated and labelled;

Testing shall verify that the data link correctly:

- (a) detects loss, corruption, duplication, or interruption of data;
- (b) maintains integrity under normal and abnormal conditions; and
- (c) supports the defined signalling system response to data link failures.

3.3.5.5 Network, transport or routing functions (where used)

Where switching, routing, tunnelling or transport mechanisms are used, testing shall verify:

- (a) correct addressing and connection management; and
- (b) system behaviour under delay, congestion, interruption or re-establishment conditions relevant to the signalling function.

3.3.5.6 Application or end-to-end communication behaviour

Testing shall verify that safety-related communication functions:

- (a) correctly detect invalid, corrupted, duplicated or delayed messages;
- (b) enforce defined timeout or fail-safe mechanisms; and
- (c) cause the signalling system to transition to, or maintain, a defined safe state in the event of communication failure.

3.3.5.7 Fail-safe behaviour

Testing shall demonstrate that any failure or abnormal behaviour at any applicable communication layer results in the signalling system responding in accordance with its defined fail-safe principles.

3.3.5.8 Optical communication systems

Where optical fibre and optical transceivers are used, inspection and testing shall verify that:

- (a) installed transceivers are compatible with the connected fibre and equipment;
and
- (b) the communication link performs correctly under expected operating conditions.

3.4 Apparatus tests

3.4.1 General

Apparatus testing shall be carried out to verify that all trackside signalling apparatus operates safely and in accordance with the design documentation.

Relays shall be tested to ensure that each contact operates in accordance with the design documentation.

3.4.2 Apparatus function test

Apparatus function testing shall be performed to test that all:

- (a) apparatus operates correctly from its local controls and power source and indicates its status correctly to local indications;
- (b) apparatus operates its contacts in correct correspondence and adjustment; and
- (c) mechanisms operate freely and within specified tolerances and in correct adjustment and that lights are correctly illuminated and focused/aligned.

Apparatus function tests should include correct:

- (d) energization and de-energization levels;
- (e) operating and release times;
- (f) movement, limits of travel and clearances;
- (g) display of aspects;
- (h) fit and interlocking between parts;
- (i) tension, or compression between parts;
- (j) operational voltage and current values (with power applied and when not applied) ;
- (k) correspondence with controls and indications; and
- (l) adjustment of contacts to correctly indicate the apparatus position with all contacts for the same position closing and opening simultaneously, and with all contacts insulated from one another and from earth, both when stationary and throughout movement.

The apparatus function test shall be carried out on installed apparatus by providing power of the correct value and polarity to the local controls, to work the apparatus.

3.5 System function test and validation

3.5.1 General

System function testing ensures that the apparatus or system under test function in accordance with the designs.

Validation ensures that the stakeholder, project and operator requirements have been achieved.

3.5.2 Circuit function test

Each individual circuit shall be tested from its power supply fuse to its final controlled function. At every intermediate location, each link and relay function, shall be verified as effective and circuit polarities are correct. Individual circuit functions, previously tested in the strap and function test, need not be repeated.

After circuits internal to locations and the external interconnecting cables have been separately tested, tests shall be carried out on the complete circuits.

These tests shall operate and verify the apparatus and the complete circuit from end to end, in a functional manner.

The following tests shall be carried out for both control and indication circuits:

- (a) Energize the circuit to pick up the final controlled function and any intermediate relays connected to the same circuit.
- (b) At all the locations involved, disconnect and replace in turn, the feed fuse and every link in the circuit, including at the power supply busbar, observing that all relays in the circuit and all indications respond in each case, by correctly changing status.
For polarized circuits, the test is carried out for each polarity.
- (c) Place a meter across the relay coils and verify correct working voltages. Voltages shall be checked throughout the circuit, not just at the coils. It is important that voltages are recorded where circuits go between different locations, particularly with DC circuits.
- (d) Investigate any voltage when the circuit is opened.
- (e) For control and indication circuits, prove that each output corresponds with its relevant input. A function test of the system ensures that when there is a control operated at the control centre, it is correctly relayed throughout the system and operates the trackside apparatus, and when there is an indication from the trackside apparatus, that it is correctly relayed throughout the system to the control centre. Each indication is to be observed to change status in correct correspondence.
- (f) Ensure contacts are in the correct configuration (i.e. front or back) as per the design documentation.

3.5.3 Through function test

Through circuit function testing shall be carried out on circuits that operate between housing/locations to prove:

- (a) the end function operates as intended when the defined electrical, logical or data input conditions are applied, and the corresponding outputs, indications and system responses are correctly produced in accordance with the design;

- (b) the circuit internal wiring has been correctly connected to the respective external cables where both have been separately tested in accordance with relevant requirements of Clause 3.2 and Clause 3.3;
- (c) de-energization of, and zero residual voltage across the circuit function, when the circuit is opened, in turn, at the fuse, each link and at each intermediate relay. The test is performed with as many other circuits energized as practical to provide a high probability of detecting the presence of any false voltages in the circuit; and
- (d) all repeat, indicating and intermediate relays, or equivalent electronic functions, correspond and operate correctly.

The processes used for through function testing should include the following:

- (e) Energize the circuit, or equivalent function, from the source to pick up the final control relay or equivalent electronic control function and any associated intermediate relays or functions.
- (f) At all the locations involved, disconnect and replace in turn the feed fuse and every link in the circuit, including at the power supply busbar, observing that all relays or equivalent function in the circuit and all indications respond in each case by correctly changing status.
- (g) Verify the wire count at the fuse and on each side of disconnection links and record on the circuit diagrams.
- (h) For polarized circuits, the test is to be carried out for each polarity.
- (i) Place a meter across the relay coils and observe correct working voltages. Investigate any non-zero voltage when the circuit is opened. Voltages should be checked throughout the circuit, not just at the coils.
- (j) Where circuits are in cascade (such as cut sections for AC traction immunization or for volt-drop purposes) the intermediate relay circuits is also similarly tested, the final relay under test being observed to respond.
- (k) Where possible and relevant, carry out tests for each through circuit as a single operation from the point of control to the point of operation and from the point of operation to the point of indication.

3.5.4 Interlocking test to control tables

Interlocking testing shall be conducted on mechanical interlockings.

Testing may be conducted on non-mechanical interlockings to ensure that the installation conforms to the interlocking requirements detailed in the control tables.

This may be carried out as an additional quality assurance measure.

Testing may be carried out as part of a set to work package.

Testing to control tables may be conducted when:

- (a) the complete interlocking is fully operational;
- (b) detailed circuit and function testing has been completed (for relay interlockings);
- (c) all test jumpers and temporary feeds have been removed; and
- (d) all controls and indications have been verified to accurately control and reflect the status of the various components of the interlocking.

Testing to control tables shall verify that all controls are in accordance with the approved signalling design.

Detailed testing to control tables' verification procedures shall be based on local standards, guidelines and procedures of individual rail organizations.

The tests shall be recorded using standard marking on the test copy of the control tables. Each page of the control table shall be signed off by the person/s conducting tests on that page.

3.5.5 Simulator or test rig testing

To facilitate testing, a simulator or a test rig may be used to emulate the expected responses from external apparatus. Simulator testing may be used to assure the adequacy of the design for all stages of testing including control table testing and principles testing.

The benefits of this type of testing are that hardware and software can be interfaced with test inputs and outputs, but it does not allow for equipment reaction times, propagation times and the time for operation of points etc., in the external environment. These timing issues should be rechecked when the system is connected to the actual apparatus to ensure there are no adverse timing effects.

Simulator testing is often used where new interlockings or signal boxes are being installed. Function testing can be done in advance of final external inputs being available, using a simulation process. This process is used to simulate the operation of the external signalling equipment. Temporary inputs are used, usually via a test panel, to simulate field inputs. These simulated inputs provide correspondence of track indications, point indications, signal and route indications, train stop indications, etc. The simulated inputs can be used to validate the new designs to ensure they will operate as per the approved design documents.

The configuration and arrangement of the inputs should be approved by the design engineer and the RIM.

Field inputs and indications should be used, when possible, to limit the amount of re-testing required when the final configuration change is made.

The use of any temporary wiring shall be fully detailed on the approved design documents as stage work wiring. The installation, testing and removal shall be documented in testing copies of the stage work design provided for the site-specific requirements.

Any function testing carried out by simulating the operation of the trackside apparatus shall be retested using the actual field equipment, including correspondence testing, to complete testing prior to commissioning.

3.5.6 Aspect sequence test

Aspect sequence testing shall:

- (a) verify that only the correct aspect and route indication are displayed to the driver of the train;
- (b) be performed in accordance with the relevant signalling plans which provide details of potential routes through the area of track under test, and with any special aspect sequence charts drawn up specifically for the test; and
- (c) ensure the complete aspect sequence is simultaneously observed in its entirety.

The principles of aspect sequence testing shall also apply to any movement authority, speed supervision or equivalent signalling information presented to the driver by an in-cab signalling system. This testing may be conducted during system integration.

3.5.7 Principles test

Principles testing is undertaken independently of the issued control table details.

Principles testing shall be carried out to validate that the system conform to signalling principles, performance specifications and site-specific operating requirements and the railway layout signalling plan.

Principles testing shall be planned and scope developed based on the design.

Principles testing should not commence until the configuration of the system has been recorded and confirmed as being the correct version for testing.

Principles testing shall include the following:

- (a) Inspection and FAT of signalling control system panels and screens, etc.
- (b) Validation of signalling scheme plans, (SAPs, hand sketches, etc.), including checking of signal spacing, clearance points, etc.
- (c) Verification of the controls and indications of the train control system.
- (d) Testing of axle-counter resets and failure-mode protection (aspect restrictions, etc.).
- (e) Correspondence testing.
- (f) Verification of alarms.

Principles testing shall verify that the system, including control tables, conforms to the application specific signalling principles and requirements.

3.6 Integration test

3.6.1 General

Integration testing shall verify that signalling components and sub-systems interact correctly when connected together, and that the integrated behaviour is consistent with allocated functional, interface and safety requirements.

3.6.2 System integration testing

3.6.2.1 Scope

System integration testing shall verify that the complete signalling system, formed from integrated sub-systems, performs its intended functions as an integrated whole within the defined system boundary.

System integration testing focuses on end-to-end behaviour rather than individual sub-system interfaces.

Integration testing shall be planned and performed in a manner appropriate to the signalling architecture, including distributed, computer-based and communications-based systems.

3.6.2.2 Requirements

System integration testing shall verify correct:

- (a) end-to-end functional behaviour of the signalling system;
- (b) interaction between multiple integrated sub-systems operating concurrently;
- (c) system behaviour across defined operational modes; and
- (d) system-level responses to defined abnormal or degraded operating conditions.

3.6.3 Sub-system integration testing

3.6.3.1 Scope

Sub-system integration testing shall verify the correct interaction between interconnected signalling sub-systems at defined interfaces. These interfaces shall be defined in accordance with the RIM engineering processes.

3.6.3.2 Requirements

Sub-system integration testing shall verify:

- (a) the correct:
 - (i) functional operation across the interface;
 - (ii) exchange and interpretation of data or commands;
 - (iii) behaviour under normal operating conditions; and
 - (iv) response to defined abnormal, degraded, or fault conditions.
- (b) the transition to, or maintenance of, a defined safe state following loss, corruption, delay or interruption of interface inputs.

3.6.3.3 Examples

Examples of sub-system integration testing for ETCS include, but are not limited to:

- (a) interlocking to Radio Block Centre (RBC);
- (b) RBC to on-board signalling systems;
- (c) RBC to RBC;
- (d) interlocking to control, supervision or traffic management systems; and
- (e) interfaces between distributed or adjacent interlockings.

3.6.3.4 Limitations

Sub-system integration testing does not constitute verification of whole-of-system operational performance or system-level requirements. Refer to AS 7474 for further guidance.

3.6.3.5 Relationship to other activities

System integration testing supports, but does not replace, system validation, operational acceptance, or whole-of-system assurance activities conducted under project-specific systems engineering and safety assurance processes. Where the project has been assessed as complex, these processes may be managed in accordance with the requirements of AS 7473:2020

This includes verification of functional behaviour, data exchange, timing and fail-safe responses across sub-system boundaries. It is important to verify that the signalling system can maintain its required performance under conditions of peak operational demand and congestion.

Where such verification is not otherwise demonstrated, stress testing shall be undertaken based on representative system loading and manufacturer-specified system capacity limits.

Where verification indicates that system operation is approaching manufacturer-recommended maximum capacity, the adequacy of system capacity shall be evaluated.

3.7 Test train

A test train or test trains may be used in a final test before the system is declared ready for train operation.

This should only be done after the completion of all other tests, and used mainly to validate the following:

- (a) Valid routes can be set and the authority to proceed is correctly provided.
- (b) Tracks are correctly detected as occupied by the test train, and the corresponding track occupancy indication is correctly generated by the detection system.
- (c) Signal and sign sighting from the train driver's cab is satisfactory.
- (d) No unnecessary interlocking lock-ups occur.
- (e) Level crossing operation approach warning timing is correct.
- (f) Correct operation of timing tracks.

The requirement for a test train for commissioning should be assessed based on the requirement to prove the safety and operation of the system and the risks (if any) of testing the system by other means.

Section 4 Computer-based systems

4.1 General

This section sets out the minimum requirements of the inspection, testing requirements and procedures for certifying computer based (CB) systems and the standard procedures and practices for carrying out and recording inspection testing.

Detailed requirements for CB systems testing methods and procedures shall be based on local standards, guidelines, manufacturer's recommendation and procedures of individual rail organizations. These requirements shall be approved for the specific application and traceable back to the system requirements.

Off-site or pre-site testing of computer-based and control systems data processes shall comply with the requirements and recommendations in AS 7717:2016 and other local requirements and guidelines.

The testing of CB systems shall ensure that the following requirements are covered:

- (a) The physical system is installed and configured in accordance with the particular design, using accepted system software and, hardware versions with the correct version of the application data, including verification of data integrity (e.g., CRC, checksum, hash, digital signature).
- (b) The system interfaces (both internal and external) have been fully considered and tested, including failure modes and alarms.
- (c) Application data has been approved.
- (d) Systems data has been checked for operation under normal, degraded and failure modes.
- (e) The application data has, as far as practical, undergone a complete principles test.
- (f) Each hardware module has been tested.
- (g) Vital communications link error rates are at an acceptable level.
- (h) Event logger operation and functionality.
- (i) Nonstandard interfaces.
- (j) Correspondence testing.

- (k) Through testing.
- (l) Response time and performance criteria have been met.
- (m) The testing of new or modified installations shall comply with the following:
- (n) Hardware modification (or replacements) shall be checked to ensure that the correct:
 - (i) number and type of circuit boards are installed in the card slots;
 - (ii) and approved power supplies are used within the prescribed limits; and
 - (iii) version of the application data and executive/firmware is installed.

The system shall then be tested in accordance with the defined application specific requirements.

When testing relay signalling equipment associated with a PBI, the PBI equipment shall be disconnected to avoid damage from high voltage insulation test equipment etc.

The regression and non-regression test requirements shall be determined for any application data modifications.

The extent and nature of any testing required shall be determined by the test engineer in accordance with the applicable test requirements of this standard and documented as part of the test plan.

Test results shall be recorded with traceability to the items in the design and the requirements that inform the design. This shall be documented in the test plan. This is to facilitate auditing and to ensure that testing is complete and not duplicated.

Test certificates shall be completed and certified by the person conducting the relevant tests.

4.2 System tests

4.2.1 General

Processor based systems consist of three elements which shall be included when formulating a test plan for processor based systems:

- (a) The hardware configuration – this will determine the response to software commands including error states and the capabilities of field modules and apparatus.
- (b) The executive software version – this will determine approval compliance and shall be validated as suitable for the hardware configuration to be used.
- (c) The approved version of the application data – this is to be the approved version of application software which has been generated considering the hardware configuration and executive software version to be employed.

4.2.2 Testing specifications

The test plan shall ensure the following:

- (a) The system employed is approved for use on the network.
- (b) The hardware provided is installed in accordance with the approved signalling design.
- (c) Correct versions of software are used and notated.
- (d) Each software item has been verified as correct through an appropriate data integrity or checksum verification.
- (e) A software simulation test is undertaken.

- (f) FAT is undertaken to simulate the software to be commissioned and to identify issues to be resolved, prior to the field testing.
- (g) Version control procedures are followed to ensure that the tested software and data are installed on site, that the installed software and data are identical to the tested versions, and that any programmable apparatus has been programmed and verified.
- (h) The hardware configuration is validated as suitable for its intended purpose by inspection and testing against the approved signalling design and engineering documentation.
- (i) Functional tests are performed in accordance with the test and commissioning plan.

4.2.3 Application tests

Hardware shall be checked to ensure that:

- (a) correct boards/cards are installed in card slots;
- (b) correct power supplies are used; and
- (c) correct hardware set up and configuration is used on cards.

The extent and nature of any testing required shall be determined by the test engineer and approved by the RIM and documented as part of the test plan.

Section 5 Trackside apparatus testing

5.1 General

Trackside apparatus shall be tested in accordance with application specific requirements.

Apparatus to be tested includes the following:

- (a) Signals.
- (b) Indicators.
- (c) Track circuits.
- (d) Axle counters.
- (e) Points.
- (f) Stop enforcement devices.
- (g) Level crossing and pedestrian crossing protection (where installed).
- (h) Power supplies.
- (i) Apparatus housings.
- (j) Relay/control rooms.
- (k) Mechanical signal box.
- (l) Computer-based systems.

Inspections and tests shall confirm the correct operation of both field apparatus and design plans and include checking:

- (m) the geographical positioning of field apparatus (including marker boards), with reference to a defined datum point;
- (n) cabling;
- (o) labelling;

- (p) that apparatus, including marker boards, has been set up, adjusted and functions in accordance with the application specific requirements; and
- (q) that apparatus achieves the application specific functional requirements.

5.2 Signals

5.2.1 Installation tests

Inspections shall be conducted to ensure that the installation conforms to the relevant signalling installation plans and specifications particularly with respect to the following:

- (a) Position – geographically located correctly in accordance with detailed design documentation.
- (b) Units – signalling light units fitted to posts agree with the detailed design documentation, with the designated heads, arrangement, hoods and backgrounds fitted and correct identification number plate attached.
- (c) Cabling – all cables conform to the approved signalling design and are correctly and securely terminated in accordance with approved signalling design and are in the correct core numbering sequence.
- (d) Telephone – installed, where specified and in accordance with detailed design documentation and operational.
- (e) Other requirements as specified in the test plan.

5.2.2 Other tests

The following tests should be performed:

- (a) Aspects – ensure that each aspect control/output correctly operates its corresponding signal aspect.
- (b) Flashing or pulsating rate – for flashing aspects, verify that the flash rate is as per detailed design requirements and flash proving works.
- (c) Speed/route indicators – prove all interlocking features including lamp proving, are effective.
- (d) Pilot staff – where fitted prove interlocking effective with all signals entering the single-line section.
- (e) Any specific test as detailed in the test plan.

5.2.3 Signal sighting

Inspections shall be conducted in accordance with the requirements of AS 7631:2024

5.3 Track circuits

5.3.1 Installation checks

Inspections shall be conducted to ensure that the installation conforms to the approved signalling design and installation specifications.

The tests and check should include the following:

- (a) Geometry – the limits of each track circuit, positions of insulated or electronic rail joints, bonds around rail joints, provision of point and other insulation, with all bonding in accordance with the bonding plan.

- (b) Type/labelling – all lineside apparatus is of the correct type, operating voltage, frequency and correctly labelled, in accordance with the design documentation.
- (c) Track connections – the track leads of each track circuit are terminated in the correct lateral and vertical position, are secure and low resistance, on the respective track and are the correct polarity, as designated by the track plan.

Commentary C5.3.1

If the connections are made through drilled holes, there is a risk of damaging rail integrity if the holes are too close together or outside the neutral zone.

- (d) Points and clip, pad and tie insulation – are in accordance with approved signalling design.
- (e) Level-crossing predictors (if applicable) – frequency and type of level-crossing predictor shunt is correctly installed on the correct track section.

Further information is provided in AS 7715

5.3.2 Tests and checks

Inspections shall be conducted to ensure that the installation conforms to the relevant signalling installation specifications.

The tests and check should include the following:

- (a) Shunt test – apply the test shunt for the type of track circuit and confirm:
 - (i) drop and pick up shunt test, to ensure that the shunting sensitivity of the track circuit is correctly adjusted; and
 - (ii) shunt test has been applied at all extremities of track and mid-point of long tracks, to ensure that train detection is effective in all parts of the track circuit.
- (b) Extraneous energy – with all adjacent track circuits energized, within operator and RIM requirements, remove the feed links of the track circuit under test and check that only the correct local indication responds.
- (c) Spark gaps – check to ensure that in the electrified area the required spark gaps are fitted with a cable attached to the prescribed connection point.
- (d) Insulations – check that rail and point insulations are correctly positioned.
- (e) Earths – check that rails are free from spurious bonds or earths.
- (f) Polarity – check polarity on feed and relay ends, and all other ends of the track circuit.
- (g) Level-crossing predictor (if applicable) – test and adjust level-crossing predictor approach section lengths and linearity in accordance with design requirements to achieve the correct functionality and in accordance with the RIM requirements.
- (h) Ballast condition – as this can affect readings.
- (i) Insulated joints/glued joints integrity has been checked including correct fasteners for the insulated joint (different clips for insulated joint lengths due to the insulated material and fasteners to bolt the joint together).

5.3.3 Other tests

Testing of the following, where indicated, shall be in accordance with the requirements of the test plan:

- (a) Track circuit parameters – a site inspection is be conducted to ensure that:

- (i) insulated rail joints – check all IRJs and electronic joints are in the correct position;
 - (ii) all train detection sections need to be measured and confirmed as correlated with signalling and bonding plans, as issued. This includes margins and lengths to be adjusted for correct operation;
 - (iii) clearance points – all points marked as at clearance, on the bonding and signalling plans, provide for the minimum clearance as defined in the application specific requirements;
 - (iv) dead sections do not exceed the maximum limit specified by the RIM, and neither joint of a staggered pair are in accordance with the application specific requirements, from any other staggered pair or from the end of the track circuit; and
 - (v) polarities correspond to plans.
- (b) Correspondence – confirm that the physical shunt on each end of each track circuit de-energizes the correct track and track repeat and operates the corresponding track indication light of the control diagram.
- (c) Shunting zone – with electronic jointless track circuits confirm that there is no shunting gap (dead zone) where track circuits abut each other.
- (d) Level-crossing predictor (if applicable) – confirm that the level-crossing predictor approach sections shunt, for their length, in a linear fashion, in accordance with application specific specifications.

5.4 Axle counters

5.4.1 Installation checks

Inspections shall be conducted to ensure that the installation conforms to the approved signalling design and installation specifications.

The tests and check should include the following:

- (a) Geometry – the limits of each track and position of rail-mounted wheel detectors are in accordance with approved signalling design.
- (b) Cabling – correct type, neatly terminated, secured, protected and labelled.
- (c) Position – the wheel detectors are mounted in the correct location, on the correct rail, and fitted in accordance with the detailed design and the manufactures requirements and specifications.
- (d) Type and position of modules in connecting box and axle counter evaluator units are in accordance with approved signalling design.
- (e) Earthing of apparatus is in accordance with approved signalling design.
- (f) Any applicable signage is installed and correct.

5.4.2 Checks/adjustments

The following checks shall be included:

- (a) The output parameters from each wheel sensor are verified to be within the specified limits.
- (b) Confirm count direction (up or down) from each wheel detector is correct.
- (c) Confirm wheels are being detected and counted accurately. This may be carried out by a dummy wheel or a test train.

- (d) Confirm only a null count (0 axles) will cause the axle counter evaluator to output track clear. (i.e. ensure both a negative and positive count occupies the track).
- (e) Tracks are correctly designated and of the correct length, as per the approved signalling design.

5.4.3 Track occupation

Confirm that all wheel detectors associated with each track cause the axle counter evaluator to output track occupied/track clear as required. Note that for wheel detectors located between adjacent axle counter tracks, a count down for one track should correspond to a count up in the adjacent track and vice versa.

5.4.4 Correspondence

Confirm that the occupation of each axle counter track de-energizes the correct track relay or computer based interlocking input and operates the corresponding track indication.

5.4.5 Modes and functions

All modes and functions of the axle counter system reset shall be tested in accordance with the approved signalling design and application specific requirements.

Further information is provided in AS 7651

5.5 Points

5.5.1 Installation checks

Inspection shall be conducted to ensure that the installation conforms to the approved signalling design and installation specifications particularly with respect to the following:

- (a) Type and position – point apparatus is in the correct position and is of the correct type, as specified and installed on the correct side of the track as shown on the approved signalling design.
- (b) Labelling – the correct point identification number, including discrimination between crossover ends, is on the point machine (or sleeper). The Normal [N] and Reverse [R] closed blade position plates are correctly attached to the sleepers. Specific signage is installed in accordance with the approved signalling design.
- (c) Wiring – Installed cabling is of the correct type and securely terminated.
- (d) Wire count/continuity – carry out a wire count of all terminations in the lineside point mechanism and detection units and continuity test of all interconnecting cables.
- (e) Head and traction bonding is installed in the correct position and is of the correct type and number.

5.5.2 Tests and checks

Inspection shall be conducted to ensure that the installation conforms to the approved signalling design and specifications particularly with respect to the following:

- (a) Operation, locking and detection – for power operated points, ensure operating time and maximum current demand (where applicable) do not exceed specified maximum values.

- (b) Detection circuit test to ensure detection is not made when the points are out of adjustment and the points are not locked.
- (c) Detection switches – where installed each detection switch is to be tested individually with a continuity tester to ensure that they are correctly adjusted and that the contacts make and break at the correct position in the stroke, in accordance with approved signalling design.
- (d) Additional drives and detectors – additional drives are correctly installed and tested as being detected, where applicable.
- (e) Flangeways and point blades have the correct clearances.
- (f) The lock is engaged when the point blade is correctly located
- (g) Emergency operation – points operate easily under emergency point crank/lever and any lock bars engage and are effective.
- (h) Point obstructions – ensure that in the event of a point obstruction the clutch, where provided, slips at the required value and cut-off timers or overload devices are effective within the specified time.
- (i) Facing point lock test.
- (j) Correspondence - check correspondence and out of correspondence for all points mechanisms to ensure the position of the points corresponds to the position called and locked by the interlocking. Each corresponding relay, contactor, input, output shall be observed for correspondence. This test is in addition to a correspondence test to the operators panel.

5.5.3 Other tests

The following tests and inspections should be undertaken as required.

- (a) Point detection – operate the points normal and reverse confirming detection locally and to the panel if possible. Ensure that the point levers, all control and detection relays and the indications are in correspondence.
- (b) Individual detection contacts – each leg of the detection circuit shall be tested independently:
 - (i) Exposed contacts – break each contact in succession to ensure that the correct detection relay de-energizes for both normal and reverse positions.
 - (ii) Microswitches – operate the appropriate micro switches in turn and strap the individual contacts to confirm their presence.
- (c) Correspondence – check correspondence and out of correspondence, on track configurations utilizing multiple point mechanisms, operate as per the test plan.
- (d) Emergency manual operation – prove that the emergency system, where fitted, puts and holds at stop all signals that interlock with the points. Also prove that when the points are to be manually operated, the power is isolated from the point mechanism.

5.6 Stop enforcement devices

Stop enforcement devices may include the following:

- (a) Train stops.
- (b) Automatic warning systems.
- (c) Automatic train protection/European Train Control System.

(d) TPWS.

An inspection shall be conducted to ensure that the device installation conforms to the relevant approved signalling design documentation, installation specifications and application specific requirements, particularly with respect to:

- (e) position – geographically located correctly with respect to signal, insulated/electronic rail joint (and level crossing where adjacent), and to running edge of rail and vertical position relative to rail; and
- (f) functionality – in accordance with design, application specific requirements.

5.7 Level-crossing protection

5.7.1 Installation checks

Inspection shall be conducted to ensure that the installation conforms to the relevant signalling installation specifications, particularly with respect to the following:

- (a) Layout – all site apparatus is located in accordance with signalling drawings and level crossing track layout plans.
- (b) Clearance – all apparatus is installed to specified rail and roadway clearance and the elevated boom arm to overhead wire clearance.
- (c) Configuration/signs – all flashing light, boom barrier and pedestrian gates are equipped with the full complement of cross-arms, audible warning devices, level crossing/stop on red/number of track signs and approach warning signs and roadway markings are installed.
- (d) Detection – type, position and setting of all detection methods is correct.
- (e) Level-crossing predictor (if applicable) – ensure that electronic apparatus cards are of the correct type and are full home in the card slots.
- (f) Lamp units – ensure that all flashing light units flash at the correct rate, are of the correct number, type, fitted with the specified backgrounds and hoods, and the units are aligned/directed in accordance with the approved diagram.
- (g) Audible warning devices – warning bells and other audible warning devices, achieve the application specific sound levels, are of the correct type, installed in the correct location and correctly orientated.
- (h) Level-crossing monitoring systems are installed correctly.

5.7.2 Checks/adjustments

Inspection shall be conducted to ensure that the installation conforms to the relevant specifications particularly with respect to the following:

- (a) Boom mechanisms – operate correctly, control and indication contacts operate correctly, and the boom clearance and lowering times are within the recommended time settings, and the boom arm is correctly configured.
- (b) Pedestrian gates/booms – operate correctly and are installed in the correct configuration and operate within the allowable time.
- (c) Power supplies – operate correctly, are of the correct type and voltage, automatic chargers are of the specified capacity and batteries have all caps and covers fitted and are of the correct type and capacity.
- (d) Level-crossing predictors (if applicable) – are correctly configured, set to the correct frequency, warning time, approach length, restart point and track drive.

5.7.3 Other tests

The following tests and inspections shall be undertaken as required:

- (a) Local circuits – detailed strap and function tests of all local circuits including the boom barrier contact switching of bell and boom arm light circuits and boom barrier detection relays.
- (b) Minimum clearance time – confirm the minimum clearance time as per signalling plans or as specified in the design specifications.
- (c) Measurements – measure boom mechanism and pedestrian gate drive and power off operation times to ensure compliance with approved signalling design.
- (d) Failure modes – test that:
 - (i) booms lower in the absence of power;
 - (ii) each boom arm lowering, causes lights to flash;
 - (iii) the test switch is effective;
 - (iv) where applicable, lifting boom arm restores any interlocked signal to stop; and
 - (v) there is correct operation of level-crossing alarms.
- (e) Simulation – test for operation of the boom barriers by simulation of both stopping and express train movements in all directions and any interlocking with signals.
- (f) Road traffic signal co-ordination – test for the correct operation of the outputs provided to associated road-traffic light system by simulation of all conditions and the receipt of inputs from the associated road-traffic lights.
- (g) Level-crossing predictors (if applicable) – test for correct operation of constant warning, motion detection, motion restart and freedom from run away or tail ringing.

Refer to AS 7658 for further information.

5.8 Power supplies

Power supplies shall be tested for the correct type, capacity, polarity and/or phasing installed, and wired to power distribution plans.

Fuses shall be checked for correct type and rating installed.

All apparatus shall be labelled as per the approved signalling design and all other appropriate labels installed where applicable (e.g., Danger High Voltage).

Inspections shall be conducted to ensure that the installation conforms to the approved signalling design and installation specifications, particularly with respect to the following:

- (a) Type and positions – power supplies are of the correct type as specified and installed at the correct positions as shown on approved signalling design.
- (b) The units are in a suitable condition to be used.
- (c) Isolation devices – isolators and circuit breakers are as per the approved signalling design and function correctly.
- (d) Extra low-voltage, low-voltage, and high-voltage distributions:
 - (i) Power cables are of the correct type.
 - (ii) Step down transformers are of the correct rating and size.

Status indications and alarms shall be tested for correct operation.

After commissioning and full load distribution established, secondary voltages shall be measured at each location in the distribution and adjusted if necessary.

NOTE:

Adjustment of the power supply transformer output will require checking of all previously set voltages.

Emergency power supplies shall be tested to ensure that:

- (e) emergency power supplies are of the rated capacity;
- (f) that main/standby changeover operates correctly with appropriate alarms and indications; and
- (g) auto transfer switches and UPS's function correctly during a switchover from mains to standby.

Standby batteries shall be tested to ensure that standby batteries operate correctly under power failure conditions, secondary cells are correctly rated, have all covers fitted, and that charging apparatus is of the correct type.

Earth leakage shall be tested:

- (h) Detectors – test earth leakage detectors and their associated alarms and indications.
- (i) Bus bars – test bus bars for earth leakage in accordance with instructions and verify that there is no interconnection between bus bars of different supplies.

5.9 Signalling equipment enclosures and rooms

Signalling equipment enclosures and rooms shall be tested to assure they comply with specific application requirements and approved signalling design.

An inspection shall be conducted to ensure that the installation conforms to the relevant signalling installation specifications, particularly with respect to checking all apparatus is installed in the correct location, in the correct numbers, has been approved to be used and is of the correct type.

5.10 Miscellaneous apparatus

All other signalling apparatus not specified, should be submitted to the same testing principles, with appropriate documentation, to satisfy the quality and safety assurance requirements for testing signalling safeworking systems.

Inspections and testing of miscellaneous apparatus shall check:

- (a) positioning of field apparatus;
- (b) cabling;
- (c) labelling;
- (d) the apparatus has been set up and adjusted to meet RIM requirements, and the apparatus operates within manufactures and RIM specifications; and
- (e) the apparatus achieves the design plan functionality in accordance with the design, application specific specifications and requirements.

Appendix A Hazard Register (Informative)

Hazard number	Hazard
9.7	Level crossing failure (Design)
9.8	Points and or release failure (Design)
9.9	Power supply failure (Design)
9.10	Signals failure (Design)
9.11	Train Authority System failure (Design)
9.12	Train detection failure (Design)
9.13	Interlocking failure (Design)
9.18	Control system failure (Construction)
9.20	Level crossing failure (Construction)
9.21	Points and or release failure (Construction)
9.22	Power supply failure (Construction)
9.23	Signals failure (Construction)
9.24	Train Authority System failure (Construction)
9.25	Train detection failure (Construction)
9.26	Interlocking failure (Construction)
9.28.1	Control system failure (Test and Commission)
9.29	Level crossing failure (Test and Commission)
9.30	Points and or release failure (Test and Commission)
9.31	Power supply failure (Test and Commission)
9.32	Signals failure (Test and Commission)
9.33	Train Authority System failure (Test and Commission)
9.34	Train detection failure (Test and Commission)
9.35	Interlocking failure (Test and Commission)

Bibliography (Informative)

The following referenced documents are used by this Standard for information only:

- AS 7651, *Axle Counters*
- AS 7658, *Level Crossings – Rail Industry Requirements*
- AS 7718, *Signalling Design Process Management*
- AS 7473, *Complex Systems Integration of Railways*
- AS 7474, *Rail Industry - System Safety*

DRAFT FOR PUBLIC CONSULTATION