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Preface

This Standard was prepared by the Signal Testing & Commissioning Development Group, overseen by the ARISO Train Control Systems Standing Committee.

This document has been updated from the previous version, including:

(a) removal of technology specific requirements;

(b) updates to enable use of digital train control technologies such as ETCS and CBTC; and

(c) increased clarity and definition of requirements.

Objective

The objective of this Standard is to provide a common framework for rail infrastructure managers (RIM) to plan and execute the inspection, testing and commissioning of new and altered signalling infrastructure.

The concepts within this Standard are intended to be applied throughout any railway signalling project, both in the context of a railway signalling and train control system project, and during the operating life of the system.

This Standard defines requirements and recommendations to effectively plan, execute and finalize the testing and commissioning activities, but does not detail the methods by which those requirements may be fulfilled

The companion standard AS 7716 defines the processes, detailed test procedures, and the performance requirements for equipment and installations which constitute the signalling and train control system.

Compliance

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

(d) Requirements.

(e) Recommendations.

(f) Permissions.

(g) 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. This includes the following:

(a) The minimum sufficient inspection and testing requirements to assure the safety of the system.

(b) Appropriate test procedures to ensure consistency in testing and testing outputs.

(c) Minimum documentation necessary to ensure a comprehensive record of test results to demonstrate the safety of the system.

(d) Appropriate processes to plan the inspection and testing to ensure that all necessary testing is completed, including unexpected changes and events.

(e) Appropriate processes for managing the testing activities to ensure that they are completed in a timely manner without wasting resources.

(f) Processes for the orderly handover of a commissioned system to the responsible RIM.

(g) Processes for ensuring that inspection and testing work is performed by persons having the necessary competency and authorization.

This document covers the testing of:

(h) the application logic that is applied in conjunction with technology-based products as a part of signalling and operational telecommunications systems;

(i) the safety requirements of a system where these are implemented by means of application logic or other engineering details; and

(j) products to ensure they are correctly installed and operating in accordance with the relevant specifications and engineering details.

This document addresses several different aspects of inspection and testing activities.

(k) Works testing – The inspection and testing requirements where new works are being implemented or major alterations are being carried out.

(l) Maintenance testing – Inspection and testing requirements for minor works such as planned maintenance works and like-for-like replacements which require a testing plan are carried out, requiring the certification of the safety of the signalling system before returning to service.

(m) Emergency works or temporary works – Inspection and testing requirements following emergency repairs or suspected wrong-side failures, which require the certification of the safety of the signalling system before returning to service.

(n) Use of monitoring and test products – Design control and certification requirements where an operational system is to be monitored, involving the extended connection of temporary wiring and monitoring equipment.

For the purposes of this document, the following applies:

(o) Design and installation – assumes that design and installation activities are undertaken in accordance with ISO 9001 and AS 7718 as applicable, and requirements specified by the relevant RIM. This document does not prescribe design or installation requirements;

(p) Inspection and testing – covers all activities from the acceptance of manufactured materials and components to the inspection and testing of elements of the

system built off-site or within the project boundaries, up to the commencement of commissioning; and

(q) Commissioning – covers all changeover, set to work, testing and certification activities involved in taking the redundant existing equipment out of service and bringing the new system into operation.

This document is structured around activities for a linear project culminating in a single commissioning, but also defines additional requirements for inspection and testing of projects involving multiple stages, each involving the commissioning of the signalling and control system in its new (if temporary) configuration.

This document is written principally around requirements for processor and relay-based signalling systems but also includes requirements for mechanical signalling equipment where that forms part of the system.

This document also applies to onboard signalling systems, for the inspection, testing and commissioning of onboard signalling systems as installed on each set or fleet unit, including verification of installation, configuration, interfaces and operational performance.

This document does not include type or product approval activities, except where site-specific testing is required to demonstrate that an approved product has been correctly applied.

Whilst this document does not address product testing as covered by AS 7702, there are requirements within this document regarding product testing in the testing and commissioning. Examples of when this could occur include:

(r) an in-service trial or pilot of the product is taking place as part of the product acceptance process;

(s) the application requirements associated with the product require site-specific tests to demonstrate that the product and the application logic have been correctly integrated; and

(t) the safety requirements for the product are not explicitly defined and therefore need to be tested on a site-specific basis.

The document includes all processes although some projects will not require every process. The following items are excluded from this document:

(u) Infrastructure on heritage railways unless there is an interface with a non-heritage railway.

(v) Infrastructure on light railways unless there is an interface with a non-heritage 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 7716:2026, *Signalling Testing Process*

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
accreditation
formal recognition that an individual or organisation has demonstrated the competence and authority to perform specific signalling, testing, or commissioning activities

1.3.2
application data
set of data which defines and configures the interlocking and controls for a particular location and functions for computer-based interlocking and other electronic systems

Note 1 to entry: Application data broadly refers to all data used in hardware. This can be broken down into more specific types such as generic data and specific data which could have different test and commissioning requirements.

1.3.3
asset register
authoritative record of signalling assets, including type, location, configuration and identification data, maintained for operational and maintenance purposes

1.3.4
automatic train protection (ATP)
system that supervises train speed and movement authority and automatically intervenes to prevent unsafe operation

1.3.5
bring into use
accept and sign into operational use in accordance with the RIM's safeworking procedures

1.3.6
booking out of use
formal process by which signalling equipment or infrastructure is removed from operational service in accordance with safeworking rules

1.3.7
certification
signing off of a test record to signify that the testing activity has been completed and that the item under test has met the design and standards requirements

Note 1 to entry: Certification can include exceptions as noted on the test record. Certification is used to indicate any missing activities or the unnecessary repetition of activities.

1.3.8
certificate of signalling
statement of assurance that all inspection and testing have been completed, and all test logs and test documentation have been collected and dealt with as required, executed and signed by the tester-in-charge

Note 1 to entry: The certificate of signalling typically covers the signalling component of the commissioning. Other disciplines such as communications and train control could have their own certificates, or they could be part of the certificate of signalling.

1.3.9
commissioning (of signalling equipment)
final phase of the implementation of signalling installation work where the installed equipment is permanently connected through, set to work, tested, accepted as ready to bring into use and then brought into operational use in accordance with the safeworking procedures

1.3.10
commissioning readiness review
structured assessment undertaken prior to commissioning to confirm that installation, testing, documentation, resources and risks are suitably controlled

1.3.11
computer based interlocking (CBI)
electronic interlocking system that uses software, configuration data and processors to control signals, points, and interfaces safely

1.3.12
configuration management
processes for identifying, controlling, tracking and verifying versions of designs, data, software and documentation throughout the project lifecycle

1.3.13
control table
tabulated definition of signalling control, interlocking and release requirements forming the basis for functional and principles testing

1.3.14
design office
authorized engineering organization or design group responsible for producing the approved designs for the new or altered signalling works

1.3.15
dynamic testing
testing conducted under simulated or real operational conditions, including train movements, to verify system behaviour and interactions

1.3.16
factory acceptance testing (FAT)
testing conducted at a manufacturer's or off-site facility to verify that equipment or systems conform to specified requirements before delivery to site

1.3.17
false feed
temporary test supply or connection used solely to facilitate inspection or testing activities

1.3.18
ground frame
local mechanical or electrical control arrangement that allows manual operation of points or other signalling equipment

1.3.19
handover package
complete, certified set of documentation provided to the rail infrastructure manager at project completion, evidencing safety, compliance and readiness for operation

1.3.20
infrastructure booking advice
advice provided to the network control officer when signalling equipment is disconnected and out of use for traffic operations, and when it is restored to use for traffic operations

1.3.21
inspection (verification)
verification activity to establish compliance with standards and design

Note 1 to entry: An inspection that involves visual observation can include visual comparison of dimensions against a physical reference. It does not include any active interference with the operation of the subject equipment or installation. Hand tracing is a verification inspection activity.

1.3.22
inspection and testing detailed plan
detailed plan that includes the inspection and testing and signalling safeworking activities necessary during each phase or stage for each specific unit of signalling apparatus or system

Note 1 to entry: The detailed plan is analyzed to generate the individual work instructions for units of work to be included in the installation and/or commissioning work packages.

1.3.23
inspection and testing outline plan
tabulation of all separable elements of the signalling and control system that will require a form of inspection and testing, and the specific inspection and testing activities required for each element

1.3.24
inspection and testing overview
general description of the inspection and testing, signalling safeworking, associated worksite protection and possession requirements for the construction and commissioning of new and altered works

Note 1 to entry: The inspection and testing overview is a general description of the scope of works, methodology and resources required for significant aspects of the inspection and testing.

1.3.25
interface coordination plan
document identifying the physical and functional interfaces between the stakeholders of a project, the work required at the interfaces, and the division of responsibilities between stakeholders, and agreed to by the stakeholder representatives

1.3.26
interlocking
safety system that prevents conflicting train movements by enforcing logical relationships between signals, points and train detection

1.3.27
nominated person
person formally appointed within a project to take responsibility for specified tasks or obligations

1.3.28
non-vital
not directly affecting system safety

1.3.29
possession
defined period during which rail traffic is excluded from a section of track to allow works, testing or commissioning

1.3.30
principles testing
testing that validates the integrity and safety logic of the interlocking by demonstrating correct behaviour under all permitted and fault conditions

1.3.31
rail infrastructure manager (RIM)
As defined in Rail Safety National Law.

1.3.32
rail safety worker (RSW)
As defined in Rail Safety National Law.

1.3.33
regression testing
testing performed to verify that changes or corrections have not adversely affected previously verified functions

1.3.34
safeworking
system of rules, procedures and controls used to ensure the safe operation of trains and the protection of personnel during works

1.3.35
safety management system (SMS)
As defined in Rail Safety National Law.

1.3.36
set to work
process of placing signalling apparatus or systems into a state suitable for certification testing

1.3.37
stagework
temporary configurations, wiring or operational arrangements used to enable phased installation or commissioning while maintaining safe railway operations

1.3.38
static testing
testing performed without train movements, used to verify correct installation, configuration and basic functionality

1.3.39
temporary wiring
wiring installed solely for testing or stagework purposes, which does not form part of the final operational configuration

1.3.40
test case
structured, step-by-step, procedure used to verify that the signalling system functions correctly according to the design specifications

1.3.41
test log
document for recording all errors and queries identified in testing, and for tracking the resolution and close-out of each log item

1.3.42
test specification
specification than can be generic or project specific, stand-alone, or contained in a method statement, code of practice, test plan, test scenario or other suitable document

1.3.43
tester-in-charge (TIC)
individual with overall responsibility and authority for the control, coordination, and certification of inspection and testing activities

1.3.44
testing
verification
systemic activity to establish compliance with design and performance requirements

Note 1 to entry: Testing involves a physical intervention with the operation of the equipment or system, while observing the resulting behaviour of the system. The intervention can be physical (e.g., the opening or bridging of a contact), active electrical (applying a voltage or current) or passive electrical (drawing a current or measuring a voltage. The latter is usually managed to minimize impact on the system's operation). For example, bell testing is a verification test activity.

1.3.45
testing strategy
written statement of the proposed testing methodology, including interface and stagework requirements, prepared on the basis of the specification, proposed layout and anticipated testing content of the scheme

1.3.46
testing work instruction
detailed instruction that lists all test steps to be carried out to complete a specified testing activity, derived from an approved test specification

1.3.47
track circuit
electrical circuit used to detect the presence or absence of a train on a defined section of track

1.3.48
validation
confirmation, through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled

Note 1 to entry: The term validated is used to designate the corresponding status.

Note 2 to entry: The use conditions for validation can be real or simulated.

Note 3 to entry: In design and development, validation concerns the process of examining an item to determine conformity with user needs.

Note 4 to entry: Validation is normally performed during the final stage of development, under defined operating conditions, although it can also be performed in earlier stages.

[SOURCE: EN 50126-1:2017]

1.3.49
verification
confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

Note 1 to entry: The term verified is used to designate the corresponding status.

Note 2 to entry: Design verification is the application of tests and appraisals to assess conformity of a design to the specified requirement.

Note 3 to entry: Verification is conducted at various life cycle phases of development, examining the system and its constituents to determine conformity to the requirements specified at the beginning of that life cycle phase.

[SOURCE: EN 50126-1:2017]

1.3.50
vital
directly affecting system safety

1.3.51
witnessing
independent observation of the testing process to ensure compliance with the testing instructions

General rail industry terms and definitions are maintained in the ARISO Glossary. Refer to:
https://www.ariso.com.au/glossary/

Section 2 Principles of testing and commissioning

2.1 General

Railway signalling and control is an equipment-based system provided for the safe and efficient movement of trains, developed as an alternative to manual systems based on regulations and verbal communications, which are inherently subject to human error.

The operational safety of the movement of trains is devolved from the RIM's SMS to the signalling system. This operational safety is then devolved on the systems designers, installers, testers and maintainers.

Signalling safety and reliability are inter-related, with signalling failures leading to the implementation of less-safe methods of moving trains such as degraded working.

The safety of the signalling system depends on correct:

(a) equipment and system design to applicable standards;

(b) manufacture to the design specifications;

(c) installation to the design and to standard practices;

(d) complete and thorough testing; and

(e) maintenance to standards.

Signalling and control systems shall not be allowed to enter or re-enter service without first being subjected to suitable and sufficient testing which proves the system:

(f) is safe in accordance with signalling standards; and

(g) functions reliably to operating requirements.

2.2 Risk management

Railway operations involve hazards that can result in harm if not adequately controlled. Risks must be reduced so far as is reasonably practicable (SFAIRP) in accordance with the Rail Safety National Law, including through robust testing and commissioning processes.

NOTE:

The Office of the National Rail Safety Regulator (ONRSR), which administers the Rail Safety National Law across Australia, has signed a Memorandum of Understanding (MOU) with the work health and safety (WHS) authorities of all state and territory jurisdiction.

Any change to the rail infrastructure shall be managed in accordance with SFAIRP principles in accordance with the RSNL.

The planning and implementation of an effective regime of inspection and testing is a critical element in reducing risks SFAIRP in a signalling project.

2.3 Verification & validation

Standards and procedures shall be established and maintained for the verification and validation of the construction and implementation of safety related signalling and telecommunications systems. These standards and procedures shall include the following:

(a) Verification that the installed system conforms to the detailed design and to client requests, safety requirements, standards and regulatory requirements.

(b) Validation that the installed system conforms to the required specifications, safety standards and client requirements.

These verification and validation processes shall be performed independently from the construction and implementation process. The degree and nature of this independence shall be determined, as a minimum, by the following factors:

(c) The risk of errors being perpetuated during the verification and validation process due to there being too close an association between the persons performing the verification and validation and those involved in the construction and implementation process.

(d) The risk imposed on the existing system both by the introduction of the system to be verified and validated and by faults or inconsistencies in that system.

Where independence cannot be achieved, other controls (such as minimum competence requirements) should be implemented to ensure any additional risk due to a lack of independence is controlled. Refer to EN 50129 for further guidance.

2.4 Objective of inspection and testing

The objective of the testing and commissioning of new or modified systems is to provide evidence through verification and validation that the system has been built and functions in accordance with the approved design, functional requirements and signalling principles.

Signal designers, installers, testers and maintainers assure safe operation by appropriate inspection and testing to approved standards.

Inspections check the finished installation against applicable standards and design.

Testing verifies that the system has been installed in accordance with the design.

Testing is performed to prove that the signalling apparatus functions in accordance with the approved design standards and user requirements, and that fail-safe apparatus and control functions will de-energize if any of the required elements are non-compliant.

The outcome of any testing and commissioning activities is an assurance from those responsible for those activities that, once commissioned, the system is:

(a) installed and tested as per the signal design; and

(b) safe for operation .

The assurance of the completeness, safety and quality of the new system shall be based on the body of evidence contained in the records produced by verification and validation activities which includes testing and commissioning records.

2.5 Testing principles

Inspections and tests shall verify:

(a) detailed conformance to the approved signalling design documentation;

(b) compliance with the applicable signalling standards;

(c) correct interlocking between conflicting routes;

(d) correct control of routes by train detection and point detection; and

(e) correspondence between controls, indications and trackside apparatus.

Inspection checks and tests as specified shall be carried out and monitored against a testing plan to assure all tasks are planned, completed, and sufficient time is allowed to effectively carry out that work.

Assurance of a correct installation is achieved by inspection checks, and electrical and functional tests of the whole of the installation against the design drawings and the particular and standard specifications and practices applicable to the work, to ensure that:

(f) the equipment is manufactured to specification;

(g) the equipment is correctly located and secured in position, correctly labelled and indexed;

(h) the equipment is correctly interconnected and interlocked and operates correctly (i.e. all wiring is as shown in the circuit diagrams);

(i) the system's discrete functions are:

(i) correctly isolated and insulated from false operation;

(ii) secured against improper movement; and

(iii) protected against interference, damage and deterioration.

(j) false feeds, temporary wiring or any extraneous or redundant equipment are removed.

2.6 Types of inspection and test

Inspection checks are visual analysis of the apparatus installed at a location to ensure that it is built to the approved design and is correctly designated.

Electrical tests comprise of:

(a) earthing tests;

(b) insulation tests;

(c) bell continuity tests:

(d) wire counts and null counts;

(e) voltage and current tests; and

(f) electrical function tests.

Function tests are the operation of manufactured or installed equipment to check if they function in accordance with the design specification.

A detailed list of tests is provided in AS 7716

The complete inspection, testing and certification plan may include a combination of work carried out on site and work done before the equipment and systems are delivered to and installed on site. The choice of pre-site or on-site testing will be based on the types of signalling technology involved and the benefits in quality, project delivery and cost that can be achieved.

Pre-site inspection and testing activities may include:

(g) simulator testing and certification of CBI application data;

(h) factory acceptance testing of complete CBI systems (temporarily set up in a factory environment);

(i) circuit and function testing of pre-wired modules, relay racks and equipment housings.

On-site inspection and testing shall comprise the completion of the planned activities not carried out during pre-sire inspection and testing. This may include:

(j) progressive inspection and testing of equipment, cables and wiring installed on site;

(k) staged pre-commissioning of new field equipment items (temporarily operating as part of the existing signalling);

(l) controlled partial pre-testing of sections of new wiring (generally in complex interlockings, to minimize scope in the final commissioning period); and

(m) all changeover installation circuit and function testing, through testing and integrity testing associated with the final commissioning period.

On-site pre-commissioning testing can be necessary to assure quality control and reduce the commissioning task.

In such cases, separable completed parts of circuits may initially be energized and set to work (using false feeds and temporary test wiring if necessary) in order to test that the separable part functions correctly.

A thorough test of the circuit shall be conducted following individual circuit testing, with all parts completed and connected and with all false feeds and temporary wiring removed.

2.7 Minimum necessary inspection and testing

An inspection and test plan for a signalling system shall describe the minimum combination of inspections and tests necessary to provide assurance evidence for the verification and validation process that the new system will operate safely, efficiently and reliably, in accordance with user requirements.

The inspection and test plan should use the minimum number of resources (i.e. competent personnel and time) necessary to achieve the above outcome.

The inspection and testing plan should aim to:

(a) perform the minimum amount of inspection and testing necessary to support assurance in line with verification and validation requirements that the commissioned system is safe for operation, and is built to the approved standards that will ensure the degree of reliability required to provide operational safety at all times;

(b) integrate the inspection and testing with the construction activities, so that the minimum possible amount of repeated testing is required; and

(c) plan and schedule inspection and testing to:

(i) ensure that design, installation and equipment faults are identified as early as possible;

(ii) minimize subsequent rework; and

(iii) ensure that faults are identified while are still visible and before they are rendered latent by subsequent installation work.

2.8 Communication protocols for inspection and testing

Throughout testing activities, clear and concise communications shall be maintained to ensure that information, instructions and requests are given in a manner that is not liable to be misunderstood.

All persons conducting inspections and tests with other personnel and communicating inspection or testing messages shall use agreed terms and pre-established question and answer formats that are unambiguous and clearly understood by those involved.

Clear and concise communication shall be maintained to ensure that information, instructions, requests and responses are given in a manner that avoids misunderstanding.

The following defined methods of identification, terminology and forms of acknowledgement/repetition shall be used:

(a) Common systems of identification (e.g., personal names, team numbers, call signs) and acknowledgement/repetition. Confirmation of the completion of an action needs to be received before the results of that action are noted.

(b) Clear, precise, and where available, standard terminology.

Colloquialisms and local common terminology in respect of name and state of equipment and geographical location should be avoided. Where standard, frequently used terminology is not available, the terminology to be used prior to undertaking the testing activity shall be agreed.

Requests for information (e.g., state of system equipment or function) shall be specific ad clearly given.

Requests leading the receiver to give a particular response shall not be used.

Persons conducting inspections and tests with other personnel shall ensure:

(c) that all persons communicating inspection or testing messages use agreed terms and pre-established question and answer formats that are unambiguous and clearly understood by those involved;

(d) that the identity of persons communicating inspection and testing messages is clearly established on each occasion; and

(e) that results are not recorded until after clear confirmation is received (i.e. do not anticipate).

Recommended communication protocols are detailed in the *ARISO Code of Practice – Safety Critical Communications*.

2.9 Certification records

Inspection and testing activities and results shall be recorded and documented in order to be able to demonstrate that all testing activities have been completed, and that the signalling infrastructure as commissioned has satisfied all requirements.

2.10 Common documentation

Testing documentation shall be common and integrated across the signalling and control systems. The testing documentation shall include, but not be limited to, the format of test strategy, test plans, test specifications, records of testing, and certificates.

Each check, adjustment or test for each individual piece of apparatus shall be documented in the test plans and associated documents. Provision shall be made for clear certification of the status of the inspection, check or test.

Test records and documents shall be completed, reviewed, checked and signed by competent persons who have conducted the specified tests.

2.11 Defining testing activities – Test specifications

Each testing activity to be conducted shall be documented and include a clear statement of the objective, content and acceptance criteria for that test.

The individual test specifications required for the testing of the project shall be supplied to the person(s) responsible for performing the testing.

Testing requirements shall be documented as required by the RIM. Test specifications shall contain the following details as a minimum:

(a) Objectives of the test.

(b) Details of the determining requirements from which the test was derived and which the test is required to substantiate.

(c) Initial and final conditions where this can influence the result.

(d) Competencies required to carry out the test.

(e) Tools, measurement and test equipment required to carry out the test

(f) A description of the test activities to be performed.

(g) Results expected and acceptance criteria (e.g., outputs correspond to inputs, measurements are within specified parameters, application logic functions in accordance with design requirements).

Where no suitable RIM approved testing specification exists for the equipment or system appropriate to the specific application, testing requirements shall be derived from the system and user requirements which include, but are not limited to:

(a) concept design;

(b) engineering details;

(c) manufacturer recommendations;

(d) safety requirements;

(e) installation specifications; and

(f) rules and regulations.

Tests and verification that the selected specification is appropriate for the specific application shall be approved by the RIM. Test specifications may be:

(g) generic or project specific; or

(h) stand-alone, or contained in a method statement, code of practice, test plan, test scenario or other suitable document or combination of documents.

Checklists can be produced in association with test specifications to aid critical appraisal of aspects of the system.

All test specifications shall be prepared by competent persons.

Test specifications relating to products that are safety-critical in application shall be independently verified. So far as is practicable, any change or addition to a test specification shall be dealt with in the same manner.

The risks arising from any necessary change to any generic test specification (e.g., in nature, content or environment) shall be assessed and controlled before any such change is implemented.

2.12 Quality assurance

The testing process shall be specified and documented in accordance with a quality system approved by the RIM.

All changes to plans and procedures shall be documented and approved to the extent of the original plan or procedure.

Testing work shall be subject to levels of supervision, quality checks and audit that are sufficient to ensure that the approved procedures and methods of work are applied correctly.

The procedures for supervision, quality check and audit shall be documented.

The levels of supervision, quality checks and audit shall be determined through assessment of:

(a) complexity of the work and the extent to which it is unusual or unique;

(b) competency of the testing personnel in relation to the work being performed;

(c) likelihood of errors being made; and

(d) consequences of such errors.

2.13 Roles and responsibilities

The signalling testing and commissioning process involves many different roles and responsibilities. All personnel undertaking and/or supporting the tasks within this process shall meet the competency requirements of the RIM.

Where the RIM does not have a specific requirement for competency for a task, the personnel shall be able to demonstrate that they have the competency to undertake that task.

Where there are legislative requirements for accreditation of engineering work or other tasks, then these shall be addressed in the inspection and test detailed plan and resourced accordingly.

Records shall be maintained of the competence of personnel undertaking testing and commissioning tasks.

Commentary *C2.13*

The Australasian Railway Association has developed the National Rail Matrices to assist RIMs in defining roles and the competencies required to carry out those roles, including for signalling design. Further information can be obtained at www.riw.net.au

2.14 Witness

A witness may be appointed to witness testing activities as deemed necessary to verify that the test plan or commissioning plan and associated procedures are being complied with. The test and commissioning strategy should define the authority of the witness to require corrective actions found necessary during the audit

The appointment of a witness shall not relieve any commissioning personnel of any responsibility for the testing and commissioning.

The witness may need to hold appropriate qualifications relevant to the testing activities.

The witness should endorse those items of the test plan or commissioning plan that have been observed and prepare a report.

2.15 Single identifiable point of responsibility

Inspection and testing work and authorities shall be managed so that the responsibility for each inspection and testing activity is allocated and can be traced back to a single individual.

All testing records shall be signed by the individual/s who conducted the test to provide traceability.

The signatures of more than one tester may appear on a single record, such as a circuit diagram used for circuit testing. Testers should use different colours for marking records to ease identification of person who made the mark.

Where a testing activity involves a team of persons, the lead tester shall be the responsible individual.

2.16 Independence of testing personnel

The principle of independent inspection and testing of new and modified work is that no safety critical outcome should rely solely on one person doing and also certifying their own work. This reduces the likelihood of the person doing the work and the checker making the same mistake due to a common cause.

EN 50129 provides further detail on the requirements for independence.

The person conducting the inspection, testing and certification work shall be responsible for the safety of the work.

There shall be a degree of independence appropriate to the safety integrity of the product in its intended application. Specifically:

(a) for non-safety-related applications, the same person is permitted to undertake the design and testing activities; and

(b) for safety-related applications, the persons undertaking testing activities shall be independent of those who produce, verify or install the designs that are being tested.

Each phase of acceptance testing shall be performed by persons independent of those who have constructed the system to be tested.

Any person who has installed vital equipment or circuits for new and altered work shall not carry out the certification inspection and tests of the vital items or circuit elements that they have installed.

System validation shall be performed by persons independent of those who have designed the system to be validated.

NOTE:

At a project engineering level, there are integrity advantages in having more familiarity, rather than less, with the physical and functional characteristics of the project.

For example, the project engineer in the role of commissioning engineer has the direct knowledge of the project, its interfaces and history necessary to ensure comprehensive inspection and testing planning, coordination and implementation.

The determination of the degree of independence appropriate to the nature and complexity of the project shall be a balanced judgement by experienced signal engineers.

The major determinant in selecting persons to perform the certification inspection and testing shall be their competence, experience and licensing or authorization to the required level.

The lack of availability of suitable personnel shall not justify any lowering or absence of the required independence.

Where EN 50129 is applied, testing, verification and validation activities shall be undertaken with a degree of independence consistent with the principles of that standard.

Where independence cannot be achieved, other controls (such as minimum competence requirements) should be implemented to assure any additional risk due to a lack of independence is controlled. Refer to EN 50129 for further guidance.

If it is not possible to achieve independence, then approval shall be given by the RIM of the alternative control measures that will be used to control the additional risk due to the lack of available competent independent resources.

2.17 Inspection and testing requirements

Certification inspection and testing shall verify that the installation is:

(a) physically in accordance with the designs and specifications;

(b) functionally in accordance with the designs and specifications;

(c) fail-safe, for the aspects of fail-safe behaviour verified through installation, inspection, and testing.

Not all fail-safe features are functionally tested. Accordingly, certification relies on fail-safe features verified through test and commissioning, together with reliance on the inclusion of other fail-safe features in the approved design and their verification through inspections, checks and other assurance

activities (e.g., back proving of relays, apparatus inspections, continuity tests, wire counts, contact proving or equivalent checks for electronic systems).

Certification testing shall be undertaken to verify that each item of signalling apparatus operates safely in relation to other items of signalling apparatus and operates safely in the presence of a train, in accordance with the design.

The control to an item of signalling apparatus shall operate over the indications of other items of signalling apparatus. The interlocking between these controls and indications shall be tested and certified.

Certification tests shall be performed to verify correspondence between each item of signalling apparatus and its individual controls and indications, both locally and centrally.

The links to control consoles and indicator diagrams, including certificating testing inclusive of timings and synchronization, shall be proved.

Where an electrical contact indicates the position of an item of trackside apparatus, contact proving tests shall be performed to verify that the contact electrically opens and closes when the trackside apparatus operates, and that it electrically opens and closes all indicating and/or repeat relays in correspondence with the apparatus.

When one item of trackside apparatus locks or is released by another, then interlocking tests shall be performed to verify the inability of each item to operate when the other item is in the conflicting state.

When one item of trackside apparatus is controlled by another, then control tests shall be performed to verify that the item returns correctly to the non-operated position when the status of the other is changed.

Where the item of trackside apparatus is controlled by another that has separate normal and reverse indications, it shall also be tested to return to the non-operated position when the wrong control indication is made.

Certification tests shall be performed to verify that trackside apparatus for train detection reliably detects the presence of a train.

RIMs and contractors undertaking signalling projects shall ensure that projects are adequately resourced with competent personnel and are able to perform their allocated duties.

Section 3 Roles and responsibilities

3.1 General

Inspection, testing and commissioning are critical activities for ensuring the safe and reliable performance of railway systems and equipment.

All personnel involved in testing and commissioning shall have clearly defined responsibilities. Evidence shall be documented that those responsibilities are understood and implemented.

In allocating roles and responsibilities, all inspection and testing related activities and needs shall be identified and adequately resourced.

3.2 Allocation of roles

Testing personnel shall be appointed in sufficient time for them to become acquainted with their roles and responsibilities. Any knowledge/skill enhancements required shall be assessed and remedied as required.

Appointees shall be notified of their delegated authorities and responsibilities.

In every signalling project there are several personnel undertaking a complex of inter-related activities, of which inspection and testing activities constitute only one part.

Depending on the scale of the project, roles may be shared by several individuals, or conversely one person may perform several roles.

Allocation of roles shall assess the nominated individual's workload and be subject to their holding the appropriate licenses and authorizations.

Regardless of the nature of the signalling works, a nominated person shall hold overall responsibility for the inspection, testing and certification of the project from the initial development of the testing and commissioning plan through to completion, and for setting the signalling to work.

3.3 Appointment of testing personnel

The RIM shall develop and implement procedures for formally appointing persons in overall charge of the testing, and for the subsequent appointment of testing personnel.

The RIM shall ensure that for each project, a nominated person is identified as being in overall charge of the testing and commissioning of signalling and control systems.

The nominated person shall be responsible for the:

(a) organization, control and satisfactory completion of the testing;

(b) appointment and deployment of suitable and sufficient testing personnel;

(c) use of suitable procedures and processes;

(d) collation of all documentation required for the purposes of testing; and

(e) recording and reporting of the testing activities.

The nominated person shall record:

(f) acceptance of any test plan or schedule affecting safety-related systems; and

(g) their assurance of the completeness, suitability and satisfactory outcome of the testing.

The nominated person shall implement a process of assessment and documentation to ensure that all testing personnel hold the necessary competencies and authorizations for the testing to which they are appointed.

Section 4 Scope of testing and commissioning

4.1 General

The testing and commissioning activities shall ensure that the entire signalling works, and the infrastructure to which they interface, will function safely and reliably after commissioning.

Where testing and commissioning involves multiple sub-systems (e.g., communications, on board systems, etc.), AS 7473 should be reviewed for guidance.

For safety related aspects, the inspection and testing shall ensure that:

(a) equipment and materials are correctly installed to specification;

(b) equipment is correctly located and secured in position, correctly labelled and correctly indexed in accordance with the design;

(c) equipment is correctly interconnected in accordance with the design;

(d) there are no connections or equipment items additional to what is in the approved design;

(e) equipment is correctly configured with the approved application data and configuration data applicable to the design;

(f) equipment correctly operates, indicates and interlocks in accordance with the design;

(g) equipment is correctly isolated and insulated from false operation, secured against improper movement, and protected against interference, damage, and deterioration, to specification and standards;

(h) redundant equipment is made inoperative and removed. If equipment cannot be removed (e.g., redundant cables intertwined with operating cables) it is clearly labelled out of service;

(i) false feeds, temporary wiring and any extraneous items are removed.

Accurate records and certification of the above activities shall be produced and maintained for handover to the RIM.

The activities required to adequately test and commission works in relation to a specific application are highly dependent upon:

(j) the technology used;

(k) the complexity;

(l) the duration; and

(m) the potential risks, for example, the type of train service.

The selection of the activities required shall assess the above issues.

Decisions taken to omit selected testing and commissioning activities specified in this document shall be supported by documented justification.

Inspection and test plans for a project shall confirm the following requirements:

(n) The correct configuration and operation of all new equipment.

(o) The correct configuration of all new and altered circuits.

(p) The correct configuration and operation of all existing circuits that can possibly have been inadvertently affected by the alteration works.

(q) The disconnection and isolation of all equipment and circuits made redundant by the works.

(r) The configuration and operational safety of all intermediate and final stages of the project.

(s) The safety and correct operation of temporary wiring provided for stageworks or testing.

(t) That design changes made in testing are correctly designed, installed, tested and documented.

(u) That the final design record correctly reflects the installed system including all design alterations.

See Section 7 for a staged approach to preparing the inspection and testing plans, including a non-exhaustive list of the required documents.

4.2 Signalling equipment to be inspected and tested

The inspection and testing activities shall cover all items of vital and non-vital signalling equipment functionality (including profiles and arrangements). This should include the following (where installed):

(a) Trackside apparatus:
  (i) Signals and indicators.
  (ii) Signaling related signage and instruction.
  (iii) Enforcement devices.
  (iv) Point operating/locking mechanisms, gauges, timings and detectors.
  (v) Track circuits, track insulation and bonding.
  (vi) Wayside condition monitoring systems and associated interfaces.
  (vii) Axle counters, treadles and electronic wheel sensors.
  (viii) Balises, beacons and transponders.
  (ix) Traction return bonding and earthing.
  (x) Ground frames and releasing switches.
  (xi) Level and pedestrian crossing lights and booms.
  (xii) Telephones.
  (xiii) Mechanical locks and keys.
  (xiv) Warning lights and guard's indicators.

(b) Trackside Locations:
  (i) Distributed CBI and object controllers and data.
  (ii) ATP interface modules.
  (iii) Local control and indicating contactors, relays and modules.
  (iv) Local power supplies.
  (v) Surge protection & earthing.

(c) Central interlocking and control room:
  (i) Interlocking, control and indicating relays.
  (ii) Computer based interlockings.
  (iii) Mechanical interlocking machines.
  (iv) Electric lever locks.
  (v) Mechanical locks and keys.
  (vi) CBI vital data.
  (vii) Control system non-vital data.
  (viii) Radio block centres.

(d) Control console and indicator diagram:
  (i) Panel processors.
  (ii) Keyboards, pushbuttons, switches, levers.
  (iii) Visual display units, lamps, audible alarms, train descriptions.
  (iv) Block instruments.
  (v) Staff instruments.

(e) Power supplies and distribution:
  (i) Mains power supplies.
  (ii) Transformers, transformer rectifier, converters, inverters.
  (iii) Generators.
  (iv) Chargers and batteries.
  (v) Uninterrupted power supplies and batteries.

(vi) Solar systems and batteries.

(vii) Main and local cables.

(f) Mechanical rodding and signal wire, remote control and indicating systems.

(g) Telemetry and data links:

(i) Non-vital controls and indications links.

(ii) Control system networks.

(iii) CBI data links.

(iv) Diversity links and controllers.

(v) CBI peer-to-peer networks.

(h) Monitoring and logging systems:

(i) Event loggers.

(ii) Level crossing monitors.

(iii) Trackside monitoring systems.

(i) Infrastructure systems and alarms:

(i) Traction return, bonding and earthing.

(ii) Electrolysis protection.

(iii) Power fail alarms.

(iv) Road traffic signal/level crossing interfaces.

(j) On-board signalling systems:

(i) Driver machine interface.

(ii) Odometry subsystem (including wheel sensors and related equipment).

(iii) Onboard vital computer systems for signalling application.

(iv) Onboard balise transmission equipment.

(v) Onboard communications equipment used by the signalling system.

(vi) Rolling stock interfaces required for signalling functionality (including brake, traction and trainline interfaces).

(vii) Onboard software, configuration and application data relevant to the signalling system.

(viii) Associated peripheral systems required for the intended signalling application.

4.3 Inspection and testing geographical boundaries

Inspection and testing activities shall include:

(a) all equipment and systems within the geographical boundaries of the construction or renewal area;

(b) signalling control circuits that pass across the boundaries (e.g., signal controls and aspect sequences, approach locking);

(c) train detection systems and track circuits that pass across a boundary;

(d) vital controls to and from adjacent interlockings;

(e) controls and indications from/to a remote control centre;

(f) alarms and indications to remote control panels or offices; and

(g) equipment outside the immediate geographical boundaries that could be affected by testing and commissioning activities (e.g., track circuits affected by lengthy commissioning track possessions).

4.4 Inspection and testing activities

Inspection and testing activities for new and modified works shall include:

(a) design control activities such as:
  (i) design correlation with existing signalling installation;
  (ii) design documentation control; and
  (iii) design documentation certification.

(b) interface coordination plans for communications and control systems;

(c) quality assurance of supplied equipment including type approvals;

(d) general apparatus inspection including inspection of the following:
  (i) work quality;
  (ii) condition;
  (iii) geographic positioning to check system configuration, component layout, clearance, secureness;
  (iv) profile;
  (v) labelling, inscription;
  (vi) type and rating;
  (vii) wards, indexing, pin coding, blanking plugs;
  (viii) security keys and locks;
  (ix) protection from and impact on operating environment hazards;
  (x) temporary wiring/redundant equipment removed/made safe; and
  (xi) null tests.

(e) installation inspections including:
  (i) points gauging;
  (ii) equipment clearances from track;
  (iii) track circuit clearance points at junctions;
  (iv) train stop gauging; and
  (v) signal sighting.

(f) circuit testing including:
  (i) bell continuity tests;
  (ii) wire count/null count;
  (iii) insulation tests;
  (iv) circuit function tests; and
  (v) data link tests.

(g) apparatus function testing including:
  (i) operation;
  (ii) adjustment; and
  (iii) correspondence to controls and indications.

(h) system function testing including:

(i) train control, programmable logic controller, or non-vital system through systems function tests;

(ii) fault management via vital and non-vital through systems;

(iii) mechanical interlocking tests;

(iv) electrical interlocking and control tests (control table);

(v) operational requirements tests;

(vi) through system function tests, for example, aspect sequence, points correspondence; and

(vii) principles tests.

(i) Verification that on-board signalling systems perform in accordance with the approved product requirements and product baseline, including hardware, software, and configuration versions applicable to the installed system.

4.5 Alterations and new interfaces

Where vital signalling equipment and/or circuits are modified or renewed, there can be a risk that the functionality or availability of the signalling could be affected. Therefore, all changes shall be inspected, tested and certified to function correctly and to conform to the approved designs.

The testing necessary shall mitigate any risk involved by detailed planning and adherence to these alteration procedures and practices.

Section 5 Testing and commissioning strategy

5.1 General

A testing strategy shall be developed to define the proposed testing methodology on the basis of the specification, proposed layout and anticipated testing content of the signalling scheme.

The overall testing and commissioning strategy should be decided before the design commences to define staging and enable design decisions which will simplify testing and commissioning activities to be made.

For each signalling project an inspection and testing strategy shall be prepared.

In the case of telecommunications systems, the requirement to produce a testing strategy is applicable only where the telecommunications testing is to be integrated with the signalling system testing.

It shall be prepared by experienced personnel in consultation with other relevant stakeholders at an early stage of the project and communicated to all involved.

If possible, the testing strategy should form part of the concept design documentation and be prepared at the design concept stage.

It is recognized that in many instances, designs can be completed well in advance of, and remote from, the construction and installation activities. In this case, the inspection and testing strategy should be determined at the beginning of the construction phase.

The inspection and testing strategy should remain flexible enough to allow changes in direction when problems arise.

The inspection and testing strategy should be kept up to date throughout the project development.

Where a separate testing strategy is not prepared, the contents of the inspection and testing detailed plan shall address the relevant strategic issues covered by this section

The inspection and testing strategy shall be approved as part of the inspection and test planning documentation.

5.2 Planning the commissioning

5.2.1 General requirements

Plans, programs and work packages for the commissioning of the works shall be developed.

A nominated person shall co-ordinate, direct and control the implementation of the commissioning stage of the works.

Where a project is commissioned in multiple stages, there shall be a separate installation and testing detailed plan and work package for each individual stage.

The plans and programs for commissioning of the works or any part thereof shall provide for all work to be carried out in compliance with the RIM's possession requirements and safeworking rules and procedures.

The plans and programs shall include rosters and work instructions for all persons engaged in the commissioning.

Rosters shall assess competency requirements and fatigue management for personnel engaged in safety related work, and contingencies for unexpected schedule overruns.

The commissioning program shall allow adequate time and resources to complete the work, including risk minimization strategies and contingencies for any undesirable eventualities that can reasonably be anticipated within the allocated possession time. This should include allowance for the situations where it becomes evident that some part of the works cannot be commissioned as planned.

Eventualities that shall be reasonably anticipated include:

(a) inclement weather;
(b) additional and delays to rail traffic through the possession area;
(c) delays in obtaining overhead power isolation and permit to work;
(d) plant breakdown;
(e) equipment failure and damage;
(f) fault rectification required in previously untested work;
(g) commissioning design modifications; and
(h) availability of personnel.

5.2.2 Operational requirements

All field activities associated with the de-commissioning, changing-over and testing work and commissioning should be carried out when rail traffic is excluded (i.e. under track possession).

If train running cannot be avoided, any testing that involves unlocking of points, the risk of displaying inappropriate signal indications to rail traffic crew, affects reliability or disrupts train running shall be carefully planned and completed in the available time.

Safeworking of trains shall be in accordance with the RIM's safeworking rules and procedures and conducted by authorized personnel.

All hazards during testing and commissioning shall be identified and contingency plans put in place.

There shall be a clear understanding and agreement between all involved parties of the safeworking systems to be employed during the period from the shutdown of the old system to the commissioning of the new system.

5.2.3 Construction locks

A separate for-construction set of locks and keys should be used during the construction and testing stages, with these being replaced with the RIM's standard maintenance locks and keys when the equipment is commissioned.

5.2.4 Testing and certification

All inspection, testing and certification carried out during the commissioning shall be recorded and the records made available for audit at any stage of the commissioning.

5.3 Content of inspection and testing strategy

The inspection and testing strategy shall be a written general description of the approach to the inspection and testing, signalling safeworking, associated worksite protection and possession requirements for the construction and commissioning of new and altered works.

The inspection and testing strategy should include sufficient details to enable the design office to develop designs which include any constraints affecting testing or commissioning.

The inspection and testing strategy shall include a written general description of the scope of works, methodology and resources required for significant aspects of the works. The inspection and testing strategy should cover the following areas:

(a) Implementation strategy for the works (e.g., on- and off-site work, operational restrictions and requirements).

(b) Identification of all third-party and internal interface work to be co-ordinated.

(c) Define the limits of the testing, including responsibilities and interfaces (e.g., equipment, area, and project interfaces), stagework requirements.

(d) Define the type and duration of commissioning and possessions and the consequential effect on the railway safeworking rules and procedures.

(e) Ascertain train operation and safeworking arrangements.

(f) Power on dates for new electrical supplies and temporary power requirements for testing.

(g) Strategy for inspection and testing for safety certification and quality assurance aligned with the implementation strategy for the works.

  (i) Identification of inspection and testing during the construction/installation phase to include the inspections, tests and certification of compliance required by the construction standards and the hold points required.

  (ii) Testing and certification strategy for work completed off-site.

  (iii) Strategy for maintaining security and integrity of equipment and systems tested and certified off site, or in advance of the final commissioning.

  (iv) Inspections & certification of associated civil work – cable routes and cables, under-line crossings, structures, foundations, formwork, and earth mats.

(h) Identification and certification of existing infrastructure (e.g., services searches, circuit correlation checking and testing).

(i) Processes to be used to confirm the condition of any existing systems to be modified (e.g., provisions of the interface coordination plan, design correlation check).

(j) Define the processes to be used to confirm the condition of any existing systems to be modified (i.e. identification of standards, correlation check, etc.)

(k) Identification of inspection and testing requirements for interface and stagework.

(l) Scope, methodologies and access limitations for inspection and testing of interface work.

(m) Scope, methodologies and responsibilities at commissioning.

(n) Locking tests.

(o) Principles testing requirements.

(p) Provisions for signalling safeworking, relocating or removing existing signalling.

(q) Provisions for protection of operating trains by ensuring that no ambiguity exists as to the signalling system in force during installation testing and commissioning (e.g., testing during traffic, installation maintenance and removal of X boards on signals, safe notice/train notice).

(r) Access requirements, inductions, and restrictions – any special access requirements to the infrastructure owners' site for conducting inspections and tests.

(s) Co-ordination with other works (e.g., track, civil, electrical (power & OHW), train control, wayside systems and telecommunications). Procedures for identifying other works, liaison with responsible parties, and identification of responsibilities for the coordination activities.

(t) Organisation chart for the inspection and testing program.

(u) Inspection and testing personnel requirements.

(v) Training and accreditation requirements for inspection and testing personnel.

(w) Take full account of timescales and personnel constraints with regard to work patterns.

(x) Create a preliminary testing programme that includes staff resources.

(y) Programme suitable and achievable work packages for individual testers to undertake.

(z) Test equipment and site communication requirements:

  (i) Test equipment and communication facility requirements for each part of the inspection and testing program, including test straps, test instruments, specialist tools, test trains, and portable radios.

  (ii) Arrangements for shared use of these facilities between groups.

(aa) Procedures for security and management of test straps, bridges and any test equipment that has the ability to manipulate the state of a relay, input or output (e.g., test rigs, test computers, and telegram or input output generators).

(bb) Special considerations.

(cc) Schedule of reviews and approvals required such as:

  (i) documentation reviews;

  (ii) inspection and testing personnel review;

  (iii) possession approvals;

(iv) access approvals;
(v) equipment and/or system type approvals;
(vi) engineering waivers required;
(vii) environmental hazards and management of their risk; and
(viii) occupational health and safety issues.

5.4 Correlation

Correlation should be conducted before detailed design commences in accordance with AS 7718.

Correlation, through a review of current as-built drawings and actual onsite equipment, should be conducted prior to installation of any new equipment and before any changes or additions are made to existing circuits.

Correlation is not required where objective evidence demonstrates that the existing equipment and circuits are in accordance with the available design drawings.

Where correlation is not practicable, the testing strategy should specify any additional testing required to mitigate risks arising from not conducting the correlation.

When correlation has been carried out, any additional testing required to mitigate the risks of correlation that could not be performed as proposed, and of records that could not be corrected, shall be detailed in the test plan.

Section 6 Interface management

6.1 General

The commissioning of a signalling and control system can require coordination between several parties and across a variety of physical interfaces.

The signalling project shall identify all interfaces. Where interfaces have the potential to affect a signalling and control system, an interface coordination plan shall be developed and implemented, detailing the coordination between all stakeholders necessary to ensure a successful commissioning

An interface coordination agreement shall be included in an interface coordination plan. This is an agreement between parties describing the responsibilities of each party.

The development of an interface coordination plan and managing interfaces through the commissioning period should be managed by a nominated person.

The format and content of the interface coordination plan shall be in accordance with RIM requirements.

6.2 Interface coordination plan

The interface coordination plan should assess the need for coordination before and during the commissioning, between all commissioning personnel.

The interface coordination plan shall assess any statutory requirements to involve or advise external parties such as:

(a) regulatory bodies (i.e. safety regulator, infrastructure authority);
(b) other projects in area, with overlaps/potential overlaps;
(c) witness/auditor;
(d) organisation/independent safety assessor (i.e. third party);

(e) road/local authorities (e.g., temporary closure of roads, level crossings, traffic management); and

(f) other infrastructure owners (e.g., opening bridges, light rail RIMs).

The interface coordination plan should also document for stageworks and commissioning any access priorities, resource sharing opportunities and the terminologies to be used to conduct the testing activities.

The interface coordination plan shall assess the need for management and testing of any physical interfaces to other systems, such as:

(g) traffic lights coordinated with level crossings;

(h) electrolysis protection; and

(i) other railways and tramways.

6.3 Interfacing with existing systems

Safety assurance of the new signalling system and of the existing signalling system at the worksite will depend in part on a clear definition and understanding of the work and the division of responsibility for the work at the interfaces, as well as on the manner in which interface work and temporary work, including stagework, is performed and on the standards to which temporary work, including stagework, is performed.

All work interfacing with the existing system shall be clearly defined in the test plan and tested accordingly.

6.4 Testing alongside operational equipment

Before any conducting any testing on equipment which forms part of, or interfaces with, an operational signalling system, arrangements shall be made to provide for the safety of the working railway and site personnel.

When the site is to be left unattended, equipment protection shall be replaced (e.g., doors/covers replaced and suitably secured). Details of any alterations to operational equipment shall be left available for reference by the maintenance personnel. This should be in the form of installation copies of the approved design and any associated modifications.

Testing activities shall be arranged so that they do not prevent maintenance and operations staff from gaining access to working equipment or existing infrastructure if required.

Before testing commences at sites containing signalling equipment in use, personnel responsible for the maintenance of the equipment shall be informed of the extent and programme of work.

Testing shall not interfere with or compromise the safety of the operational railway in any way. If there is an identified risk of testing impacting the operational railway, controls shall be put in place.

6.5 Interfaces outside commissioning boundaries

The interface coordination plan should also assess elements outside the defined boundaries of the commissioning area which can possibly have been affected by the commissioning activities.

These can include:

(a) train detection arrangements outside commissioning limits, where detection is potentially compromised by lack of traffic due to line closure for an extended commissioning possession;

(b) remote alarms – electrical operations centre; and

(c) data inputs to traffic management systems, operations control, timetable and passenger information.

6.6 Decommissioning and disposal

The impact of decommissioning and disposal on any system or external facility associated with the system to be decommissioned shall be assessed, and plans developed to manage that impact.

6.7 Operational requirements

All field activities associated with the decommissioning, changing-over and testing works should be carried out without any rail traffic. If this is unavoidable, any testing that is going to disrupt the train running shall be carefully planned and completed in the time available. All risks shall be assessed and controls put in place against the time when a hazard occurs.

All testing and commissioning personnel shall comply with the RIMs safeworking rules and procedures.

There shall be a clear understanding and agreement between all involved parties of the safeworking systems to be employed during the period from the shutdown of the old system to the commissioning of the new system.

6.8 Interface documentation requirements for associated train control and telecommunications systems

Where train control or telecommunications systems are the responsibility of a separate group, the responsible train control or telecommunications system group shall provide final certification documentation at commissioning, attesting that the system has been inspected, tested and certified safe and fit for purpose.

The certification documentation to be provided shall be agreed between the parties and documented in an interface coordination plan.

The certification documentation shall be comparable to the requirements for the signalling system and be based on an effective quality management system and processes.

At commissioning, the agreed certification documentation shall be provided in a timely manner to enable the interface and/or the integrated system/s to be signed into use.

Section 7 Testing and commissioning plans and work packages

7.1 General

The RIM's SMS, the planning process and personnel competence are important in ensuring that railway signalling systems are safe for the operation of trains.

The testing and commissioning of railway signalling projects shall be planned. The planning process for testing and commissioning for each signalling project shall assess the following requirements:

(a) The signalling system involved and type of equipment used.

(b) The formal allocation of responsibility to staff.

(c) The methodology to be used.

(d) The production and formal documentation of activities and tasks, the personnel planned to do the work, allocation of responsibilities and personnel competencies required for the activities and associated tasks.

(e) The independence required of personnel involvement among the different parts of the works.

(f) Whether equipment tested off site requires retesting, and to what extent that testing is required.

Commentary *C7.1*

Whilst some equipment and location cases could have been fully tested prior to movement to site, retesting could be required due to the impacts of travel or the time that the equipment has been sitting on site unused. These considerations are in addition to the normal site testing being completed as part of the commissioning process.

(g) The review and certification process.

(h) Documentation to be used for the inspection and test detailed plans.

(i) Other resources required such as special tools, test equipment, etc.

7.2 Test plans

A person shall be nominated and be responsible for the production and implementation of the testing plan and any associated commissioning plans. Execution of these tasks may be delegated to other competent persons but the nominated person remains responsible for their completion.

Test plans may require reviews from specialist engineering personnel, depending on the equipment being tested and commissioned.

Commentary *C7.2*

Test and commissioning activities could cover multiple disciplines such as principles and communications, requiring specialist knowledge to ensure all testing requirements are met.

All personnel involved in the testing and commission shall be given adequate notice of, and be fully conversant with, their role in implementing the testing plan.

All testers involved in the work shall be fully briefed and provided with written notes detailing what is to be done in each phase of the work. These notes may take the form of work instructions detailing specific work activities.

Plans shall include definition of processes, work activities and controls to achieve compliance with all the requirements of this document.

7.3 Planning inspection, testing and commissioning activities

A comprehensive and detailed plan for the testing and commissioning of the project, and a method for recording and documenting the results of all testing and commissioning activities, shall be developed and implemented.

A staged approach to preparing the inspection and testing plans shall be undertaken. The suite of plans shall include:

(a) an inspection and testing strategy (see Section 5); and

(b) an inspection and test detailed plan.

An inspection and testing outline plan should also be developed following the inspection and testing strategy. For simple commissioning events, this may not be required. Further information is provided in Clause 7.5

The documentation associated with the inspection and test detailed plan should be arranged into the following three collections or packages:

(c) Installation inspection and testing work package.

(d) Commissioning work package.

(e) Documentation handover package.

Where a project is to be commissioned in multiple stages, this shall be detailed in the inspection and testing strategy and be the basis for the production of multiple sets of commissioning plans and work packages.

7.4 Inspection and testing outline plan

7.4.1 General

The inspection and testing outline plan should be a tabulation of all separable elements of the signalling and control system that will require some form of inspection and testing, and the specific inspection and testing activities required for each element.

Where an inspection and testing outline plan is not developed, it can be necessary to include this information in the inspection and test detailed plan.

Inspection and testing outline plans provide a means of capturing all items of equipment and testing requirements at a high level to ensure that nothing becomes lost in the detailed test and commissioning plans.

The inspection and testing outline plan should provide an overview of the individual activities to be performed on the particular systems and apparatus that constitute the works. The activities include those identified in the inspection and testing strategy and are used to plan the sequencing and the general resources certifying them.

7.4.2 System/apparatus

The inspection and test outline plan should identify the system and apparatus elements required to be inspected and tested, consistent with the inspection and testing strategy.

At this stage, identification should include the types and quantities of system and apparatus elements to be tested. Detailed identification of individual elements may be provided in the inspection and test detailed plan. These are the system elements identified in the inspection and testing strategy, described in more detail.

7.4.3 Activity

Inspection and testing activities should be categorized as follows:

(a) Design process management.

(b) A joint site inspection for the documentation of the site integrity agreement portion of the interface coordination plan.

(c) Acceptance inspection and testing of manufactured equipment including type approvals.

(d) Quality and construction inspections.

(e) General apparatus inspections.

(f) Cable testing.

(g) Circuit testing, including terminal wire and null counts.

(h) Circuit function testing.

(i) Set to work and test.

(j) Test and certify.

(k) Apparatus function testing.

(l) Software data testing (off-site).

(m) Control system data testing (FAT).

(n) Integration testing.

(o) System function testing.

(p) Principles testing.

(q) Data link testing.

The above items should be broken down into stand-alone units of work that are applicable to individual systems or apparatus.

7.4.4 Site integrity agreement

A site integrity agreement is made between the construction teams and testing and commissioning teams as to the state of construction activities. The agreement should include information on:

(a) works completed that vary from the approved design;

(b) works that are not completed;

(c) to be added, removed or altered during the commissioning.

7.4.5 Additional information

The inspection and testing outline plan should describe the:

(a) competency certification requirements of the person who will certify the results of an inspection or testing activity;

(b) documents required for the recording of the certification of each activity; and

(c) approximate start time and duration planned for an activity for use in developing the inspection and testing program.

The standards and documents referenced in the inspection and testing outline plan should describe the performance requirements and acceptance criteria for the activity.

7.5 Inspection and test detailed plan

The inspection and test detailed plan shall be based on the inspection and test strategy and the inspection and test outline plan (where developed).

The inspection and test detailed plan shall expand the detail to include the inspection and testing and signalling safeworking activities necessary during each phase/stage for each specific unit of signalling apparatus/system.

The inspection and test detailed plan may form part of a verification and validation plan or may serve as the verification and validation reference where a separate plan is not provided.

The inspection and test detailed plan shall be analysed to generate the individual work instructions for units of work to be included in the installation and/or commissioning work packages.

The inspection and test detailed plan shall include worksite protection requirements for the testing and commissioning works.

The inspection and test detailed plan shall list all individual elements and apparatus or systems identified in the outline plan. This can include:

(a) locations and relay rooms;

(b) cable routes;
(c) points;
(d) signals;
(e) track circuits or axle counters;
(f) power supplies;
(g) interfaces;
(h) electronic interlockings and data links;
(i) telemetry systems;
(j) control systems;
(k) telecommunications systems; and
(l) other apparatus or systems.

The inspection and test detailed plan shall list all apparatus that will become redundant.

Each item the inspection, testing and signalling safeworking activities required shall be documented using an agreed format.

For each apparatus, system or sub-system within the scope of works, inspection and test methods shall be applied to verify correct installation, configuration, interfaces and functional performance prior to certification.

For each item and activity:

(a) the location of the equipment shall be noted;
(b) the planned timing and duration shall be determined;
(c) the personnel and competency requirements shall be determined;
(d) any special requirements (e.g., approvals, training, tools or test equipment) shall be determined;
(e) the appropriate test certificate shall be identified; and
(f) the reference test specification and acceptance criteria shall be determined.

Signalling safeworking activities for signalling apparatus should include:

(g) the RIM's signal safeworking procedures covering:
  (i) booking out and disconnection of signalling;
  (ii) certification and booking signalling into use;
  (iii) damage to signalling equipment;
  (iv) temporary bridging of signalling functions;
  (v) signalling equipment security;
  (vi) locking and keys;
  (vii) concessions and waivers, and
  (viii) safety-critical testing requirements.
(h) the installation, maintenance and removal of cross boards or bags on signals and any specific requirements to assist testing (where unavoidable) during traffic.

Based on the above information, testing activities should be grouped into units of work to be incorporated into work instructions Work instructions shall then be allocated into the applicable Installation or commissioning work package

7.6 Installation work package

The installation work package (also called the installation, inspection and test works package) shall be used to document the quality and safety assurance testing activities through the installation phase of the project, prior to the start of the commissioning phase.

The elements to be incorporated into the installation work package shall be determined from the works program, the inspection and testing detailed plan, and quality control procedures.

The principal contents of the work package are quality assurance and test certification relating to received materials, and the work instructions for all inspection, testing and certification activities during the installation phase, together with the test results and certificates produced.

The installation work package shall contain all safety and quality assurance records for signalling items manufactured for subsequent installation at site. The originals of test certificates provided by equipment manufacturers or suppliers shall be provided for insertion in the installation work package prior to the installation of the respective equipment.

Work instructions for all installation-phase inspection and testing activities identified in the detailed test plan shall be developed and approved for use.

The work instruction shall detail the work required to complete the installation inspection and testing, safeworking requirements, checklists, certificates and other records required for the activity, to provide the necessary quality control and safety assurance required by the RIM.

An activity shall be defined by the following:

(a) A stand-alone unit of work.

(b) Work required on a piece of equipment or apparatus that is individually numbered or that is identified on a working drawing.

(c) Equipment brought into use or taken out of use.

(d) Testing as set out in standards and procedures.

(e) Safeworking and signalling safeworking requirements.

(f) Documentation requirement.

A task shall be one of any number of elements of work that are required to complete an activity.

The typical installation work package contents shall comprise the following sections:

(g) Authorization – formal approval approving and authorizing the use of the work package.

(h) Register of working documents – titles, version numbers and issue dates of all design records (e.g., circuit books, signalling plans, etc.) used for the inspection and testing activities.

(i) Register of quality assurance documents:

  (i) Titles, version numbers and issue dates and storage location of quality assurance documents for received materials.

  (ii) The originals of quality assurance documents received can also be included (If these are not too voluminous).

(j) Register of type approvals – records and certificates of any type approvals required for novel materials and equipment used.

(k) Accreditation/competency certificates and permits to work – records of assessment of individuals' competencies to perform allocated inspection and testing activities, and (if space permits) copies of individuals' competency records.

(l) Pre-site test certificates – test certificates provided for completed testing of equipment and systems completed before delivery to site, which will not be repeated after installation.

(m) Installation and inspection and testing log – chronological log of installation works, site photography, inspection and testing activities and issues arising out of those, together with records of how issues have been resolved.

(n) Register of testing work instructions – numerical register of all testing work instructions generated, and how each has been addressed.

(o) Prepared testing work instructions – original copies of all testing work instructions prepared and awaiting issue to work teams.

(p) Issued testing work instructions – copies of all testing work instructions issued to work teams and awaiting return of completed instruction.

(q) Completed testing work instructions – original copies of all testing work instructions issued to work teams which have been returned completed and signed, with all incomplete actions and issues noted resolved by transferring to new testing work instructions or as otherwise determined. Returned testing work instructions to include originals of all inspection and test forms and certificates required for the work involved.

(r) Register of testing work instructions and issues carried forward:

  (i) Register of all testing work instructions that could not be completed in the installation phase but can be deferred to the commissioning phase without endangering the project schedule, as well as any other installation phase issues that need to be carried over.

  (ii) Original copies of all testing work instructions carried forward.

(s) Certification:

  (i) Certification that all planned inspection and testing activities have been completed with satisfactory results or can be carried forward to the commissioning phase.

  (ii) Includes completed and signed installation status certificates as well as variations to the inspection and testing detailed plan and approved waivers to standards.

(t) Document transmittals – copies of transmittal documents for all design documents received and for all certified test copies being returned to the design office for production of the for-commissioning issues.

The completed and certified installation inspection and test work package form an important input to the commissioning readiness review (sometimes referred to as the pre-commissioning meeting).

7.7 Commissioning work package

7.7.1 Overview

The commissioning work package shall be used to manage and document the safeworking, final installation/change over, set to work and testing activities through the commissioning of the works.

The commissioning work package shall be issued prior to the commencement of the commissioning activity. The time between issuing the commissioning work package and the commissioning activity should be sufficient to enable all involved personnel to review and understand the works and their role in the commissioning.

The work package shall be divided into three main sections as detailed in Clause 7.7.2

7.7.2 Section 1 – Preparation

7.7.2.1 Documentation

The following documents shall be included in the commissioning work package:

(a) Authorization – formal acceptance of the commissioning works package, authorizing its use for the commissioning of the works.

(b) Minutes of commissioning readiness meeting (pre-commissioning meeting)

(c) Register of working documents – titles, drawing numbers, version numbers and issue dates of all design records (e.g., circuit books, signalling plans, CBI documentation, etc.) used for the commissioning activities.

(d) Safeworking forms and permits – safeworking forms, infrastructure booking forms, electrical access permits, etc.

(e) Safe notice or train notice – the RIM's notice advising details of any new and altered work or alteration that results in a change to any physical or operational interface with signallers or train drivers. This includes providing the RIM with full detail of all alterations in time to be advertised in accordance with RIM requirements. A copy of the published notice is included in the commissioning work package.

7.7.2.2 Scope of works

The scope of works for the commissioning is a list of activities, which is broken down into the three phases of the commissioning covering all the following activities:

(a) Pre-commissioning period activities

(b) Commissioning period activities

(c) Post-commissioning period activities

The scope of works shall reference the applicable activities from the inspection and testing plan, signalling safeworking requirements and principles test plan.

The scope of works shall include the required activities necessary to complete the verification of each working drawing prior to commissioning, and to enable the certified commissioning copy in the post commissioning period to be updated and approved. This may include:

(d) working drawings issued with commissioning work instructions to be marked up signed and certified as a record of inspection and testing; or

(e) verification of the signalling plan, track insulation plan and signal sighting forms following setting to work.

7.7.2.3 Commissioning program

The commissioning program shall be prepared to schedule activities throughout the commissioning period.

The commissioning plans shall include (where applicable) the following:

(a) The commissioning scope of works.

(b) The inspection and testing plan.

(c) The signalling safeworking requirements.

(d) The possession program.

(e) Worksite protection requirements.

(f) Principles testing program.

(g) Train control and/or telecommunications systems testing program.

(h) Other works program.

(i) Test engine availability.

(j) The availability of rostered personnel within competency and fatigue management guidelines.

7.7.2.4 Commissioning notices

The commissioning notice provides critical information for all personnel engaged in or associated with the commissioning.

The notice shall provide details under the following sections:

(a) Scope of the commissioning – times, limits, description of work.

(b) Track possession details – possession notes, safe notice number, train notice.

(c) Electrical isolations details – power off permit – details and arrangements.

(d) Commissioning headquarters – location, names and contact details of key commissioning personnel.

(e) Accreditation and competency statement – personnel to carry out duties only within the bounds of their accreditation.

(f) Reporting for duty – start and finish locations where all personnel sign on and off duty.

(g) Team leader instructions – issue, use and signing of work instructions, team leader responsibilities.

(h) Instructions for team members:

  (i) Assembly areas, working under direction of team leader.

  (ii) Team leader to provide working instructions.

(i) Reporting instructions for personnel unable to attend as arranged.

(j) Testing and certification – instructions and communications protocols for personnel conducting aspect and correspondence testing

(k) Communications facilities – description of the various communications available, radio channel usage, telephones numbers for testing, commissioning headquarters and emergency numbers.

(l) Pre-commissioning meeting – required attendees, location and time of pre-commissioning meeting.

(m) Post-commissioning meeting:

  (i) Details of persons attending, location, date and time of post-commissioning meeting.

  (ii) Details of method of submission of comments for consideration at the meeting.

(n) Occupational health and safety – requirements for site induction and personal protection equipment; location of first aid boxes and personnel.

(o) Environmental:

  (i) List of environmental risks and preventative measures in place.

  (ii) Actions required in case of an incident.

(iii) Detail any equipment provided, location and persons available to respond.

(iv) Detail notification requirements to the rail management centre for their advice to the RIM environmental response team.

(p) Vehicles and equipment – listings of minimum resources that personnel are expected bring to site for their allocated work (as applicable: vehicles, hand tools, meters, wet weather gear, torch and battery, hand-signalling equipment, special testing equipment).

(q) Meals and facilities – locations of toilets and meal rooms, details of what will be provided (if any).

(r) Personnel rosters and team allocations – the management and team structure that will be put into place for the commissioning, as an organisation chart or other agreed format. This section identifies the teams that will be required, nominate the level of competencies required for team leaders and team members for each team, and show the shifts and times when all individuals will be rostered to work.

(s) Accreditation/competency certificates and permits to work – records of assessment of individuals' competencies to perform allocated inspection and testing activities, and (if space permits) copies of individuals' competency records.

(t) Register of pre-commissioning work instructions – numerical register of all pre-commissioning work instructions generated, and how each has been dealt with. Includes work instructions carried forward from installation work package.

(u) Prepared pre-commissioning work instructions – original copies of all work instructions prepared and awaiting issue to work teams, for activities leading up to the actual commissioning period

(v) Completed pre-commissioning work instructions – original copies of pre-commissioning work instructions issued to work teams which have been returned completed and signed, with all incomplete actions and issues noted resolved by transferring to new work instructions or as otherwise determined. Returned work instructions includes originals of all inspection and test forms and certificates required for the work involved.

7.7.3 Section 2 – Implementation

The implementation stage shall include the development of the following documents:

(a) Register of commissioning work instructions – numerical register of all commissioning work instructions generated, and how each has been addresses.

(b) Prepared commissioning work instructions – original copies of all work instructions prepared and awaiting issue to work teams, for activities during the commissioning period.

(c) Completed commissioning work instructions – original copies of commissioning work instructions issued to work teams which have been returned completed and signed, with all incomplete actions and issues noted resolved by transferring to new work instructions or as otherwise determined. Returned work instructions to include originals of all inspection and test forms and certificates required for the work involved.

(d) Register of post-commissioning work instructions – numerical register of all post-commissioning work instructions generated.

Prepared post-commissioning work instructions – original copies of all work instructions prepared and awaiting issue to work teams, for activities to be carried out after the actual commissioning period. Includes actions arising out of the commissioning and carried forward to the post-commissioning period.

Completed post-commissioning work instructions – original copies of all post-commissioning work instructions issued to work teams which have been returned completed and signed, with all incomplete actions and issues noted resolved by transferring to new work instructions or as otherwise determined. Returned work instructions to include originals of all inspection and test forms and certificates required for the work involved.

7.7.4 Section 3 – Evaluation

A certificate that validates the signalling system is ready for commissioning shall be completed and signed once:

(a) all inspection and testing activities have been completed in accordance with the inspection and test detailed plan, and all work instructions and test cases have been completed, or planned to be resolved as part of commissioning or post-commissioning activities;

(b) all required commissioning, inspection, testing and certification is complete;

(c) all sub-systems have been validated and test certificates have been received (e.g., trackside systems, communications systems, on-board systems and other interfacing sub-systems);

(d) all redundant equipment has been decommissioned and made safe (so far as is reasonably practical. See Clause 11.4);

(e) the works, or the relevant part thereof, are fit for purpose and ready for use and meet all rail safety requirements;

(f) where implemented, system integration has been demonstrated in accordance with the inspection and test detailed plan, or the system integration plan where the inspection and test detailed plan references the system integration plan; and

(g) any conditions exported to the RIM are explicitly identified or referenced.

When the certificate of signalling is completed and signed, the new and altered works can be booked into use in accordance with the provisions of the RIM's safeworking rules and procedures.

A chronological log of commissioning works shall be maintained. A commissioning log should include:

(h) safeworking actions;

(i) decommissioning activities;

(j) changeovers;

(k) interface works;

(l) set to work and inspection and testing activities and issues arising out of those; and

(m) records of how issues have been resolved.

A register of design modifications including all modification instruction forms (mod forms) generated during the commissioning should be maintained. All mod completed forms shall be sequentially numbered and dated.

Issued modification instruction forms should include copies of all mod forms issued during the commissioning.

An attendance book shall include a register of attendance of all personnel involved in the commissioning. Personal identifications shall be issued giving access to particular parts of the commissioning area.

If attendance is managed as a function of an electronic attendance and competency management system, this need not be included in the work package.

Document transmittals should include copies of transmittal documents for all design documents received and for all certified test copies being returned to the design office for production of the as-commissioned/for-maintenance issues.

7.8 Handover package

The handover package is a package of signed off documents handed over to the RIM representative certifying that the signalling project deliverables have been provided except for minor defects listed and programmed for rectification.

The hand over package shall include:

(a) a copy of the practical completion certificate;

(b) a copy of the defects and omissions form; and

(c) interim maintenance copies of design documents.

The hand over package should also include copies of transmittal documents and acknowledgment receipts for the following items:

(d) Asset register information.

(e) Spare equipment.

(f) Copy of commissioning work package (where applicable).

(g) As built copies of site documentation and drawings (e.g., detailed site survey drawings, signal sighting forms, installation drawings, equipment housing layout plans, mechanical drawings, structures and buildings, clearance diagrams, level crossing layout plans).

(h) Copies of any other documents required to be provided as agreed on the project work interface agreement.

(i) When all known defects and omissions have been satisfactorily rectified and completed.

A copy of the final certificate of signalling shall be signed by the RIM's representative and be included in the handover package.

Section 8 Off-site testing

8.1 General

It is possible to conduct all inspection and testing activities associated with a signalling project on site, but unlikely to be efficient in use of time or resources.

Where equipment is assembled and wired at an off-site facility, it can be preferable to test the equipment to the maximum extent practicable, while still in the factory environment.

Testing activities may be performed for quality control or certification purposes. Where testing is relied upon for certification of any part of the installation, the scope, controls, and acceptance criteria applicable to that testing shall be defined and documented.

For computer-based or programmable systems, application logic may be verified off site as part of the testing process, with appropriate controls to ensure consistency between off-site verification and the installed system.

8.2 Standards applicable

Pre-site testing of data and pre-assembled equipment shall be subject to the same standards of performance, documentation and competency requirements as all other testing activities associated with the signalling works, except where testing is only for purposes of quality assurance.

8.3 Independence

Personnel involved in the pre-site testing of data and pre-assembled equipment shall apply the same standards of testing independence as is applicable for all other testing activities associated with the signalling works in accordance with Clause 2.16 of this document.

8.4 Pre-site testing of computer-based signalling data

8.4.1 General

This section specifies the inspection and testing requirements that are specific to computer-based signalling data, including interlocking data. These requirements shall be additional to the general requirements for testing of circuits and equipment, and in some aspects are different from the general requirements for testing relay-based interlocking equipment.

Application data for computer-based signalling data systems and control systems is normally tested and certified off site.

Depending on the system under test, this testing should be carried out on the system-specific design/test workstation, or on the actual hardware temporarily connected in its intended configuration, in a factory environment, with simulated control and fringe area interfaces.

This document has been written for generalized computer-based signalling equipment. Testing and commissioning of specific types of computer-based signalling equipment shall include the manufacturer's requirements and any equipment specific test procedures published by the RIM.

This section does not cover the following items:

(a) Factory acceptance tests of computer-based signalling equipment (hardware) (Refer to AS 7716).

(b) Testing of ancillary systems such as computer-based visual display unit (VDU) signal control systems.

8.4.2 Test equipment and software

Computer-based signalling systems are generally provided with ancillary hardware and software for the preparation and testing of application data, and the testing of field equipment. Where provided, these are normally integral parts of the computer-based signalling safety system and use of them forms part of the system safety case.

Where the manufacturer of the computer-based signalling system has provided system-specific test equipment and software for testing of application data and installed equipment, these shall be used in the testing of the system, in accordance with the manufacturer's instructions

8.4.3 Pre-site design checking and function testing

The interlocking and control functions of a computer-based signalling system are determined by its site-specific system configuration and application data. As far as practical the bulk of the functional testing

shall be completed prior to site installation through the use of interlocking simulators and factory test mock-ups.

For computer-based signalling systems, system operation and safety shall be verified through validation of the system configuration and application data.

The designer shall maintain configuration management and version control of all development hardware and software and for the computer-based signalling system. This may include design systems (including any compilers and analysis software used), simulators, maintenance or technician's terminals, and event loggers or playback systems.

Software and hardware versions shall be checked and verified against the relevant type approval documentation with note made that the intended application complies with all listed conditions of approval.

8.4.4 Pre-site/simulation testing

A formal set of tests shall be conducted prior to the equipment being installed on-site. These tests shall fully test the computer-based signalling system hardware and software. Tests that depend on equipment available only on site, and for which simulation is not reasonably practicable, may be excluded from pre-site testing. Any such tests shall be completed on site when the equipment is available, in accordance with the inspection and test detailed plan.

Pre-site simulation testing of application and configuration data shall be carried out using an approved simulator and a temporary installation of the equipment configuration, as appropriate to the system under test.

Where a temporary installation is used, it shall be installed and configured in accordance with the approved signalling design documentation, including applicable communication links between units. Interfaces to field equipment and adjacent systems not under test may be simulated.

The temporary installation shall use system software and hardware in accordance with the approved signalling or system design documentation.

Application and configuration data to be tested shall have undergone inspection and verification prior to testing, and backup copies shall be retained for reference.

Test procedures may be automated in accordance with the approved test procedure.

8.4.5 Simulator testing

Functional tests shall be carried out by means of a simulator. The pre-site simulator testing shall include the following:

(a) Function testing to control tables.

(b) Principles testing (design integrity testing).

(c) Cross boundary tests to adjacent interlockings and other computer-based systems (where practical to do so).

(d) All controls in the computer-based interlocking area.

(e) Simulation of all vital and non-vital inputs and outputs.

(f) Simulation of faults, alarms and event logging.

(g) Total system monitoring of commands and controls implemented by the system.

During the simulator testing, all the interlocking and controls shall be function tested to the control tables in accordance with the testing procedure outlined in Section 19 of this document using simulated inputs and outputs.

A permanent record shall be kept by the system of all tests carried out. This record shall be available for future reference and archive purposes.

8.4.6 Configuration management and version control

Strict version control shall be maintained over application data tested and issued for uploading into CBI and other computer-based systems in the field.

8.4.7 Control centre – Site testing precautions

It is important that testing correctly proves the item or function being tested.

Many computer-based VDU signal control systems include pre-test functions within the signal control system that prevent an unavailable signal command being issued to the field-based CBI equipment. This could mask the testing of that function within the CBI equipment.

When using the control system to perform final testing of the installed CBI system, any pre-test functions shall be disabled

The test plan shall clearly identify the arrangements that need to be made for function testing the CBI system in the field.

8.4.8 On site testing of computer-based signalling data

Where interlocking, control, or equivalent system functions have been functionally tested and certified during pre-site testing, repetition of all functional testing on site is not required.

Sufficient on-site testing shall be undertaken to confirm that signalling controls, including the control of points and signals or their functional equivalents, operate correctly in the installed environment.

The initial purpose of the on-site testing shall verify that:

(a) all on-site installation work has been carried out correctly;

(b) all vital and non-vital data links function correctly;

(c) redundancy arrangements function correctly;

(d) the complete system functions correctly within the control centre and from the control centre to the lineside equipment; and

(e) all local fringe area controls that are not included in the central interlockings operate correctly.

The remaining tests that shall be performed on site are:

(f) correct correspondence of all inputs from field equipment to the train control system (e.g., track circuits, detection etc.);

(g) aspect testing of all signals;

(h) a principles test of the complete system.

8.4.9 Testing alterations to installations

Signalling projects can involve making and testing modifications to a working interlocking or computer-based signalling system, including changes to operational or safety requirements, or as part of staged implementation strategies.

Additional testing may also be required where alterations are made to equipment installed as per design due to errors found during the testing process.

8.4.10 Application data for alterations

Where application or configuration data is altered, a comparison shall be carried out between the original data and the altered data to identify the areas requiring inspection and testing.

The inspection and test detailed plan shall include requirements for such testing, including regression testing to verify correct operation of affected functions and non-regression testing to confirm that unaffected functions continue to operate as intended.

The revised application data shall contain an updated version number.

A process shall be developed for managing version control of the application data for all stagework.

Each stage shall be independently checked and verified, and the documents clearly marked with the version identification data applicable.

Before a version of data is installed, the version identification shall be independently checked against the distribution records to ensure that it is the correct version.

8.4.11 Pre-commissioning testing of CBI alterations

Where the test plan calls for design alterations to a computer-based signalling system (e.g., CBI interlocking) to be tested prior to the commissioning period a process shall be documented and implemented for:

(a) uploading the correct application data before a testing session; and

(b) restoring the correct version of the current working application data before the system is restored to normal service.

The process shall include recording the details at every changeover of the data version being uploaded.

Where a working signalling installation is modified by the addition of new system elements, those elements shall not be connected to operational communication links until authorized testing or commissioning activities are undertaken.

Where the signalling system has been secured non-operational in accordance with the RIM's requirements, communication link testing and testing of alterations to the working system may be undertaken prior to commissioning. Otherwise, such testing shall be carried out as part of commissioning activities.

8.4.12 On-board computer-based signalling systems

Pre-network testing of on-board computer-based signalling systems shall be undertaken in accordance with an approved inspection and test detailed plan and shall:

(a) verify the correct implementation of software, configuration, and application data forming part of the on-board signalling sub-system;

(b) verify interfaces at the boundary of the on-board signalling sub-system, including the correct transmission, receipt, and interpretation of data in accordance with defined interface requirements;

(c) demonstrate correct functionality of the on-board signalling sub-system under normal, degraded, and fault conditions, including response to invalid, missing or corrupted inputs at its interfaces;

(d) be supported by simulation, laboratory testing or other controlled test environments that are representative of the intended operational configuration;

(e) ensure all testing is undertaken under controlled configuration, including management of software versions, configuration data and test environments;

(f) confirm that the on-board signalling sub-system satisfies the allocated sub-system requirements; and

(g) produce objective evidence of test completion, including recorded results, identified defects and any limitations or conditions relevant to commissioning.

(h) identify, record, and manage defects and non-conformances in accordance with the applicable defect management process.

8.5 Equipment assembled and wired off-site

8.5.1 Pre-site testing of assembled equipment

Equipment cabinets, location cases, signals, relay racks or equipment racks that are wholly or partly pre-wired off site shall be inspected and pre-site tested following the completion of the fitting out and wiring and prior to delivery.

The inspection and testing shall include:

(a) documentation check;

(b) general apparatus inspection;

(c) bell continuity test;

(d) insulation test; and

(e) wire count and null count.

Equipment assembled and wired off-site could be subject to particular risks associated with transportation to the installation site. These risks include water damage, vibration and interference by unauthorized persons resulting in physical damage to rack mounted equipment, wiring, terminations and insulation.

Where these risks cannot be controlled, pre–site inspection and testing shall be done only as a quality control check, not a certification inspection and test.

Where pre–site testing is performed as a quality control activity it shall be carried out, recorded, inspected and tested in accordance with this document. This may be done using the approved for construction design drawings.

The drawings used to conduct this testing shall be clearly identified as pre-site test copy.

If any part of the certificate cannot be completed due to the equipment or wiring being incomplete, then these deficiencies shall be listed on the respective drawing and on the pre-site test certificate. Pre-site testing shall not be conducted on incomplete work unless authorized.

A pre-site test certificate shall be completed and made available prior to dispatch of the equipment to site.

A copy of the pre-site test certificate shall be attached to the equipment.

8.5.2 Pre-site certification testing

Where appropriate risk mitigation strategies are agreed, pre-site inspection and testing may be accepted as the certification inspection and testing. In such cases, the equipment and circuits shall be completed without defects or omissions, before commencing testing.

Pre-site certification testing shall be conducted by personnel holding the necessary competencies and authorizations.

Pre-site certification testing shall be performed and recorded using approved for testing copies of the design drawings. Testing copies shall be marked up and signed in the manner normal for certification

testing. In this case, the pre-site test certificate shall be replaced by or identified as the certification test certificate.

After pre-site certification testing, equipment shall be adequately secured and protected (until commissioned) from the possibility of alteration by installation crews or persons not fully aware of the certified conditions.

The equipment and circuits shall be protected from the possibility of damage, degradation or other condition that could impair their certified integrity.

An equipment rack which has completed off-site testing and certification shall be identified by clearly visible labelling affixed to both sides of the rack to prevent subsequent uncontrolled work which could void the test certification, create the need for repeated certification testing or, in the worst case, remain untested.

Once all pre-site testing has been completed and all the drawing sheets have been signed as an indication that all testing has been completed, the marked up and signed design drawings shall be submitted as part of the inspection and testing records.

Section 9 Installation inspection and testing

9.1 General

To ensure the safety of the final signalling scheme, it is necessary to implement a regime of inspection and testing that proceeds in step with the installation program, throughout the entire project period.

Testing should not commence until all construction and installation activities have been completed.

A construction handover certificate may be used, detailing the state of construction readiness at the time of handover and any identified deficiencies or items of non-compliance.

Where used, construction handover certificate shall:

(a) confirm that the installation and equipment meets the approved design;

(b) detail any variations to design that could affect the commissioning; and

(c) include details of any incomplete works.

When the signalling equipment is handed over for testing, it should not be altered without approval.

9.2 Extent and rigour of the testing process

The extent and rigour of testing shall be proportionate to the hazards and risks associated with the system under test. This shall include consideration of the potential for incorrect system behaviour, incorrect configuration or data, interface failures and failures in the execution or control of the testing process.

The testing approach shall include measures to reduce the likelihood of systematic errors in testing, such as independence, diversity, or overlap of test activities, so that failures or omissions in one test activity are likely to be identified by another.

The novelty and acceptance of the system and its components, the complexity of the installation and construction, and the scale of change shall be assessed when determining the extent and rigour of the testing to ensure the overall system is fit for purpose before entry into service.

9.3 Order of inspection and testing

Inspection and testing shall be planned and performed in a logical sequence that progressively builds confidence in the correctness of the installed works.

This shall include inspection and testing of individual assemblies or elements prior to testing of interconnected or integrated systems, such that defects are identified and addressed at the earliest practicable stage.

The inspection and test detailed plan shall define the sequence of inspection and testing activities appropriate to the scope and staging of the works. Activities should be carried out in accordance with that sequence.

Progressive inspection and testing typically involves verifying individual elements before combined or integrated testing, to reduce the risk of latent faults being carried into later stages.

9.4 Phases of the testing process

Testing shall be conducted in phases. The phases shall begin with testing that the individual items of equipment and sub-systems are correctly installed and configured, then progressively testing the integration of those sub-systems into systems.

Testing processes may take place:

(a) under a manufacturer's own testing process (in the case of factory acceptance testing);

(b) off-site under the control of the test plan; or

(c) on-site under the control of the test plan.

Acceptance inspections and tests shall be performed for externally manufactured equipment for which supplier's certificates of conformance are required.

Preliminary pre-site tests of pre-wired relay racks and locations shall be carried out.

Cable installation tests shall include:

(d) pre-site insulation test records and certificates;

(e) insulation tests as underground cable is progressively trenched and back filled but not terminated; and

(f) insulation tests of all external cable after it has been terminated.

As the installation of trackside apparatus to a location is completed or as the equipment installation is completed within a trackside location, or within the centralized interlocking and control location, or within the RIM's control centre, then these separate parts shall be individually set to work and tested, using false feeds where necessary.

Signed test records shall be completed for each separate part tested.

Any temporary test supplies, wiring, and straps shall be removed after each completed test.

Certification testing shall be performed when the item to be inspected and tested is complete and not liable to further interference or damage.

General apparatus inspections should be carried out separately or in conjunction with other inspections and tests. This should include:

(g) verification of correct equipment and terminal type;

(h) labelling (back and front) and positioning, including the pin coding/indexing of relay plug in bases;

(i) relay position to analysis, detachable tops and the like completed prior to circuit bell continuity tests and wire counts.

Circuit testing shall be performed after wiring and cabling is terminated.

Documentation checks shall be completed prior to and following completion of testing of each circuit or page.

Apparatus function testing shall be performed after the apparatus is installed, powered up and set to work.

System function testing from the control location or centre shall be performed after the installation and all apparatus function testing is complete. All communications links shall be tested prior to system function testing.

Before certification function testing commences, testers shall ensure that:

(j) circuit wiring testing is complete;

(k) circuit wiring is secured against interference; and

(l) the approved final circuit wiring diagrams are correctly certified as bell continuity tested, wire and null counted, and insulation tested.

Mechanical interlocking and/or electrical interlocking and control tests may be conducted with the operation of the trackside apparatus simulated. Where this is carried out, correspondence tests and through tests shall follow these tests.

Where it has not been possible to connect and test functions prior to commissioning the signalling system, then, at the time of commissioning, a through function test shall be carried out sufficient to complete the testing program.

As part of the commissioning, the following tests shall be performed in all cases to ensure that the trackside equipment is operating correctly and in correspondence with controls and indications:

(m) Test correspondence of all field indications back to control centre.

(n) For each designed route, verify that the authority to proceed is correctly established, displayed, held, and withdrawn, including verification of route indication and the correct sequencing of associated indications or movement authorities.

(o) Operate points normal and reverse and verify correspondence between the control switch, the detection and the lie of the points.

(p) Release and operate each ground frame.

(q) Operate any emergency switch machine/emergency operation locks and verify point detection is lost and interlocked signals or movement authorities return to stop.

(r) Any other inspections and tests deemed necessary by the verification and validation plan, or inspection and testing detailed plan.

If deficiencies are discovered in interlocking or controls during commissioning, then all functions affected shall be considered as defective and be rectified and retested in accordance with design and defect management procedures.

9.5 Test logs

A test log shall be used to record all queries, disagreements or deficiencies that have been identified from the beginning to the end of testing.

If the test log is in electronic form, it shall provide a secure and permanent record of all entries, updates and signoffs and identities of signatories, equivalent to a paper record.

A methodology shall be implemented for the recording of errors and observations identified during testing. This methodology shall be documented in the test plan.

All errors and observation shall be recorded in a timely manner, be uniquely identifiable to the project and be unambiguous in content. The records shall be retrievable for inspection and retained with the testing records.

Each test log entry shall document:

(a) the design document identifier;

(b) the event that gave rise to the record;

(c) the location (geographical and technical);

(d) the version reference of the item(s) concerned; and

(e) why the record is being made.

Each item shall be recorded on a separate test log entry. A single entry may be used to record multiple items where there is a common solution to all the items listed (for example, multiple missing labels).

Responses shall:

(f) be sought from the appropriate authority (usually the design or installation organisations);

(g) be traceable to the original error record;

(h) give a clear statement of the action required; and

(i) reference any associated modification documentation or data; and

(j) record the status of each error record and tracked through to closeout.

All resulting modifications shall be subject to a retest. Such retesting shall include all parts of the installation which could have been affected by the alteration. All modifications and retesting shall be recorded in the test log.

A test log register should also be created as an over arching document to allow the tracking of each individual log and its status.

On each change of shift, commissioning personnel shall be given an update briefing on the test log status. The signoffs by the outgoing and incoming team leaders shall be recorded on the test log.

All records shall be closed-out, or an agreement made for any outstanding or deferred actions. These shall be recorded in accordance with the established process.

Records shall be capable of analysis to show error trends, systematic failure and the integrity level at which the failures occurred. The need for, and extent of, such analysis shall be determined.

9.6 Disconnections

9.6.1 General requirements

Any disconnection that affects the use of operational equipment within the scope of this document shall be made in accordance with the RIM's safeworking rules and procedures.

Where disconnections are required in order to protect the railway during testing work, the disconnections shall be selected so that:

(a) they are not compromised by the work subsequently to be carried out;

(b) they are effective under all circumstances;

(c) they do not have to be reconnected for testing (e.g., to test the approach locking look-back or aspect sequence controls) unless further protection is first established; and

(d) in the event of partial hand-back to the signaller they remain effective for equipment that is not available for use.

9.6.2 Identification of disconnections

Disconnections shall be clearly identified and protected to prevent inadvertent reconnection in accordance with RIM procedures.

9.6.3 Verification of disconnections

The effectiveness of disconnections shall be verified before being relied upon.

9.6.4 Situations where equipment cannot be restored to service

If an item of equipment cannot be safely restored to service, it shall be booked out of use in accordance with the RIM's safeworking rules and procedures.

9.7 Cleanliness of work areas

All precautions shall be taken to ensure that working circuits cannot be accidentally damaged or shorted out by loose conductive materials such as short strands of wire or metal drilling swarf.

All necessary precautions shall be taken to ensure that all such material is cleaned up and disposed of, so that none remains on either the floor or any surface where it could possibly transfer to a working signalling circuit.

Of particular concern is the placement of new or removed plug-in relays on these surfaces and the risk of picking up the material on the relay contacts. Prior to plugging-in, the relay and its base shall be closely examined for any contamination and thoroughly cleaned if necessary.

9.8 Installation inspection and testing status certificate

An installation inspection and testing status certificate shall be completed to certify that all planned certification inspections and tests to be carried out during the installation stage have been properly completed or transferred to the commissioning work package.

Acceptance of the installation inspection and testing status certificate shall be a prerequisite to commencement of review and approval of the commissioning work package.

The status certificate shall document the transfer of all uncompleted installation work instructions and uncompleted actions from the installation inspection and testing log and lists any approved variations to the inspection and testing plan or waivers to standards or procedures.

Section 10 Commissioning readiness review

10.1 General

Before proceeding with a commissioning event, a commissioning readiness review shall be conducted.

The purpose of the commissioning readiness review is to establish that:

(a) all installation, testing and supporting works have progressed to an acceptable state;

(b) the commissioning as proposed has an acceptable probability of success;

(c) the commissioning represents a low risk to network safety and operations; and

(d) any conditions for approval to commission the system have been identified.

10.2 Requirements

10.2.1 Readiness review

The readiness review shall establish whether the following has been completed:

(a) The installation works have been carried out to the most up-to-date version of the engineering details.

(b) All testing activities that can be completed before the final commissioning have been completed.

(c) Type approvals of any novel equipment or systems are completed, or interim approvals have been issued.

(d) All equipment that can be installed prior to the final commissioning has been installed and tested.

(e) Where the commissioning involves alterations to existing systems, the installation and pre-testing work is as complete as reasonably practicable, leaving only the minimum work for the commissioning as determined by the physical constraints of the site.

(f) An inspection has been completed to indicate that the required standards of work quality have been achieved.

(g) An installation inspection and testing status certificate has been completed and signed, certifying that all planned certification inspections and tests to be carried out during the installation stage have been properly completed or transferred to the commissioning work package.

(h) Approved for commissioning design documentation, and interlocking or other system data, is available before the commissioning date.

(i) Commissioning plans and work packages are completed and approved

(j) All logistics support elements are in place.

(k) Network access and track possessions required for commissioning period have been granted.

(l) Other discipline supporting works (e.g., track, overhead) are ready and assurances have been received.

(m) All necessary competent testing and commissioning personnel are available and committed.

Where one or more of the above items has not been completed, the commissioning may proceed if there is evidence that the incomplete item/s do not pose a risk to entering the system into service (see Section 12).

The commissioning shall not proceed if certification testing will be jeopardized by compression into too small a timescale that over-extends testing personnel.

10.2.2 Pre-commissioning conference and meeting

Pre-commissioning conference meetings shall be arranged to determine whether the works have progressed sufficiently to permit the commissioning to proceed.

The outcome of each meeting shall determine whether the commissioning proceeds or is deferred.

The pre-commissioning meeting should be held at a suitable interval prior to commissioning and in accordance with the RIMs requirements. Follow up meetings can possibly be required to address any identified issues.

Pre-commissioning minutes, with any conditions highlighted and attendance list for the meeting, shall be included in the commissioning work package.

The meeting shall be attended by commissioning personnel, along with representatives of other disciplines, including:

(a) integrated systems (i.e. train control, telecommunications systems and other interfacing systems);

(b) operations;

(c) regional and local signal representatives; and

(d) maintenance representatives.

Plans shall be developed and communicated to ensure that any signalling risks associated with the commissioning not proceeding are mitigated (e.g., non-commissioned signalling equipment is secure, etc.)

10.3 Logistics and maintenance support items

Before the commissioning commences all logistics and maintenance support items shall be delivered, in place and available for use.

Logistics support items shall include:

(a) training on novel equipment for maintainers;

(b) second-line support and design;

(c) training materials on novel equipment;

(d) equipment manuals;

(e) spares as identified (this does not include materials provided on site to cover commissioning contingencies);

(f) asset register data; and

(g) Geographic Information System (GIS) survey data.

Section 11 Decommissioning

11.1 Decommissioning and disposal

Decommissioning is the process of permanently removing signalling equipment, functions or data from operational service and securing the railway such that the removed elements can no longer influence train operations.

Decommissioning activities shall be planned and conducted to ensure that rail operations remain safe, including verification that all decommissioned equipment, functions or data are isolated, disabled or removed, and that any physical, electrical, logical or data interfaces to remaining operational systems are correctly managed with no ambiguity as to their operational status.

Where decommissioning is undertaken as part of staged works or prior to commissioning of replacement equipment, the railway shall be left in a defined, verified, and approved safe operating state, with no ambiguity regarding which signalling equipment, functions or data are operational, in accordance with the RIM's safeworking rules and procedures.

11.2 Standards and procedures

Decommissioning and disposal shall be planned as part of the testing and commissioning activities. Safe and efficient disposal shall be a condition of the final completion of the project.

Procedures shall be established for decommissioning operational signalling and safety related telecommunications systems prior to disposal. The procedures shall assess and address the need to:

(a) maintain safe railway operations during decommissioning and demolition prior to disposal;

(b) ensure that no ambiguity exists regarding the type of safeworking or signalling and telecommunications system in force at any one location or time;

(c) ensure that decommissioned equipment is clearly identified as such;

(d) prevent inappropriate re-use of decommissioned equipment prior to disposal;

(e) eliminate, so far as is reasonability practicable, any public hazard associated with decommissioned equipment, based on an assessment of both short and long-term conditions.

11.3 Responsibility

A person shall be nominated as being responsible for:

(a) establishing the impact of decommissioning and disposal on any system or external facility associated with the system to be decommissioned;

(b) planning the decommissioning, including the establishment of procedures for:

(i) the identification and removal of all decommissioned and redundant equipment;

(ii) the safe shut-down of the system and any associated external facility;

(iii) the safe dismantling of the system and any associated external facility;

(iv) the assurance of continued functioning and safety integrity of any systems or external facility affected by the decommissioning of the system;

(v) all redundant materials, structures and equipment, including wire and cable shall be removed during the commissioning wherever such equipment may impinge on the operation of the new work or could lead to confusion or distraction of RSWs; and

(vi) train staffs, Annett keys and locks, fortress keys and locks shall be handed to the commissioning engineer and a receipt obtained.

11.4 Redundant equipment

Equipment identified for recovery shall be independently confirmed as correctly identified before recovery commences.

Redundant equipment that cannot be completely recovered shall be identified in the test plan.

Redundant equipment that is not removed as planned during the commissioning shall be reported in a test log.

Any special measures required to control the risks with leaving redundant equipment in situ shall be in place prior to entry into service.

Where any redundant application logic is to be retained in the system, verification shall be applied to demonstrate that the safety of the operational railway cannot be adversely affected. In all other situations, redundant application logic shall be recovered prior to the verification of the application logic.

If any product or application logic is to be left in place it shall be disconnected and/or configured in a manner that no irregular or confusing indications or information to be given to any infrastructure personnel, train driver or road user.

11.5 Redundant traction bonding

Existing traction bonding shall not be disconnected unless or until:

(a) a permit to work (or equivalent) has been issued by the RIM;

(b) the new traction bonding is installed and prepared for changeover in accordance with the approved design requirements ;

(c) approved stagework or final bonding design is installed, ready for changeover and it is safe to do so;

(d) the track circuits concerned have been disconnected and booked out of use, and if required; and/or

(e) the traction overhead power has been isolated and a permit to work has been issued.

Temporary bonding shall be installed in accordance with RIM procedures prior to any disconnections to manage stray current risk. Where temporary bonding is used, these bonds shall be removed when the final bonding arrangement is installed and tested.

11.6 Standalone decommissioning of redundant equipment

Where a project consists only of the decommissioning of redundant signalling:

(a) the decommissioning shall only be done to an approved design; and/or

(b) the remaining signalling at the interfaces shall be tested and recommissioned in accordance with the requirements of this document.

Section 12 Commissioning and handover

12.1 General

12.1.1 Function testing and validation

The RIM shall have procedures in place to ensure that suitable and sufficient testing of systems, sub-systems, materials and components is carried out to give assurance as far as safety of the operational railway is concerned that they are in accordance with those specified in the approved design.

The RIM shall have procedures in place to ensure that such testing (e.g., signal testing) is carried out without importing risk to the operational railway.

12.1.2 Testing and commissioning of works

The RIM shall have procedures in place to ensure that construction work is subject to such testing and commissioning as is necessary to satisfy the verification and validation requirements for acceptance of the system.

12.1.3 Notification of the works

At an agreed interval before the commissioning, a traffic operating notice shall be published and issued to inform RSWs of the proposed commissioning. It should describe any interim and final operational changes to the system.

12.1.4 Operational requirements

Test and commissioning activities could require periods where no rail vehicles are within the commissioning area. Conversely, rail vehicles could also be required for testing of signalling systems. All

requirements for rail vehicles and rail vehicle free periods shall be clearly identified in the inspection and test detailed plan.

All hazards associate with rail traffic during a commissioning shall be assessed and contingency plans in place against the time when a hazard occurs.

There shall be a clear understanding and agreement between all involved parties of the safeworking systems to be employed during the period from the shutdown of the old system to the commissioning of the new system.

Any changes to the safeworking arrangements during the commissioning shall be communicated to all commissioning personnel in accordance with RIM safeworking rules and procedures. This includes when rail vehicles enter a commissioning area for testing purposes.

12.1.5 Liaison with network control officer

Communication paths between commissioning personnel and the network control officer shall be clearly defined and agreed at all times.

12.1.6 Booking out of use

Clear and detailed advice shall be provided regarding those items of signalling infrastructure which are to be taken out of service.

This advice shall be in the form of a written document in standard format, providing all relevant detail.

The advice shall be signed, countersigned, and held by the person responsible for the control of trains into or through the area where the signalling has been disarranged.

The document shall include provision for subsequent advice when the infrastructure is again available for operation and provide for all signatories or their representatives to sign acknowledging receipt of this advice.

This document should be a standard form such as an infrastructure booking advice.

12.1.7 Commissioning activities

Commissioning involves the decommissioning of redundant signalling, completion of all installation and wiring not previously completed within the works area and at interfaces, updating or installation of new computer-based signalling data, all remaining verification and validation testing in readiness for handover.

The commissioning works shall be carried out in accordance with the approved commissioning plan.

Commissioning personnel shall be advised in case of changes to the safeworking environment.

All commissioning activities shall be as defined in the inspection and test detailed plan, associated commissioning work package, and individual work instructions.

Work instructions shall be marked up to record completed activities, and any incomplete work or new issues arising out of the commissioning work reported.

All faults and issues identified and noted in the work instructions shall be recorded in the commissioning log. These shall be assessed for resolution during the commissioning or deferred for post-commissioning attention.

All incomplete activities, or activities arising out of the commissioning works, shall be documented as new, additional work instructions.

A process shall be implemented for the resolution of design errors identified during the commissioning by the production and issue of modification instruction sheets. These shall be included in the final testing records and as-commissioned design documentation.

A control method shall be implemented for the issue, receipt, assessment and carrying-forward of all work instructions.

12.1.8 Progress reporting

The progress of the testing shall be continuously monitored. The current status of what has been completed and what is still to be done shall be clearly visible. The use of a summary checklist upon each check list item is endorsed as complete, is a method that will satisfy this monitoring requirement.

12.1.9 Items previously tested and certified

Modifications to sub-systems and systems that have been tested or partially tested shall be controlled so as to preserve the assurances given by earlier testing. Alternatively, sufficient re-testing shall be undertaken to confirm that the integrity of the tested sub-systems has not been compromised.

The installed equipment and application logic under test shall be securely maintained at all times from unauthorized access.

12.2 Finalization of commissioning and handover

12.2.1 General

Before the installation is handed over to be placed into service, the following shall be completed:

(a) All test logs have been collected, inspected and audited to ensure that they are completed and signed off by the tester who performed the tests.

(b) Where a test log is not completed due to, including but not limited to the installation is not complete or the installed system does not conform to the railways signalling standards, the test log shall be endorsed with the reason for non-completion.

Where a test log is not completed, the RIM may accept handover of the signalling system with conditions applied. This is typically known as a partial handover.

(c) All plans, diagrams, and certifications have been collected, collated and properly annotated.

Where it is not practicable to return completed documentation prior to the handover, confirmation that the work has been completed shall be communicated and recorded. The completed documentation should be returned as soon as practically possible.

Notice in writing shall be given in electronic form provided that the sender can be identified and the message authenticated.

12.2.2 Certificate of signalling

When all test logs and documentation have been collected and dealt with as required, the certificate of signalling shall be completed to certify that the testing is complete. This can then be submitted for acceptance of the commissioned works.

If there are any logs that are unresolved or unable to be resolved, they are to be recorded in a post commissioning log. In this case, a conditional certificate shall be signed stating all the remaining issues with a resolution time frame agreed between all relevant parties.

The commissioning and testing records and documentation shall be reviewed to confirm that the works, or the relevant part thereof, are fit for purpose and ready for use and meet all rail safety requirements. This should include checking that the following are complete:

(a) All required changeovers.

(b) All set to work.

(c) All commissioning and inspection activities.

(d) All testing and certification.

(e) All redundant equipment has been decommissioned and made safe.

All safety critical test logs remaining open requiring restriction on operations shall be discussed with the RIM to confirm the action to be taken, prior to proposing that the system is ready entry into service.

The new and altered works shall then be booked into use in accordance with the provisions of the RIM's network rules and procedures.

12.2.3 Entry into service

The RIM shall determine the documentation required for controlling entry into service.

Entry into service shall be permitted only when there is documented evidence of the proper completion of all installation and testing activities associated with the project.

The documentation shall, as a minimum, consist of a summary of the completed test certificates, the as-built design details and a summary list of the error records. Examples of other documentation that could be required include:

(a) documentary evidence of design verification and approval;

(b) product acceptance certification;

(c) scheme approvals certification;

(d) level crossing orders;

(e) maintenance requirements and arrangements;

(f) authorization of any non-compliance;

(g) asset record data.

Prior to entry into service:

(h) the system shall be restored to its normal operating state; and

(i) any simulation elements or releases provided for testing shall be completely disconnected from the commissioned system.

12.2.4 Post-commissioning meeting

A post-commissioning meeting shall be held within two weeks of the end of the commissioning period, to identify, review and record all uncompleted activities and tasks and to identify dates and responsibilities for their completion.

The meeting should be attended by all key stakeholders who were involved or impacted by the commissioning.

A report of the meeting should be created for issue to all attendees, and for inclusion in the commissioning works package.

12.2.5 Delegation of authority

The authorization of entry to service of a commissioned system may be delegated. Such delegation shall be formally recorded.

12.2.6 Monitoring and other measures

Any monitoring or other measures that are required shall be confirmed as in place and effective before entry into service.

12.2.7 Trial running

Where trial running (e.g., test trains during the commissioning period or shadow service running) is to be conducted, all necessary agreements and protection arrangements shall be in place before authorizing commencement.

12.2.8 Security

The site and systems shall be made secure against unauthorized access upon completion of testing work.

12.3 Project completion

12.3.1 Equipment removal

All released or surplus signals, signs, signalling equipment, relays, cables and wiring shall be promptly removed from site.

All surplus insulated rail joints temporarily bonded during commissioning shall be addressed in accordance with the RIM's requirements to ensure that the permanent rail condition is safe, compliant and suitable for ongoing operation.

12.3.2 Plan revision and issue

All plans, drawings and tabulations shall be promptly revised to include any modifications to circuit design or terminations as recorded on the official testing copies and modification sheets, then reissued as complete new bound and dated as in service plans, as required by the RIM's drawing control system.

12.3.3 Permanent testing record

All marked up and certified copies of testing plans, tabulations, test certificates, check lists and logbook shall be consolidated into a permanent record of the testing and commissioning of the project. These records shall be made part of the handover package to be retained as required by the RIM's record management system.

12.3.4 Asset register

The type, location, name and serial number of all equipment installed and released shall be kept in a permanent record for maintenance purposes, as required by the RIM's asset management system.

12.3.5 Project acceptance

A final inspection shall be made by the RIM to verify that the project has been completed to the RIM's requirements. An acceptance certificate may then be issued to certify that the project has been completed.

Section 13 Defects and non-conformances

13.1 Error rectification

Errors found during the testing shall be re-verified following correction. The re-verification shall be sufficient to cover the extent of the correction.

Where a data change is required, the regression and non-regression testing requirements shall be determined and tested.

13.2 Re-entry into service

Correct correspondence between command and control equipment, and correct operation of the system shall be observed before permitting re-entry into service.

Prior to entry into service:

(a) the system shall be restored to its normal (quiescent) state; and

(b) any simulation elements or releases provided for testing shall be completely disconnected from the commissioned system.

13.3 Outstanding actions

The RIM may accept the works for entry into service with outstanding actions, provided that any outstanding actions do not affect the safety of the operational system or, where safety could be affected, suitable and sufficient risk reduction measures are implemented.

A timescale shall be placed and monitored on the resolution of any outstanding actions. The timescale should be based on the risks associated with leaving the work undone and practicalities of completing the outstanding action. An upper limit of six months is generally sufficient to cover such work.

The outstanding actions report shall be closed out by being transferred to a documented action plan that is formally accepted by the affected organizations.

13.4 Concessions

Tests specified in this document that are not performed shall be supported by appropriate documented justification and approved by the RIM or the person responsible for the signalling system.

Section 14 Documentation and records

14.1 Management of records

Testing and commissioning involves the careful management of two types of documentation and records:

(a) Documents presenting the design details for the signalling works.

(b) Documents recording the performance and results of inspection and testing activities.

The two classes of document are related in that those in the first group provide the basis for the activities which generate the second group, but they have different management requirements.

14.2 Design documents and data

14.2.1 General

Procedures shall be implemented to ensure that all inspection and testing is performed using current and approved version of design issued for the installation under test.

Design documents used for testing and/or test recording purposes shall be readily identifiable to ensure that:

(a) they are not confused with the installation or maintenance documents;

(b) where check marks or other test records are made on the documents, such marks are made only on the testing copies; and

(c) they are retained as part of the testing records.

Design details for signalling works are documented in two forms, closely aligned to the type of technology involved:

(d) Designs for hard wired circuits and physical infrastructure are normally presented in the form of paper documents – sheets, books and roll plans. Designs may also be presented electronically if permitted by the RIM.

(e) Designs for application and configuration data in computer-based signalling systems shall exist as digital information and be created, stored and distributed using controlled electronic storage and distribution mechanisms that provide version control, integrity protection, authorized access and compliance with applicable cyber security requirements.

Each form has distinct requirements for managing the control and identification of versions of design issued, installed and tested.

14.2.2 Design documents for hard-wired circuits

Individual circuit sheets/circuit books shall show:

(a) design details;

(b) version data;

(c) relationship to associated circuits (e.g., sheet/page numbers);

(d) design state (for construction, for test, commissioning, etc.);

(e) check and approval status;

(f) testing check marks; and

(g) testers name, signature and date.

14.2.3 Design documents for application data

Design documents for application data shall provide means of version control similar to those used for hard-wired circuits.

Method of issue, record of issue and upload of application data shall be defined in the inspection and test detailed plan, assure that the integrity of the data is maintained, and the correct version uploaded to the target hardware.

Application data files issued for installation shall be readily identifiable as to their contents, target system, issue date and version.

There shall be a clear identification to the document containing the complete details and history of the data file.

An effective means of version control shall be used for all application data supplied for installation in CBI, train control and ATP systems.

This shall include secure storage and transport of new versions received, procedures for correct installation of the data, and processes for securing and archiving or destroying superseded versions of data after a new one has been installed and tested.

Requirements for managing the installation of application data for design alterations and modifications to correct errors found in testing fault are given in Section 15.

The design shall:

(a) be up to date with the latest control sheet;

(b) ensure all pages are correct to that control sheet; and

(c) verify that testing has been planned or completed to the latest versions.

Version control shall be maintained within the register of working drawings included in the installation, and then the commissioning, work package.

All certified office copies (COCs) of the design shall be returned as soon as is practicable (nominally within 28 days) following the completion of the works.

14.3 Inspection and test records

14.3.1 Management of test records

The RIM shall ensure that suitable and sufficient records concerning safety of the operational railway are made and kept in respect of all construction work.

In the following section, the concept of record will encompass electronic records as well as paper records, as determined by the signalling, design and testing technologies involved in a particular signalling system.

A system of test recording and certification shall be implemented with each test plan. All tests shall be recorded. Recording by exception is not permitted.

Test data (e.g., measurements, etc.) shall be recorded wherever this is necessary to demonstrate that:

(a) test acceptance criteria have (or have not) been met; or

(b) the specified tests have been completed in accordance with the test specification.

The recording and certification system shall be defined and prepared prior to the commencement of the testing and commissioning.

Tests shall be recorded by a method appropriate to the technology, its application and the test management system.

Where tests and results are to be recorded automatically, the products used for recording shall be of a kind type approved for the purpose.

Test records, test data and certification shall be presented in a clear, durable and retrievable form.

Within each project, there shall be consistency in presentation.

14.3.2 Test records for application data

An effective system shall be implemented for recording the carrying out of tests on the application data and for recording the results obtained.

The method shall be at least as effective as the system used in recording the testing of hard-wired circuits.

14.3.3 Test records for hard-wired circuits

The RIM may authorize the application of a system of annotated check marks on the engineering details for the recording of test activities. Such a system shall be defined in, or referenced from, the test plan.

Check marks shall be unambiguous and of sufficient clarity to enable correct understanding by others.

The testing copy of the design details shall be the primary auditable record of testing achievement.

Individual tests shall be recorded on the test copies using check marks specified in the testing plan.

Check marks shall be traceable to the person who made them.

14.3.4 Annotation

The methods of annotation to be employed in recording tests shall be defined as early as possible and specified in the test plan. Decisions shall be made on:

(a) a precise method of confirming the successful completion of a test;

(b) a precise method of confirming a second test on the same item on the same primary records of test;

(c) a clear identification of who carried out the test (e.g., printed name and position);

(d) the allocation of specific marking colours to be used by each tester;

(e) a method of adding reminder notes and comments to documents;

(f) precise methods of confirming completed sections (e.g., individual sheets, series of tests, stage-works);

(g) a method of identifying errors and invoking corrective action in the event of failed tests; and

(h) the maintenance of test logs showing the tests failed and the remedial action taken.

Test records of each test shall be made at the time the test is being carried out.

The person making the test shall be required to certify the record of the test.

Where work is passed from one team to another for completion, the status of the testing work shall be clearly recorded and the team taking up the work properly briefed on the condition of the infrastructure.

Certificates and checklists should be used as necessary to demonstrate that all testing activities have been fully carried out, their format being dependent upon the nature of the testing involved. Certificates themselves should be kept as simple as possible.

Test certification shall be generated for each test or group of tests, and shall include the following information as a minimum:

(i) Title and reference – the reference shall be project specific and unique for each certificate within the project.

(j) Test specification(s) employed and the equipment/functions under test.

(k) Results of test.

(l) All relevant version or control reference(s) of the product/application logic under test.

(m) The name of the person controlling the test.

(n) The names of any official witnesses to the test.

(o) The date (and time, if critical) of the test.

A summary of test certificates shall be produced in association with the test plan and certification. This summary shall confirm the proper completion of all relevant testing and commissioning against all the required test specifications.

14.3.5 Operational configuration/adjustment records

Where test data or adjustment/configuration data (e.g., a track circuit maintenance record card) is required to be made available to maintainers, the RIM shall approve the data recording method. These records shall be made available to the maintenance organization at time of entry into service.

14.4 Records of technical approvals

All technical approvals associated with the project shall be conducted and documented in accordance with the RIM's standards. Complete records of technical approvals shall be handed over to be retained by the RIM.

The RIM shall ensure that the technical approval process is fully documented and that records of all technical approvals are retained.

Where appropriate the records shall be made available to the person or organization responsible for maintaining the changed infrastructure.

Section 15 Modifications and design changes

15.1 General

15.1.1 Installation discrepancies identified in testing

Where testing has identified a case where installed infrastructure is not installed or functioning in accordance with the approved design, a test log entry has been recorded, and the necessary corrective action does not involve any alteration to the approved design, the test log record shall be passed to the appropriate person for action.

When the issue has been resolved, the test log record shall be annotated accordingly and return the case to the tester for testing to resume.

All resulting modifications shall be subject to a retest. Such retesting shall include all parts of the installation which could have been affected by the alteration, or where the previous test results can possibly have been rendered invalid by the discrepancy identified. All modifications and retesting shall be recorded in the test log.

15.1.2 Design errors or shortcomings identified prior to commissioning

Any error or shortcoming in circuit design identified prior to commissioning shall be corrected only with wiring changes carried out in accordance with an approved alteration design.

The changes could affect existing or new circuits, or more likely a combination of the two.

All alteration designs shall be independently checked and approved by authorized, competent persons.

Any error or shortcoming in computer-based signalling, CBI, or control system data identified during testing shall be corrected by the installation of a new version of the data that incorporates the required changes.

The modified data shall be independently verified and approved before being issued. Where possible, modified data should be tested on a simulator.

The issued data shall be accompanied by the required version control documentation.

The installation of the new data in the computer-based signalling, CBI, or control system shall comply with the normal software version control procedures.

For corrections made before the commissioning, the design changes shall be presented on updated pages of the approved for test design circuit book, issued by the design office.

Amendments to issued designs shall be accompanied with updated title and control pages, to facilitate maintaining version control of the document.

In cases where the designer has placed design staff co-located with the installation and testing staff to facilitate speedy correction of design issues found in testing, the resulting alteration designs shall be subject to the same standard of drafting, independent checking, verification and version control as if it were done in the design office.

15.1.3 Design errors or shortcomings identified in commissioning

For corrections required after the commissioning commences, the alteration shall be presented on modification instruction sheets (modification sheet) or a modified design drawing. A separate design drawing shall be produced for each page of the circuit book affected by the design alteration. Each modified drawing shall be securely fastened to the corresponding original design drawing.

All testing mark-ups shall be done on the issued modified drawing.

All site modifications shall be subject to a comprehensive retest, to the same standard as the existing wiring. Such retesting shall include all parts of the installation which could have been affected by the alteration.

Modifications to sub-systems and systems that have been tested or partially tested shall be controlled to preserve the assurances given by earlier testing; or alternatively, sufficient re-testing shall be undertaken to confirm that the integrity of the tested sub-systems has not been compromised.

Section 16 Temporary wiring, pre-wiring and stageworks

16.1 General

This section describes the management of equipment, wiring and data installed as preparatory steps leading to the final system configuration.

It encompasses:

(a) temporary wiring installed only for testing purposes, which will form no part of the final installation;

(b) temporary wiring to enable the installation and connection of field equipment that is not yet operational;

(c) pre-commissioned equipment that will form part of the final configuration, installed and temporarily operated from the existing signal interlocking (also referred to as staging-in);

(d) wiring installed and partially connected to the working system, to minimize the time needed for changeovers during a commissioning;

(e) stagework, with equipment installed and commissioned in an intermediate configuration, to enable continued rail operations while major track reconfigurations are carried out.

16.2 Temporary wiring standards

Temporary work and stagework shall be carried out to standards that will not compromise the safety of any operating part of the signalling system. Where the minimum standards for temporary or stageworks are not detailed in this or any other standard, the minimum standards to be employed shall be to as new standards or otherwise only as agreed in the site integrity agreement.

Existing signalling equipment or circuits shall only be interfered with, disconnected or connected in accordance with the provisions of the RIM's signalling maintenance procedures.

Existing signalling equipment and circuits shall refer to any installed and commissioned equipment and circuits whether currently in use or booked out of use.

16.3 Planning for stagework

The works program, testing strategy, inspection and testing plan and installation methodologies shall assess requirements associated with the scope of stagework and temporary work. These shall include:

(a) minimizing the work that requires track possession to commission by completing all possible installation, inspection and testing prior to the commissioning track possession;

(b) clearly identifying in the inspection and testing plan, the scope of the works to be carried out, the work program, the design and materials for implementation of stagework, new equipment to be commissioned and old equipment to be removed or placed out of use, temporary work or interfacing work, and the documentation to be produced;

(c) incorporating equipment that will form part of the works and is installed by others but is required to be inoperative and by-passed until commissioning to allow the existing system to operate, making provision for such works by others;

(d) where necessary for the progress of the works, carrying out any alteration, relocation, adjustment, reconfiguration or protection of existing infrastructure;

(e) inspecting and testing any alteration, relocation, adjustment or reconfiguration to existing equipment before certifying its suitability to be restored to use;

(f) for temporary work and interfaces, minimizing the amount of equipment temporarily mounted, and work carried out, within an existing location by using, where practicable, temporary enclosures mounted adjacent to the existing location;

(g) identifying all temporary work in a manner that is immediately clear and obvious to any interested observer;

(h) providing positive identification to differentiate between commissioned items of equipment, circuits situated in housings with other items of equipment, or circuits that have not yet been commissioned;

(i) as soon as temporary work is no longer required, restoring the situation to the condition applying before the temporary work was carried out, or to the satisfaction of the RIM;

(j) arranging for the removal of any temporary bridging during commissioning;

(k) arranging positive identification of trackside equipment installed and not yet brought into use, or removed, by the provision of secure covers and X signs on signals as per network rules;

(l) control of stagework design; and

(m) handover to the RIM.

Any new wiring that is run within or into an existing location or item of signalling apparatus shall be:

(n) effectively secured to ensure there is no possibility (under any circumstances) by physical movement that an electrical connection can occur between the new wiring and the existing working wiring or terminals and no possibility of mistaken connection;

(o) protected from accidental contact with working circuits using suitable insulating devices to securely insulate the exposed ends of loose wiring, such as the use of secured insulation tubes applied over Q crimps or blind pre-insulated crimp connectors.

Where practical and permissible, the wiring should be terminated on terminals isolated for the purpose.

All such new wiring shall be fully tested, results recorded, and clearly and distinctly identified and labelled as new work yet to be commissioned.

New wiring shall be connected to spare terminals of link terminations for cable or wiring runs provided the terminals are proved spare and are clearly and reliably isolated with the link removed entirely or securely disconnected.

Any existing spare terminals shall be confirmed to be voltage free and isolated from the working signalling system before being used to terminate new wiring.

New wiring shall be connected to spare terminals of existing items of signalling operating or processing equipment only while the item and all connected circuits are disconnected and booked out of use.

The existing item shall be restored to use after the connection to the spare terminal is securely made and prior to commissioning the new wiring, but only provided each new wire is properly insulated and clearly and reliably isolated at its other end until the new circuit is commissioned.

Where applicable, the existing item of equipment shall also be mechanically disconnected to prevent its movement before any electrical connections are made.

Any mechanical disconnection shall be made only by suitably accredited personnel.

16.4 Identification and labelling of alteration wiring

At stud termination points (i.e. shelf relays and trackside equipment) where new wiring is to be connected to working circuits, or where old wiring is to be disconnected from working circuits, each wire shall be fitted with a tag clearly identifying the circuit and terminal to which it applies and the terminal to which it runs. The other end of any such wire shall be similarly tagged.

Both ends of the wiring shall be securely insulated whether a crimp lug has been installed or not.

For plug-in relay bases and screw terminals in relay rooms, the new wire shall be insulated and secured in or near to its final position and be fitted with the wiring beads to designate the terminal/fuse number or relay base position.

16.5 Temporary wiring

16.5.1 Control and removal of temporary wiring

The use of temporary wiring shall be controlled.

The installation and removal of all temporary wiring should be recorded.

Temporary wiring shall be disconnected and removed as soon as it has served its purpose.

16.5.2 Temporary stagework wiring

Temporary stagework wiring shall be of a distinctive colouring. Where there are multiple stages in a project then the stagework wire for each stage shall be clearly identifiable.

A chart shall be placed into each signalling location clearly identifying the wiring colours, which stage of the project they relate to, and contact details for the person responsible for the stagework.

The scheme of colours for stagework and test wiring for the project shall be in accordance with RIM standards and procedures.

The identification scheme shall be documented in the interface coordination plan.

16.6 Stagework

Stagework refers to arrangements by which the complete project area is divided into a number of separate parts, which are commissioned in successive stages of the project, generally to enable each lot of commissioning work to fit into an available track possession window.

Each stage shall be installed, tested and commissioned to a separate approved design.

A separate test plan and a separate commissioning plan shall be prepared for each stage.

Each stage will involve a quantity of temporary installation and wiring provided to make the system safe and functional in the stage configuration but will not form part of the final system configuration. These temporary arrangements are referred to as stageworks.

Stagework is frequently associated with major changes to track layouts, or the progressive introduction of new signalling systems in an overall program that is determined by the need to agree possessions with the RIMs.

The alternative to stagework can be a restriction or close-down of the rail network lasting for several weeks or months while the track and signalling works are carried out.

In stageworks, the project area goes through several iterations where sections are taken out of service, altered and recommissioned for normal operation. Each iteration brings the overall project closer to its intended final configuration, although some stages might be configurations that are not part of the final configuration, but are introduced purely to facilitate further work.

Each stage involves alterations to the track configuration and interlocking logic. Staging may be applied:

(a) to break down a large project into smaller manageable units, each of which can be commissioned within the time and resource limits of an available track possession; and

(b) to enable continued train operations while a track layout is undergoing major reconfiguration involving progressive alterations to different parts of the track layout.

A complex project could run over several years and involve multiple individual stages.

16.7 Enabling works

Enabling works are a minor form of stagework in which existing infrastructure, in particular cable routes and equipment housings, is relocated clear of planned track or civil works, without any resulting alteration to the design or functioning of the existing signalling system.

Enabling works may be treated as like-for-like minor works and be subject to the same standard of test planning, testing and commissioning.

Wiring to be commissioned or decommissioned in stages shall be clearly labelled as to what stage it is to be commissioned or decommissioned.

On changeover, the stage labelling shall be removed, the correct labelling applied, and the arrangements made permanent.

To clearly designate and identify stagework in progress at a location a notice identifying the work team responsible and the distinguishing colours for wiring shall be displayed at each location affected.

On changeover to the final state, the stage labelling shall be removed, the correct labelling applied, and the arrangements made permanent. To clearly designate and identify stagework in progress at a location. The work team responsible and distinguishing colours for wiring should be documented and displayed at each location affected.

16.8 Pre-commissioning

Also referred to as staging-in of individual items, pre-commissioning is a special and limited form of stage-work.

Temporary connections to pre-commissioned equipment shall be configured in a way that prevents the equipment from being inadvertently energized from the new interlocking system.

Pre-commissioning is the practice of installing and setting to work individual items of field equipment which will form part of the final signalling scheme, with temporary arrangements to operate them as part of the existing signalling.

Items which may be pre-commissioned include signals, point machines, and train detection.

Pre-commissioning may involve minor changes to the configuration of ground equipment (e.g., turnout replaced with a longer unit in the same location, or a new signal installed in front of the existing one) but will involve no changes to the interlocking logic.

A feature of pre-commissioned equipment will usually be the provision of an interface termination unit, providing permanent connections to the new interlocking equipment and safe temporary connections to the existing interlocking.

An extreme form of pre-commissioning is the installation of a heart transplant interlocking, where the existing interlocking equipment is replaced with a new processor based interlocking, to facilitate the subsequent signalling alterations.

The heart transplant replicates exactly the functions of the existing interlocking, and interfaces transparently to the existing control panel and field equipment.

Section 17 Minor works and alterations

17.1 Minor changes

In some circumstances, minor changes to systems are necessary following planned maintenance, faults or failures.

Minor changes are those where the application logic, functionality and operation of the system are unaltered.

Examples include re-allocation of a relay contact or cable core or replacement of an item by an operationally equivalent item.

17.2 Testing following minor changes and renewals

Where the work can be pre-planned, the extent of the testing shall be documented in a test plan prior to the implementation. This plan shall include or reference the relevant test specifications.

Arrangements for the control of deviations from the test plan shall be specified. Changes shall be documented.

Test plans shall be subject to independent verification by a competent person.

17.3 Minor works

17.3.1 General

Minor works are classified as works where a single work team is carrying out a change to the signal infrastructure and the work does not require coordination with other signalling teams working in the same area implementing other works. It also includes works, where the works are carried out simultaneously by multiple teams working independently without any interfaces or overlaps.

Examples of works that are classified as minor signalling work include the following:

(a) Conversion (upgrade) of trackside equipment such as signals, train stops, track circuits, point drives or level crossings.

(b) Like for like renewal of trackside equipment with minor adaptations.

(c) Additional items that do not require changes to existing interlocking wiring and data, such as repeater signals, buffer stop lights, level crossing monitors and surge protection devices.

(d) Additional items that require only minor changes to interlocking wiring and data, such as upgraded power supplies or emergency change-over contactors, guard indicators, warning lights and telemetry interface.

Like for like replacement is defined as equipment with identical form, fit and function as the existing equipment.

Control table changes shall not be classed as minor works.

17.3.2 Test requirements for minor changes

Work that is a minor change shall be tested in accordance with the main requirements of this document, based on the nature of, and risks associated with, the change being made.

The level and extent of signalling testing and commissioning can vary depending on various criteria, as determined by the RIM, associated with the particular signalling tasks to be tested and commissioned.

Section 18 Personnel and competency

18.1 General

RIMs and contractors undertaking signalling projects shall ensure that projects are adequately resourced for their respective parts with competent personnel who are able to perform their allocated duties.

Personnel engaged in testing activities shall not be coerced or unduly pressured in the exercise of their duty. There shall be supervision to ensure this requirement is met.

18.2 Staffing levels

The staffing levels required for a testing and commissioning scheme shall be defined in the inspection and test detailed plan.

Staffing levels shall be sufficient to ensure that all inspection and testing activities can be completed in the time available, with due regard to:

(a) compliance with requirements for independence of testing activities;

(b) avoiding undue pressures to complete testing activities in a rushed or incomplete manner;

(c) WHS issues, especially fatigue and limits to working hours;

(d) contingencies such as extreme weather and train traffic through the worksite;

(e) work on track access limitations;

(f) interference from concurrent civil/electrical works and work trains;

(g) delayed construction works and equipment failures.

18.3 Competency of individuals

Testing and commissioning of signalling work shall be performed by, or under the direct supervision of personnel competent to perform such work.

Assessment of capability shall be determined with reference to industry competency standards and the RIM requirements.

A process shall be implemented to ensure that all persons performing safety related testing and commissioning activities have the required competencies and authorizations to carry out the allocated work.

The review of each person's competency to perform work shall be recorded in a form approved by the RIM

18.4 Competence

The RIM shall be satisfied that all staff on testing and commissioning duties are competent and authorized to carry out the roles to which they are allocated in the testing plan.

Testing staff shall have documented proof of competence in accordance with the RIM's competence standards for signalling and control systems personnel.

Proof of competence may be documented in an approved centralized competence management system, provided that the details of individual task or equipment competencies are readily accessible to the tester-in-charge and other authorized stakeholders

18.5 Briefing of staff involved in testing and commissioning

Each person involved in the commissioning shall be given notice of, and made fully conversant with, their role in implementing the testing plan.

All testers involved in the work shall be fully briefed and are provided with written notes detailing what is to be done in each phase of the work.

Section 19 Test methods and procedures

19.1 General

Detailed requirements for testing procedures and methods do not fall within the scope of this document.

Details of methodology and procedures for planning and executing inspection and testing are detailed in AS 7716.

The following sections define the general outcomes to be achieved by the testing specified in this document.

19.2 Principles tests

Principles testing confirms the integrity of the interlocking design. It validates that the design and installation together are functional and safe in accordance with the approved scope, user requirements and design specifications and applicable signalling principles. Principles testing applies to all interlocking types irrespective of the technology. It covers CBI software (vital and non-vital) integrity validation, and conventional relay based and mechanical interlockings.

Principles testing proceeds by checking that all operational conditions expected to be simultaneously set up can be. For example, parallel routes, checking operation under probable failure conditions, and simulating train movements for both long and short trains. Principles testing attempts to defeat the interlocking by setting up conflicting conditions and showing they are rejected.

To ensure such requirements are adequately captured, a principles testing plan shall be developed for each project or scheme, as identified in the inspection and testing strategy, and inspection and testing plans.

The principles testing plan shall detail each principles testing activity to be undertaken.

19.3 Verification tests – Electromechanical systems

19.3.1 Detailed circuit tests

Detailed tests shall be carried out to ensure:

(a) every contact, terminal, wire and functional item shown on the circuit diagram is actually in the circuit exactly as shown;

(b) each contact is electrically opened and closed by operation of its controlling device and is correctly adjusted;

(c) each contact, fuse and link effectively opens and closes the circuit under test;

(d) the circuit does not include any contact, terminal or wires not shown in the circuit diagram; and

(e) the insulation of the circuit is satisfactory.

Following satisfactory completion of the above items, the circuit as a whole shall function as designed.

19.3.2 Cable tests

Cables tests shall be carried out on each core of the cables to check:

(a) continuity of conductors;

(b) insulation resistance;

(c) correct terminations.

All results of the cable tests shall be recorded on appropriate cable test record sheets.

19.3.3 Apparatus tests

Apparatus tests as detailed in AS 7716 shall be carried out to verify that each item of trackside signalling apparatus operates safely.

19.4 Function tests – Electromechanical systems

Tests shall be done to verify that both the installation and the design are functionally in accordance with the approved concept and design specification.

Further tests shall then be done to validate that the installed system operates in accordance with the required signalling principles, rules and regulations.

The following tests shall be done concurrently:

(a) Apparatus Function Testing.

(b) Function Testing to Control Tables.

19.5 Validation tests – electromechanical systems

The following tests shall be done to verify that both the installation and design functionality satisfy the relevant standards and user requirements:

(a) Principles Test.

(b) Aspect Sequence Testing.

(c) Points correspondence and out of correspondence testing.

19.6 Verification tests – Processor based systems

All products and application logic shall be verified against the relevant test specifications before being permitted to enter into service.

Verification shall comprise static testing and dynamic testing for both product installation and system integration.

Application logic for signalling systems shall be subject to requirements to assure the safety functions have been realized, and that principles testing as required for validation of the system and defined in the validation plan has been completed.

The testing stage of verification shall not commence until the engineering details for construction purposes have been given technical approval.

19.7 Verification – Static testing

Static testing shall be applied in order to demonstrate that:

(a) equipment has been installed in accordance with the specifications;

(b) equipment can be powered and will operate as required; and

(c) equipment and application logic can be properly integrated into the complete system.

These demonstrations shall be applied in the order shown above. It is permissible to move from one step to the next only when it has been demonstrated that the next step can commence without importing any risk.

Examples of the types of tests and checks performed during static testing include, but are not limited to:

(d) visual inspection that correct equipment has been installed;

(e) security and equipment labelling/identification correct;

(f) product configuration correct;

(g) wire count and continuity test;

(h) rating, regulation and discrimination of power supplies;

(i) design logic functionality (e.g., strap and function test);

(j) where duplicated sub-systems exist, each is able to operate with the required level of functionality;

(k) diagnostic reporting effectiveness;
(l) input/output configuration;
(m) failure modes;
(n) degraded mode operation;
(o) effects of transients;
(p) cross-boundary and through testing of circuits and data;
(q) alarms operate as specified;
(r) correct isolation of independent sub-systems;
(s) mechanical or electrical adjustment effected.

19.8 Verification of the application logic – Processor based systems – Function test to control tables

In signalling systems, the activity of verifying that the application logic shall meet the requirements of the control tables (control tables includes locking tables or any other tabulated definition of the control requirements). This is commonly termed the function test to control tables or the control table test.

Tests shall be carried out on each signalling function to ensure that all the controls specified in the control tables (or equivalent) are present and effective.

The application logic may be verified by use of simulation systems. The extent of verification testing by simulation shall be defined in the test plan.

If it is necessary to prove the correct application of safety requirements associated with the particular type of technology employed (e.g., sequencing, timing, generic controls), then the nature of the technology shall be assessed in order to determine how the testing is to be carried out.

Where a control is required to be in the application logic but is not possible to test due to the nature of the technology, this shall be stated in the test specification, together with any alternative testing to be performed to mitigate any reasonably foreseeable hazard.

Functions to be tested shall include, but are not limited to:

(a) point interlocking;
(b) route interlocking;
(c) sectional and sequential route releasing;
(d) route calling and setting;
(e) end of movement authority operation and sequencing;
(f) degraded mode movement authorities (where achieved by technical means);
(g) approach locking;
(h) train operated route release;
(i) train protection, control and warning sub-systems;
(j) block controls;
(k) level crossing protection;
(l) personnel warning systems; and
(m) special controls.

19.8.1 Verification – Dynamic testing

Dynamic testing is applied to demonstrate that the elements of the system will respond correctly when in operational use. Dynamic testing shall be performed by simulation or using trains, as appropriate. The following are examples of possible test requirements:

(a) Timing functions.

(b) The correct establishment, maintenance and termination of communications between elements of the system (including communication with train-borne products where necessary).

(c) Changeover between modes of operation.

(d) Communication sub-system properties (e.g., data rates, protocol, etc.)

(e) Transmission timings, network delays, and sequencing.

On-board signalling systems braking performance shall be validated prior to integration testing in accordance with the requirements of AS 7510 and applicable product or type approval processes.

On-board signalling dynamic verification shall be undertaken in accordance with the inspection and test detailed plan and should include, as a minimum:

(f) interaction between the on-board signalling sub-system and braking systems, including braking commands generated by any signalling automatic train protection system;

(g) communication between the on-board signalling sub-system and the trackside sub-system;

(h) any on-board signalling or platform-based door system that interfaces with the trackside signalling system;

(i) speed supervision and braking intervention in accordance with the permitted speed authorized by the RTO;

(j) limit and end of movement authority; and

(k) special track conditions provided by the RTO

Guidance for dynamic verification can be obtained from AS 7726. The full set of verification requirements should be derived from an engineering management plan that considers the requirements of the system under test, guidance for complex system integration can be obtained from AS 7473

19.8.2 Verification of the integrated system

When the sub-systems have been fully integrated, a verification of the complete system may commence. Testing, analysis and audit shall be performed to demonstrate that the complete system functions and operates in conformance with the engineering details.

Verification shall demonstrate that correct correspondence exists between all commands, controls, status detecting mechanisms and their indications, both within the integrated system and to any external interfaces.

19.9 Validation of the application logic – Processor based systems

For products designed and implemented in accordance with EN 50129, the application logic shall be tested in accordance with the requirements of the relevant safety case and product application requirements.

However, in certain systems the safety and application requirements are not explicitly specified, but the core safety principles are set out in the defined standards or other documents. In such cases, validation testing shall be performed to demonstrate that the designers of the application logic have correctly

interpreted the requirements of the relevant standards and such other documents as define the required functionality. This validation testing should be carried out as part of principles testing (see Clause 19.2)

The validation activities shall be defined in test specifications. This shall be determined by reference to:

(a) mandatory safety requirements;
(b) concept design documentation;
(c) technical constraints; and
(d) project-specific risk control measures.

Application logic may be validated by use of simulation systems. Before using simulation systems, the risks associated with using such systems shall be assessed. For example, the simulation could mask the actual operation of the application logic.

19.10 Test copies of designs

A complete set of independently checked and approved plans and diagrams shall be provided for the exclusive use of testing staff. The range of plans may include the following:

(a) Signalling arrangement plan (i.e. track plan).
(b) Signal bonding plan.
(c) Signal construction/cable running plan.
(d) Signal power distribution.
(e) Signal circuit plans.
(f) Box layouts, termination lists, wiring diagrams.
(g) Relay contact analysis.
(h) Control console and diagram.
(i) Signal control tables.
(j) Signal aspect sequence charts.
(k) Level crossing focusing diagrams.
(l) Points control tables.
(m) Level crossing control tables.

The copies of the approved designs provided for testing shall be identified for this purpose by using a method which clearly distinguishes them from drawings issued for other purposes, for instance the use of uniquely coloured paper.

Once approved designs have been issued, any required modifications shall only be produced as an approved modification in accordance with established design procedures.

19.11 Configuration control of design documents and data

Testing shall be undertaken to specifications, concept design documents, approved designs and data that are complete and of the correct status.

All testing documentation shall be subject to version control.

Modifications to sub-systems and systems that have been tested or partially tested shall be controlled to preserve the assurances given by earlier testing; or alternatively, sufficient re-testing shall be undertaken to confirm that the integrity of the tested sub-systems has not been compromised.

During testing, all installed signalling equipment and application logic shall be protected from unauthorized access through defined technical and procedural security controls.

Section 20 Monitoring and test equipment

20.1 General

Only approved test equipment shall be connected to signalling circuits and equipment.

Test lamps shall not be used as they may provide a significant leakage path for circuit currents. Electrical test instruments shall have insulated probes, etc.

All instruments and apparatus used to carry out inspections and tests shall be fit for purpose, and in good order.

Where critical values are to be recorded, test instruments shall be calibrated and bear the certificate of a recognized authority as to their accuracy.

20.2 Use of monitoring and test products

20.2.1 Overview

This section details the arrangements for the insertion and recovery of monitoring and test equipment into operational signalling and communications systems.

The requirements shall apply to all test and monitoring instrumentation that is connected to safety-related operational products.

20.2.2 The connection of test or monitoring equipment – products of operational system

The connection or use of test or monitoring equipment shall not jeopardize the safeworking of operational products.

Only test or monitoring equipment that has been approved by the RIM shall be connected to working infrastructure

20.2.3 Integrity of connection arrangements

Temporary wiring for testing purposes shall be installed in accordance with an approved design issued for the purpose. A copy of the circuit diagrams for all temporary test wiring in a location shall be maintained in the equipment housing at all times.

Temporary test wiring shall be readily distinguishable from permanent and stagework wiring

The connection of temporary unattended monitoring equipment shall be designed, installed and tested by personnel competent in the application of the instrumentation and in the systems to which it is being connected.

It is permissible for the work to be treated as a minor change. It shall be tested in accordance with the main requirements of this document, based on the nature of, and risks associated with, the change being made.

Appendix A Hazard Register (Informative)

Hazard number	Hazard
9.1	Communication cables & route lines failure (Design)
9.1.2	Human Error, Health Failure, Environment Failure, Security Breach and or Vandalism.
9.1.2.1	Incorrect design
9.2	Cables failure (Design)
9.2.1	Human Error, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach and Vandalism.
9.2.1.1	Excessive voltage drop
9.2.1.2	Leakage between circuits
9.2.1.3	Lack of spare cores
9.2.1.4	Low frequency / mains induction
9.3	Cable routes failure (Design)
9.4	Cable communications failure (Design)
9.4.1	Human Error, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach and Vandalism.
9.4.1.1	Excessive loss in communications cables
9.4.1.2	Crosstalk between communication channels
9.4.1.3	Communications interface and design
9.4.1.4	Noise interference into circuits
9.4.1.5	Low frequency / mains induction
9.4.1.6	Lack of spare channels
9.5	Wireless communications failure (Design)
9.6	Field equipment and or enclosures failures (Design)
9.6.1	Human Error, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach and Vandalism.
9.6.1.1	Equipment not operating as intended and/or equipment failure
9.6.1.2	Equipment not being suitable for a specific use or location
9.6.1.3	Equipment not interfacing with existing equipment/design
9.6.1.4	Equipment not operating as intended
9.7	Level crossing failure (Design)
9.7.1	Human Error, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach and Vandalism.

Hazard number	Hazard
9.7.1.1	Incorrect design resulting in the crossings not operating as intended which, in turn, could result in road or rail collisions
9.7.1.2	Level crossing designs not being compatible with train operating requirements
9.7.1.3	Post commissioning changes to train operating conditions (speed, direction or stopping)
9.7.1.4	Road layout, road speed changes, or type of road traffic assumption
9.7.1.5	Damage to level crossings protection equipment by road traffic
9.7.1.6	Queuing and stacking of road motor vehicles across level crossings
9.7.1.7	Position of signals in proximity to level crossings not being appropriate for level crossings' safety and reliability
9.7.1.8	Crossing warnings failing to operate on the approach of trains to warn road users
9.7.1.9	Trains overrunning protecting signals into crossing limits
9.7.1.10	All operating scenarios not being accommodated in the design for activation (directional stick logic)
9.7.1.11	Design incorrect and not consistent with existing design
9.7.1.12	Incorrect sequence of operation due to dissimilar equipment characteristics for train detection devices
9.8	Points and or release failure (Design)
9.8.1	Human Error, Track Obstruction, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach, and Vandalism.
9.8.1.1	Points detection being inconclusive or incorrect (e.g. N&R showing together or normal showing for reverse and reverse for normal (consistent through set))
9.8.1.2	Multiple point ends not being consistent which may or may not show in correspondence.
9.8.1.3	Positions of point machines for manual operation or maintenance access
9.8.1.4	Different design implementations for the same configuration but for different equipment leading to later mistakes in installation and maintenance
9.8.1.5	Point layout being too complex for manual working in degraded mode
9.8.1.6	Lack of supplementary detection and back drive when it is needed, to assure switch position along the length. (Derailment hazard (includes swing nose))
9.8.1.7	persons being hit by handcranks while disconnecting EOL key
9.8.1.8	Ability to release points or ground frame using unauthorized keys
9.8.1.9	Project design being incorrect
9.9	Power supply failure (Design)

Hazard number	Hazard
9.9.1	Human Error, Track Failure, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach and Vandalism.
9.9.1.1	Low voltage at equipment (during operation)
9.9.1.2	Voltage regulation on load
9.9.1.3	Excessive (high) voltage
9.9.1.4	Incorrect polarity
9.9.1.5	Unfiltered supply
9.9.1.6	Loss of power supply
9.9.1.7	Loss of power supply – lack of redundancy
9.9.1.8	Loss of power supply – failure of redundancy
9.9.1.9	Inadequate backup time
9.9.1.10	Inadequate backup rating
9.9.1.12	Ineffective changeover
9.9.1.13	Standby capacity not being maintained because energy storage is inadequate
9.9.1.14	Incorrect operation of redundancy system
9.9.1.15	Inadequate surge protection
9.1	Signals (Definition: Any indication given to a driver, lights on stick, driver display, notice boards) failure (Design)
9.10.1	Human Error, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach and Vandalism.
9.10.1.1	Inadequate operational distances in positioning of signals
9.10.1.2	Signalling principles not matching operational scenarios
9.10.1.3	Failure to consider signal sighting
9.10.1.4	Incorrect signals being specified (e.g. range, spread)
9.10.1.5	Supply voltage not matching signal specification
9.10.1.6	Interlocking proving pulses causing signal mal-operation
9.10.1.7	Pickup in cables incorrectly lighting aspects
9.10.1.8	Inadequate isolation between aspects
9.10.1.9	Misreading of route indicators
9.10.1.10	Inadequate transient protection & earthing
9.10.1.11	Misreading Signals
9.10.1.12	Interfaces between different signalling systems (different aspect sequences)

Hazard number	Hazard
9.10.1.13	Transitions from external signals into cabs
9.10.1.14	Maintenance not being considered
9.10.1.15	Interfaces with physical rail infrastructure
9.10.1.16	EH&S (Environmental, Health and Safety) hazards
9.10.1.17	Designer competency
9.10.1.18	Inadequate consideration of failure modes
9.10.1.19	Design not taking account of technology (e.g. tilt masts)
9.10.1.20	The ability to read signs in time
9.10.1.21	The readability of in cab displays
9.10.1.22	Operating despite failures of signalling systems
9.10.1.23	Reliance on train protection rather than signalling
9.10.1.24	Inadequate headways
9.10.1.25	The use of approach clearings
9.10.1.26	Applying signal controls to level crossings
9.10.1.27	The placement of signals in relation to driver misjudgement
9.10.1.28	Designs not being correct or meeting standards and principles or operations requirements
9.10.1.29	Operation with failures of trains
9.10.1.30	Inadequate spacing of signal lights on one mast
9.11	Train Authority Systems failure (Design)
9.12	Train detection failure (Design)
9.12.1	Human Error, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach and Vandalism.
9.12.1.1	Incorrectly showing section to be clear when actually occupied
9.12.1.2	Incorrect track circuit clearance points
9.12.1.3	Incorrectly showing occupied when clear, disrupting the operation of the network, moving to a degraded mode
9.13	Interlocking failure (Design)
9.13.1	Human Error, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach and Vandalism.
9.13.1.1	Inadequate interlocking principles
9.13.1.2	Signalling scheme plans which aren't appropriate

Hazard number	Hazard
9.13.1.3	Inadequate operational requirements
9.13.1.4	Inadequate operation of SPAD controls
9.13.1.5	Designer failing tot consider the implications of control tables
9.13.1.6	Source material being incorrect
9.13.1.7	Designer and check errors
9.13.1.8	The useability of design and checking tools for signalling design
9.13.1.9	Designers under time and delivery pressures
9.13.1.10	Interfaces to signalling objects being inappropriate
9.13.1.11	The lack of correlation with source material
9.13.1.12	Designers' lack of understanding of current systems
9.13.1.13	Designers' lack of understanding of new systems
9.13.1.14	Designers not competent
9.13.1.15	Inappropriate interlocking systems
9.13.1.16	Inadequate interlocking performance
9.13.1.17	Inadequate environmental considerations
9.13.1.18	Communications between systems
9.13.1.19	Inappropriate Power Supply Units, no break supply, earthing or transient protections.
9.13.1.20	Lack of understanding of future upgrades
9.13.1.21	No consideration for maintainers
9.13.1.22	Poor interlocking architecture
9.13.1.23	Inappropriate Safety Requirements
9.13.1.24	Version and configuration management
9.14	Communication cables & route lines failure (Construction)
9.14.1	Design Failure, Human Error, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach and Vandalism.
9.14.1.1	Cables damaged and earth to core
9.14.1.2	Cables damaged/shorts core to core
9.14.1.3	Cables damaged and open circuit core
9.14.1.4	Cable damaged in above ground cable routes, post construction
9.14.1.5	Cables damaged during installation in routes
9.14.1.6	Cables having low insulation resistance core to core and earth

Hazard number	Hazard
9.14.1.7	Cables jointed and open circuits
9.14.1.8	Cables jointed and faults to earth
9.14.1.9	Low frequency / mains induction
9.14.1.10	Cable end & terminations being insecure & untidy
9.14.1.11	Cable terminations not being adequately identified
9.15	Cable routes failure (Construction)
9.16	Cable communications failure (Construction)
9.16.1	Design Failure, Human Error, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach and Vandalism.
9.16.1.1	Excessive loss in communication cables
9.16.1.2	Crosstalk between communication channels
9.16.1.3	Noise interference into circuits
9.16.1.4	Noise interference into circuits
9.16.1.5	Low frequency and mains induction
9.17	Wireless communications failure (Construction)
9.18	Control system failure (Construction)
9.19	Field equipment and or enclosure failures (Construction)
9.19.1	Design Failure, Human Error, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach, and Vandalism.
9.19.1.1	Lighting surge damage to equipment
9.19.1.2	Poor construction
9.19.1.3	Incorrect position
9.19.1.4	Incorrect position
9.19.1.5	Damage to equipment
9.2	Level crossing failure (Construction)
9.21	Points and or release failure (Construction)
9.21.1	Design Failure, Human Error, Track Obstruction, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach, and Vandalism.
9.21.1.1	Points being open outside tolerance when detected as normal or reverse
9.21.1.2	Points not moving from normal to reverse
9.21.1.3	Manual handling of points equipment to get to sites leading to physical injury or damage to equipment

Hazard number	Hazard
9.21.1.4	injury caused by manual operation of point machines
9.21.1.5	Cables crossing tracks leading to trip hazards or electrical failure
9.21.1.6	Equipment being at risk of damage by track machines (e.g. tamper)
9.21.1.7	being hit by handcranks while disconnecting EOL keys
9.22	Power supply failure (Construction)
9.23	Signals failure (Construction)
9.24	Train Authority System failure (Construction)
9.24.1	Design Failure, Human Error, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach and Vandalism.
9.24.1.1	Field equipment being installed contrary to design intent
9.24.1.2	Inadequate sighting of signage, indicators, etc.
9.24.1.3	Installed but non-commissioned signage and indicators causing confusion
9.24.1.4	Non-compliance with design
9.24.1.5	Incorrect installation of infrastructure equipment and control systems
9.24.1.6	The "as-built" designs being inaccurate
9.24.1.7	Poor quality of construction leading to unreliable or unsafe installation
9.24.1.8	Poor quality materials leading to unreliable or unsafe installation
9.25	Train detection failure (Construction)
9.25.1	Design Failure, Human Error, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach and Vandalism.
9.25.1.1	Axle counter heads not detecting every or any wheels
9.25.1.2	Slip trips and falls due to mechanical obstructions caused by train detection equipment
9.25.1.3	Inappropriate positioning of train detection equipment in relation to other physical hazards (dis box under ladder)
9.25.1.4	Shorting or electrical interference of train detection equipment in the location case
9.25.1.5	Electrical shocks installing equipment in proximity to live equipment
9.26	Interlocking failure (Construction)
9.27	communication cables & route lines failure (Test and Commission)
9.27.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Track Obstructions, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach, Train load not secure, Vandalism and or Threat.
9.27.1.1	Testing Processes

Hazard number	Hazard
9.28	Control system failure (Test and Commission)
9.28.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Track Obstructions, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach, Train loads not secure, Vandalism and or Threat.
9.28.1.1	Indications not reflecting field status
9.28.1.2	Documents being out of date
9.28.1.3	Designs not finished
9.28.1.4	Installations incomplete
9.28.1.5	Planned Track Access being inadequate
9.28.1.6	Failure of Factory Acceptance Testing (FAT) to real configuration
9.28.1.7	Incorrect or uncalibrated or wrong version of tools and test equipment
9.28.1.8	Inadequate testing communications
9.28.1.9	Competency of (TIC) Testers in Charge and Signals Testers
9.28.1.10	Not testing to final interlocking system and field objects
9.28.1.11	Stageworks being badly identified for design and construction
9.28.1.12	Inadequate communications with safe working staff and control staff
9.28.1.13	Leaving temporary test stuff (jumpers etc.) behind
9.28.1.14	On site and off site interface testing remaining incomplete
9.28.1.15	Inadequate nomenclature in defining specific functions
9.28.1.16	Principles not being tested (functional testing only)
9.28.1.17	Scope definition between contractors and the Railway being inadequately defined (who tests what)
9.28.1.18	Not following or understanding testing processes
9.28.1.19	Resource availability (including competencies and experience)
9.28.1.20	TIC under pressure for finishing job (prior to all testing and certification being completed)
9.28.1.21	System configuration tests remaining incomplete or misunderstood
9.28.1.22	On site modifications not following proper processes
9.28.1.23	Not installing and testing correct versions of application data
9.28.1.24	Using incorrect versions of executive, hardware, test tools
9.28.1.25	Site changes not being managed properly
9.28.1.26	Masking of errors due to lack of separation of non-vital and vital testing

Hazard number	Hazard
9.28.1.27	Controls not being returned to the correct state of blocks and technician controls
9.28.1.28	Fatigue
9.29	Level crossing failure (Test and Commission)
9.29.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Track Obstruction, Health Failure, Organisation SMS Failure, Environment Failure, Security Breach, Train loads not secure, Vandalism and or Threat.
9.29.1.1	Working at height testing road signals
9.29.1.2	Being hit by road traffic testing road protection equipment
9.29.1.3	Road vehicles or the public being hit by trains
9.29.1.4	Injuries caused by manual operation of level crossing equipment
9.29.1.5	Electrical shocks installing equipment in proximity to live equipment
9.29.1.6	Incorrectly functioning level crossing systems compared to design
9.29.1.7	Test team members being injured by test train
9.29.1.8	All operating scenarios not being accommodated in the design for activation (directional stick logic)
9.29.1.9	Road markings and signage not being compatible with level crossing designs
9.3	Points and or release failure (Test and Commission)
9.30.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Track Obstructions, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach, Train loads not secure, Vandalism and or Threat.
9.30.1.1	Body parts being caught between switch and stock, or in machine mechanisms whilst testing points on power
9.30.1.2	Electrical shocks hazard testing circuits
9.30.1.3	Slips, trips and falls over mechanical parts
9.30.1.4	Points not operating properly due to lack of thorough testing, causing derailment
9.30.1.5	Points installed and tested in isolation but not commissioned into the system (i.e. not visible to signaller) and being incorrectly positioned or moved by intervention, prior to handing control back to traffic)
9.30.1.6	Points parts being installed and left potentially free to move by not being positioned correctly and secured or not being secured
9.30.1.7	The ability to release points using a key needing to be allowed or authorized.
9.31	Power supply failure (Test and Commission)
9.31.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Track Obstructions, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach, Train loads not secure, Vandalism and or Threat.

Hazard number	Hazard
9.31.1.1	Low voltage at equipment (during operation) or (voltage regulation on load)
9.31.1.2	Excessive (high) voltage
9.31.1.3	Unfiltered supply
9.31.1.4	Incorrect polarity
9.31.1.5	Stray voltages on busbar
9.31.1.6	Intermittent loss of power
9.31.1.7	Loss of power supply – failure of redundancy
9.31.1.8	Ineffective changeover
9.31.1.9	Standby capacity not being maintained – energy storage inadequate
9.31.1.10	Electric shock to construction personnel
9.31.1.11	Surge protection ineffective
9.31.1.12	Signalling power supply being connected to earth
9.31.1.13	Incorrect interfacing to existing systems
9.32	Signals failure (Test and Commission)
9.32.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Track Obstructions, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach, Train loads not secure, Vandalism and or Threat.
9.32.1.1	Documents being out of date
9.32.1.2	Design not being finished
9.32.1.3	Installation being incomplete
9.32.1.4	Planned Track Access being inadequate
9.32.1.5	Not FAT tested to real configuration
9.32.1.6	Incorrect or uncalibrated tools and test equipment
9.32.1.7	Competency of TICs and Testers
9.32.1.8	Not testing to final control system
9.32.1.9	Stageworks being badly identified for design and construction
9.32.1.10	Inadequate communications with safe working staff and control centre
9.32.1.11	Leaving temporary test wiring (jumpers etc.) in place
9.32.1.12	On site and off site interface testing remaining incomplete
9.32.1.13	Inadequate nomenclature and dressing of signals
9.32.1.14	Principles not being tested (just functional testing)

Hazard number	Hazard
9.32.1.15	Scope definition between contractors and the Railway remaining inadequately defined (who tests what)
9.32.1.16	Not following or understanding testing processes
9.32.1.17	Resource availability (including competencies, experience)
9.32.1.18	TIC under pressure for finishing jobs (when it is not finished)
9.32.1.19	Test trains
9.32.1.20	Incorrect final sighting and aligning of signals
9.32.1.21	On site modifications not following proper processes
9.32.1.22	Fatigue
9.33	Train Authority System failure (Test and Commission)
9.33.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Track Obstructions, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach, Train loads not secure, Vandalism and or Threat.
9.33.1.1	Location Boards being in the wrong position
9.33.1.2	Locations not being the same as design GPS positions
9.33.1.3	Wrong signs being installed
9.33.1.4	Designs not being correct to field
9.33.1.5	Train radio black spots
9.33.1.7	Testing not correctly performed
9.33.1.8	Staff being removed without electric release
9.33.1.9	Inability to remove staffs
9.33.1.10	Incorrectly named staffs
9.33.1.11	Incorrectly named staffs or ticket books
9.33.1.12	Staff boxes not locked
9.33.1.13	Staffs open wrong boxes – incorrect wording on keys
9.34	Train detection failure (Test and Commission)
9.34.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Track Obstructions, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach, Train loads not secure, Vandalism and or Threat.
9.34.1.1	Incorrectly showing clear when occupied trains could be allowed into occupied sections
9.34.1.2	Incorrect track circuit clearance points
9.34.1.3	Track circuits showing occupied when clear

Hazard number	Hazard
9.35	Interlocking failure (Test and Commission)
9.35.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Track Obstructions, Health Failure, Organisational SMS Failure, Environment Failure, Security Breach, Train loads not secure, Vandalism and or Threat.
9.35.1.1	Documents being out of date
9.35.1.2	Design not being finished
9.35.1.3	Installations remaining incomplete
9.35.1.4	Planned Track Access being inadequate
9.35.1.5	Not being FAT tested to real configuration
9.35.1.6	Incorrect or uncalibrated or wrong version of tools and test equipment
9.35.1.7	Inadequate testing communications
9.35.1.8	Competencies of TICs and Testers
9.35.1.9	Not testing to final control system
9.35.1.10	Stageworks being badly identified for design and construction
9.35.1.11	Inadequate communications with safe working staff and control centre
9.35.1.12	Leaving temporary test wiring (jumpers etc.) in place
9.35.1.13	On and off site interface testing remaining incomplete
9.35.1.14	Inadequate nomenclature
9.35.1.15	Principles not being tested (just functional testing)
9.35.1.16	Scope definition between contractors and Railway being inadequately defined (who tests what)
9.35.1.17	Not following or understanding testing process
9.35.1.18	Resource availability (including competencies, experience)
9.35.1.19	TIC being under pressure for finishing jobs (when not finished)
9.35.1.20	Test trains
9.35.1.21	System configuration tests remaining incomplete or misunderstood
9.35.1.22	On site modifications not following proper processes
9.35.1.23	Not installing and testing correct versions of application data
9.35.1.24	Using incorrect versions of executive, hardware and test tools
9.35.1.25	Site changes not being managed properly
9.35.1.26	Train movements (interlocking disarranged)
9.35.1.27	Masking of errors due to lack of separation of non-vital and vital testing

Hazard number	Hazard
9.35.1.28	Fatigue
9.36	Communication cables & route lines failure (Operations)
9.37	Controls system failure (Operations)
9.38	Field equipment and or enclosure failure (Operations)
9.39	Level crossing failure (Operations)
9.4	Points and or release failure (Operations)
9.41	Power supply failure (Operations)
9.42	Signals failure (Operations)
9.43	Train Authority System failure (Operations)
9.44	Train detection failure (Operations)
9.45	Interlocking failure (Operations)
9.46	Communication cables & route lines failure (Maintenance)
9.47	Control system (including telemetry failure) failure (Maintenance)
9.48	Field equipment and or enclosures failure (Maintenance)
9.49	Level crossing failure (Maintenance)
9.5	Points and or release failure (Maintenance)
9.51	Power supply (Maintenance)
9.52	Signals failure (Maintenance)
9.53	Train Authority System failure (Maintenance)
9.54	Train detection failure (Maintenance)
9.55	Interlocking failure (Maintenance)
9.56	Communication cables & route lines failure (De-commission)
9.56.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Environment Failure, Security Breach, Vandalism and or Threat.
9.56.1.1	Line Poles collapsing
9.56.1.2	Signal infrastructure failure
9.56.1.3	Signal equipment being damaged
9.56.1.4	Unprotected electrical voltages
9.56.1.5	Equipment being damaged through incorrect operation
9.56.1.6	Interference with 3rd party services
9.57	Control system failure (De-commission)

Hazard number	Hazard
9.57.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Environment Failure, Security Breach, Vandalism and or Threat.
9.57.1.1	Decommissioned field sites not being disconnected and removed and thereby continuing to communicate with the live control system and network, leading to failure
9.57.1.2	Inaccurate documentation (including control system data) for removal of interlocking
9.58	Field equipment and or enclosure failure (De-commission)
9.58.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Environment Failure, Security Breach, Vandalism and or Threat.
9.58.1.1	Signal infrastructure failure
9.58.1.2	Signal equipment being damaged
9.58.1.3	Unprotected electrical voltages
9.58.1.4	Equipment being damaged by incorrect operation
9.58.1.5	Interference with 3rd party services
9.59	Level crossing failure (De-commission)
9.59.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Environment Failure, Security Breach, Vandalism and or Threat.
9.59.1.1	Signal infrastructure failure
9.59.1.2	Interference with 3rd party services
9.6	Points and or release failure (De-commission)
9.60.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Environment Failure, Security Breach, Vandalism and or Threat.
9.60.1.1	Decommissioning the wrong equipment leading to signal equipment failure
9.60.1.2	Decommissioned equipment not being managed until it is removed resulting in accidents -Unsecured turnout switch blades
9.60.1.3	Trip hazards from redundant equipment
9.60.1.4	Not certifying tracks after equipment has been removed
9.61	Power supply failure (De-commission)
9.61.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Environment Failure, Security Breach, Vandalism and or Threat.
9.61.1.1	Signal infrastructure failure
9.61.1.2	Signal equipment being damaged
9.61.1.3	Unprotected electrical voltages

Hazard number	Hazard
9.61.1.4	Equipment being damaged by incorrect operation
9.61.1.5	Interference with 3rd party services
9.62	Signals failure (De-commission)
9.62.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Environment Failure, Security Breach, Vandalism and or Threat.
9.62.1.1	Inadequate management of decommissioned signals until they are removed
9.62.1.2	Redundant concrete signal bases causing derailment of track machines
9.62.1.3	Inaccurate documentation (including control system data) for the removal of signals
9.63	Train Authority System failure (De-commission)
9.63.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Environment Failure, Security Breach, Vandalism and or Threat.
9.63.1.1	Signs and boards not being removed leading to confusion
9.63.1.2	Removing the system prematurely
9.64	Train detection failure (De-commission)
9.64.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Environment Failure, Security Breach, Vandalism and or Threat.
9.64.1.1	Signal infrastructure failure
9.64.1.2	Interference with other services or functions
9.65	Interlocking failure (De-commission)
9.65.1	Derailment / Collision, Design Failure, Human Error, Track Failure, Environment Failure, Security Breach, Vandalism and or Threat.
9.65.1.1	Decommissioned interlocking (especially part decommissioned) not being physically removed leading to confusion with live equipment/interlocking
9.65.1.2	Inaccurate documentation (including control system data) for the removal of interlocking leading to extended mean time for repair and consequential train delays

Appendix B Bibliography (Informative)

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

- AS 7473, *Complex system integration in railways*
- AS/NZS ISO 9001, *Quality Systems for Design/Development, Production, Installation and Servicing*
- EN50129, *Railway Applications – Communication, Signalling and Processing Systems – Safety Related Electronic Systems for Signalling*