

AS 7717:2016



Signal Testing & Commissioning



Train Control Systems Standard



This Australian Standard® AS 7717 Signal Testing & Commissioning was prepared by a Rail Industry Safety and Standards Board (RISSB) Development Group consisting of representatives from the following organisations:

Metro Trains Melbourne

Queensland Rail

ARTC

JHG

AECOM

Brookfield Rail

Rio Tinto

The Standard was approved by the Development Group and the Train Control Systems Standing Committee in August, 2016. On September 15, 2016 the RISSB Board approved the Standard for release.

This Standard was issued for public consultation and was independently validated before being approved.

Development of the Standard was undertaken in accordance with RISSB's accredited process. As part of the approval process, the Standing Committee verified that proper process was followed in developing the Standard.

RISSB wishes to acknowledge the positive contribution of subject matter experts in the development of this Standard. Their efforts ranged from membership of the Development Group through to individuals providing comment on a draft of the Standard during the open review.

I commend this Standard to the Australasian rail industry as it represents industry good practice and has been developed through a rigorous process.



Paul Daly
Chief Executive Officer
Rail Industry Safety and Standards Board

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Contents

1	Introduction.....	10
1.1	Purpose	10
1.2	Scope	10
1.3	Justification	12
1.4	Compliance.....	12
1.5	Referenced documents.....	13
1.5.1	Normative references.....	13
1.6	Definitions	13
2	Principles of testing and commissioning	18
2.1	General.....	18
2.2	Risk management and SFAIRP	19
2.3	Verification & validation.....	19
2.4	Objective of inspection and testing.....	20
2.5	Testing principles.....	20
2.6	Types of inspection and test	21
2.7	Minimum necessary inspection and testing	22
2.8	Communication protocols for inspection and testing	22
2.9	Certification records	23
2.10	Common documentation	23
2.11	Defining testing activities - Test specifications	24
2.12	Quality assurance	25
2.13	Witness.....	25
2.14	Single identifiable point of responsibility	26
2.15	Independence of testing personnel	26
2.16	Inspection and testing requirements	27
3	Roles and responsibilities	28
3.1	General.....	28
3.2	Allocation of roles	28
3.3	Appointment of testing personnel.....	29
3.4	Roles related to inspection, testing and commissioning	29
4	Scope of testing and commissioning.....	30
4.1	General.....	30
4.2	Signalling equipment to be inspected and tested	31
4.3	Inspection and testing geographical boundaries	32
4.4	Inspection and testing activities.....	33
4.5	Alterations and new interfaces	34
5	Testing and commissioning strategy.....	34
5.1	General.....	34
5.2	Content of testing strategy	35

6	Interface management.....	36
6.1	General.....	36
6.2	Interface coordination plan.....	36
6.3	Interfacing with existing systems.....	37
6.4	Testing alongside operational equipment.....	38
6.5	Interfaces outside commissioning boundaries.....	38
6.6	De-commissioning and disposal.....	38
6.7	Operational requirements.....	38
6.8	Interface documentation requirements for associated train control and telecommunications systems.....	38
7	Testing and commissioning plans and work packages	39
7.1	General.....	39
7.2	Test plans	39
7.3	Testing and commissioning plans and work packages.....	40
7.3.1	Planning inspection, testing and commissioning activities.....	40
7.4	Inspection and testing overview	41
7.5	Inspection and testing outline plan	42
7.5.1	System/apparatus	43
7.5.2	Activity	43
7.5.3	Certified by	43
7.5.4	Certification documents	44
7.5.5	Standards and procedures.....	44
7.5.6	Time	44
7.6	Inspection and testing detailed plan	44
7.6.1	Installation work package structure	46
7.7	Commissioning plan.....	47
7.7.1	General requirements	47
7.7.2	Operational requirements.....	48
7.7.3	Testing and certification	48
7.8	Commissioning work package	48
7.8.1	Section 1 – Preparation	48
7.8.2	Commissioning program	49
7.8.3	Section 2 – Implementation.....	51
7.8.4	Section 3 – Evaluation	52
7.9	Handover package.....	53
8	Off-site testing	53
8.1	General.....	53
8.2	Standards applicable	54
8.3	Independence	54
8.4	Pre-site testing of CBI and control systems data.....	54
8.4.1	General.....	54
8.4.2	Test Equipment and Software.....	54

8.4.3	Pre-Site Design Checking and Function Testing	55
8.4.4	Pre-Site / Simulation Testing.....	55
8.4.5	Simulator Testing	55
8.4.6	Configuration Management and Version Control.....	56
8.4.7	Control Centre - Site Testing Precautions	56
8.4.8	On site testing of CBI	56
8.4.9	Testing Alterations to a Working Installation.....	57
8.4.10	Pre-commissioning Testing of CBI Alterations	57
8.5	Equipment assembled and wired off-site.....	57
8.5.1	Pre-site testing of assembled equipment	57
8.5.2	Pre-site Certification Testing	58
9	Installation inspection and testing	59
9.1	General.....	59
9.2	Extent and rigour of the testing process	59
9.3	Order of inspection and testing	59
9.4	Phases of the testing process	59
9.5	Error reporting and test logs.....	61
9.6	Disconnections	62
9.6.1	Identification of disconnections	62
9.6.2	Verification of disconnections.....	62
9.6.3	Situations where equipment cannot be restored to service	62
9.7	Cleanliness of work areas	62
9.8	Installation inspection and testing status certificate	62
10	Commissioning readiness review	63
10.1	General.....	63
10.2	Requirements	63
10.2.1	Pre-Commissioning Conference and Meeting	63
10.3	Logistics and maintenance support items	64
11	De-commissioning.....	65
11.1	Decommissioning and Disposal	65
11.2	Standards and procedures.....	65
11.3	Responsibility.....	66
11.4	Redundant equipment.....	66
11.5	Redundant traction bonding	66
11.6	Standalone decommissioning of redundant equipment	67
12	Commissioning and handover	67
12.1	General.....	67
12.1.1	Function testing and Validation	67
12.1.2	Testing and commissioning of works	67
12.1.3	Notification of the works	67
12.1.4	Operational requirements.....	67

12.1.5	Liaison with Network Controller	68
12.1.6	Booking Out of Use	68
12.1.7	Commissioning Activities	68
12.1.8	Progress Reporting	69
12.1.9	Items Previously Tested and Certified	69
12.2	Finalisation of commissioning & handover	69
12.2.1	General	69
12.2.2	Commissioning Certificate	70
12.2.3	Entry into Service	70
12.2.4	Delegation of Authority	71
12.2.5	Monitoring and other Measures	71
12.2.6	Trial Running	71
12.2.7	Security	71
12.3	Project completion	71
12.3.1	Equipment removal	71
12.3.2	Plan revision & issue	71
12.3.3	Permanent testing record	71
12.3.4	Asset register	72
12.3.5	Project acceptance	72
13	Defects and non-conformances	72
13.1	Test logs	72
13.2	Error rectification	72
13.3	Re-entry into service	73
13.4	Outstanding actions	73
13.5	Concessions	73
14	Documentation and records	73
14.1	Management of records (General)	73
14.2	Design documents and data	73
14.2.1	Design documents for hard-wired circuits	74
14.2.2	Design documents for application data	74
14.3	Inspection and test records	75
14.3.1	Management of test records	75
14.3.2	Test records for application data	76
14.3.3	Test records for hard-wired circuits	76
14.3.4	Operational configuration / adjustment records	77
14.4	Records of technical approvals	77
15	Modifications and design changes	78
15.1	General	78
15.1.1	Installation discrepancies identified in testing	78
15.1.2	Design errors or shortcomings identified in testing	78
15.1.3	Design errors or shortcomings identified in commissioning	78

16	Temporary wiring, pre-wiring and stageworks.....	79
16.1	General.....	79
16.2	Temporary wiring standards.....	79
16.3	Planning for stage work	80
16.4	Identification and labelling of alteration wiring	81
16.5	Temporary wiring	82
16.5.1	Control and Removal of Temporary Wiring	82
16.5.2	Temporary Stagework Wiring.....	82
16.6	Stagework.....	82
16.7	Enabling works	83
16.8	Pre-commissioning	83
17	Minor works and alterations	84
17.1	Minor changes	84
17.2	Test planning	84
17.2.1	Testing following minor changes and renewals	84
17.3	Minor works	84
17.3.1	General.....	84
17.3.2	Test requirements for minor changes.....	85
18	Personnel and competency	85
18.1	General.....	85
18.1.1	Resources for testing and commissioning	85
18.2	Staffing levels	85
18.2.1	Avoidance of undue pressure during testing	85
18.3	Competency of organisations.....	85
18.4	Competency of individuals	86
18.5	Staffing	86
18.5.1	Competence	86
18.5.2	Briefing of staff involved in testing and commissioning.....	86
19	Test methods and procedures	87
19.1	General.....	87
19.2	Verification tests - electromechanical systems	87
19.2.1	Detailed circuit tests.....	87
19.2.2	Cable tests.....	87
19.2.3	Apparatus tests.....	87
19.3	Function tests - electromechanical systems.....	88
19.4	Validation tests - electromechanical systems	88
19.5	Verification tests – processor based systems.....	88
19.5.1	Verification - static testing	88
19.6	Verification of the application logic - Processor based systems - Function test to control tables	89
19.6.1	Verification - Dynamic Testing	90

19.6.2	Verification of the Integrated System	90
19.7	Validation of the application logic - processor based systems	90
19.8	Test copies of designs	91
19.8.1	Configuration control of design documents and data.....	91
20	Monitoring and test equipment.....	92
20.1	General.....	92
20.1.1	Testing Equipment.....	92
20.2	Use of monitoring and test products.....	92
20.2.1	Introduction	92
20.2.2	The connection of test or monitoring equipment - products of operational system 92	
20.2.3	Integrity of connection arrangements	92

Appendix Contents

Appendix A	Hazard register items	94
Appendix B	T&C test plans	105

1 Introduction

1.1 Purpose

This Standard is intended to provide a common framework for Rail Transport Operators (RTOs) 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 control system project, and during the operating life of the system.

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

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

1.2 Scope

This Standard is intended to be applied to railway signalling works and to specify the following –

- (a) the minimum sufficient inspection & testing requirements to assure the safety of the system;
- (b) appropriate test procedures to ensure consistency in testing and results;
- (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 waste of resources;
- (f) processes for the orderly handover of commissioned system to the responsible operator;
- (g) processes for ensuring that inspection testing work is performed by persons having the necessary competency and authorisation.

This document covers the testing of –

- (a) the application logic that is applied in conjunction with technology-based product as a part of signalling and operational telecommunications systems;
- (b) the safety requirements of a system where these are implemented by means of application logic or other engineering details;
- (c) products, insofar as they are correctly installed and operating in accordance with the relevant specifications and engineering details.

On-board systems: This Standard does not include testing and commissioning of the train-borne components and sub-systems of ATP, cab signalling and similar systems. Testing and commissioning of on-board systems may be added into the next revision of the standard.

Product testing: Except as noted below this document does not address product testing as covered by AS 7505. In some cases, product testing has to be included in the testing and commissioning processes required by this document. Examples include situations where –

- (a) an in-service trial or pilot of the product is taking place as part of the product acceptance process;
- (b) the application requirements associated with the product require site-specific tests to demonstrate that the product and the application logic have been correctly integrated;
- (c) the safety requirements for the product are not explicitly defined and therefore need to be tested on a site-specific basis.

Contents of this document: This standard addresses several different aspects of inspection and testing activities.

- (a) **Works testing** - This inspection and testing requirements where new works are being implemented or major alterations are being carried out.
- (b) **Maintenance testing** - Inspection and testing requirements for minor works such as planned maintenance works and like-for-like replacements are carried out, which require the certification of the safety of the signalling system before returning to service.
- (c) **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.
- (d) **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 Standard:

- (a) **Design and installation** - assumes that such design is undertaken in accordance with the requirements of AS7680 for signalling equipment and systems, or ISO 9001 for telecommunications equipment and systems. Similarly reference to installation assumes that such installation is undertaken in accordance with the requirements of the Rail Infrastructure Owner involved.
- (b) **Inspection and testing** - covers all such 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 point of commissioning.
- (c) **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 Standard 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 Standard 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.

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

- (a) Infrastructure on Heritage Railways unless there is an interface with a non-Heritage Railway.
- (b) Infrastructure on tram ways unless there is an interface with a non-Heritage Railway.

1.3 Justification

Justification of this standard has been undertaken throughout the development process by –

- (a) identification of the hazards addressed by this Standard;
- (b) correlation between the hazards addressed and recognised industry occurrences and issues;
- (c) prioritisation based on the recognised industry occurrences and issues.

Justification of this Standard has been undertaken based on the safety, social and commercial benefits from the implementation of this Standard.

Hazards addressed by this Standard are identified from the RISSB Hazard Register and linked to two types of controls explained in Section 1.4.

The hazards and controls should be used as a guide when undertaking risk assessments, prior to the introduction of the standard into an organisation.

1.4 Compliance

There are two types of control contained within Australian Standards developed by RISSB:

- (a) Mandatory requirements
- (b) Recommended requirements.

Each of these types of control address hazards that are deemed to require controls on the basis of existing Australian and international Codes of practice and Standards.

A **mandatory** requirement is a requirement that the Standard provides as the only way of treating the hazard.

Mandatory requirements are identified within the text by the term 'shall'.

A **recommended** requirement is one where the standard recognises that there are limitations to the universal application of the requirement and that there may be circumstances where the control cannot be applied or that other controls may be appropriate or satisfactory, subject to

agreement with the Rail Infrastructure Manager (RIM), Rolling Stock Operator (RSO), and/or Rail Safety Regulator.

Recommended clauses are mandatory unless the RIM or RSO can demonstrate a better method of controlling the risk.

Recommended requirements are to be considered when compliance with the Standard is being assessed.

Recommended requirements are identified within the text by the term 'should'.

Hazards addressed by this Standard are included in an appendix. Refer to the RISSB website for the latest Hazard Register Guideline: www.rissb.com.au

1.5 Referenced documents

1.5.1 Normative references

The following referenced documents are indispensable for the application of this Standard:

- (a) AS 4292.4 Railway Safety Management Part 4: Signalling and telecommunications systems and equipment
- (b) AS/NZS ISO 9001 Quality Systems for Design/Development, Production, Installation and Servicing
- (c) EN50129 Railway Applications - Communication, Signalling And Processing Systems - Safety Related Electronic Systems For Signalling

1.6 Definitions

General railway technical terms can be referred to the "National Guideline - Glossary of Railway Terminology".

Specific terms used in this Standard (including those drawn from the Glossary) are defined below:

Application data: For CBI and other electronic systems, that set of data which defines and configures the interlocking and controls for a particular location and functions

Authorised Engineering Organisation (AEO): A body authorised to design, install and or test and commission new or altered signalling infrastructure for a Railway Infrastructure Manager

Bring into use: Accept and sign into operational use in accordance with the RIMs safeworking procedures

Certification: Certification is the 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; may include EXCEPTIONS as noted on the test record. Certification is used to indicate any missing activities or the unnecessary repetition of activities.

Chief Signal Engineer: The individual who holds ultimate engineering authority for authorising and approving design changes to the signalling system

The Chief Signal Engineer may delegate various engineering design authorities and responsibilities

Commissioner: The person holding ultimate responsibility for the safety certification and commissioning of the signalling works, and certification of the safety of the signalling works to be commissioned, who signs the works as “brought into use.” (Also known as Commissioning Coordinator, Commissioning Engineer)

Commissioning (of signalling equipment): The 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.

Commissioning Certificate: 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.

Commissioning Manager: Person having overall control of commissioning activities, including the management of interfaces with other disciplines

Construction Manager: The person responsible for managing the construction of the new and altered project infrastructure to design and specification whilst ensuring the integrity of the existing infrastructure

Degraded Mode Conditions: The state of the part of the railway system when it continues to operate in a restricted manner due to the failure of one or more components

Design Office: The AEO/design group responsible for producing the approved designs for the new or altered signalling works, to which the project will be installed, tested and commissioned

Designer: Individual member of the design group responsible for designing changes to the signalling infrastructure

Fail-safe: The capability of an item or a system to ensure that any failure in a predictable or specified mode will result only in that item or system reaching and remaining in a safe condition.

Hazard Register: The RISSB Hazard Register.

Infrastructure Booking Advice: Form of advice provided to Network Controller, when signalling equipment is disconnected and out of use for traffic operations, and when it is restored to use for traffic operations.

Infrastructure group: The Group allocated responsibility for all or part of the infrastructure owner's assets.

Infrastructure Maintainer: The organisation responsible for day-to-day maintenance of the signalling (and other) rail infrastructure

Inspection (verification): A passive verification activity to establish compliance with standards and design. It involves visual observation and may 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.

Inspection and Testing Detailed Plan: Based on the Overview or Outline Plan, it expands 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 detailed plan is analysed to generate the individual work instructions for units of work to be included in the Installation and/or Commissioning work packages.

Inspection and Testing Outline Plan: 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.

Inspection and Testing Overview: A 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.

Further, it is a general description of the scope of works, methodology and resources required for significant aspects of the inspection and testing

Installer: Person or team carrying out the installation of new signalling infrastructure or additions or changes to existing signalling infrastructure

Instructions: Instructions state what tests are to be carried out, and will establish, step by step, the process to be followed.

Interface Coordination Plan: Document identifying the physical and functional interfaces between the stakeholders to a project, the work required at the interfaces, and the division of responsibilities between stakeholders, and agreed to by the stakeholder representatives.

Lead Tester: Person responsible for leading a team of testing personnel carrying out independent inspection, testing and certification activities in compliance with work instructions and standards

Manufacturer: An entity that makes and assembles equipment for rail infrastructure

Network Controller: The part of the Rail Transport Operator responsible for managing day-to-day train operations and track access

Operator: The person or body responsible by reason of ownership, control or management, for the provision, maintenance or operation of trains, or a combination of these, or a person or body acting on its behalf.

Operator: The person or body responsible by reason of ownership, control or management, for the provision, maintenance or operation of trains, or a combination of these, or a person or body acting on its behalf.

Principal Designer: The person having the delegated engineering / signalling design authority for authorising and approving designs for configuration changes and alterations to the existing or new signalling infrastructure.

Procedures: Handbooks, manuals, specifications and similar documents that establish how equipment, circuits, etc. are tested.

Project Engineer: Person having day-to-day responsibility for managing the installation of changes or alterations to the signalling infrastructure.

Project Manager: Person having overall responsibility for managing the delivery of configuration changes or alterations to the signalling infrastructure.

Rail infrastructure: The facilities that are necessary to enable a railway to operate.

It includes –

- (a) railway tracks and associated railway track structures; and

- (b) service roads, signalling systems, communications systems, rolling stock control systems, train control systems and data management systems; and
- (c) notices and signs; and
- (d) electrical power supply and electric traction systems; and
- (e) associated buildings, workshops, depots and yards; and
- (f) plant, machinery and equipment,

but does not include —

- (a) rolling stock; or
- (b) any facility, or facility of a class, that is prescribed by the national regulations not to be rail infrastructure.

Rail Infrastructure Manager (RIM): in relation to rail infrastructure of a railway, means the person who has effective control and management of the rail infrastructure, whether or not the person —

- (a) owns the rail infrastructure; or
- (b) has a statutory or contractual right to use the rail infrastructure or to control, or provide, access to it.

Rail Network Owner: Rail Infrastructure Manager with the authority and responsibility to provide new and altered rail infrastructure

Rail Safety Regulator: A national, state or territory government body responsible for ensuring compliance with the applicable rail safety legislation.

Rail Transport Operator (RTO): For the purposes of this Standard the RTO is the Operator or Railway Infrastructure Manager responsible for the type approval of railway products.

An organisation that has an agreement with a Rail Infrastructure Manager (RIM) to enter and use a rail Network, and means —

- (a) a rail infrastructure manager; or
- (b) a rolling stock operator; or
- (c) a person who is both a rail infrastructure manager and a rolling stock operator

Railway Operation: Any one or more of the following:

- (a) the construction and maintenance, or the construction or maintenance, of infrastructure of a railway;
- (b) the operation or movement, or causing the operation or movement, by any means, of any rolling stock on a railway, including operating a railway service if the operator of the service operates or moves, or causes the operation or movement of, rolling stock;
- (c) the construction and maintenance, or construction or maintenance, of rolling stock.

Rolling Stock Operator (RSO): A person who has effective control and management of the operation or movement of rolling stock on rail infrastructure for a railway, but does not include a person by reason only that the person drives the rolling stock or controls the network or the network signals;

Rolling Stock: Any vehicle that operates on, or intends to operate on, or uses a railway track, including any loading on such a vehicle, but excluding a vehicle designed for both on- and off-track use when not operating on the track. Rolling stock is a collective term for a large range of rail vehicles of various types, including locomotives, freight wagons, passenger cars, track machines and road-rail vehicles.

Safety Case: A formal presentation of evidence, arguments and assumptions aimed at providing assurance that a system, product or other change to the railway has met its safety requirements and that the safety requirements are adequate

Safety Critical: Directly influencing safety (when applied to equipment or systems).

Safety Management System: A documented system for describing how an RTO manages safety under applicable rail safety legislation.

Set to Work: Installed, tested and certified, and available for operational use

Shall: Indicates that a statement is mandatory

Should: Indicates a recommendation

Signalling and telecommunications system: A system which provides a means to safely regulate the movement of trains on a railway through the use of appropriate technology.

Signalling Maintenance Manager: The manager within the Infrastructure Group responsible for maintaining the group's train control system

Stagework: Where a larger project is commissioned in a number of steps or 'stages' separated in time, to enable each lot of commissioning work to fit into an available track possession window, the temporary installation and wiring provided to make the system safe and functional in each stage configuration are referred to as stageworks.

Test Log: A document for recording all errors and queries identified in testing, and for tracking the resolution and close-out of each log item.

Test Specification: A test specification may be generic or project specific; it may be stand-alone, or contained in a method statement, code of practice, test plan, test scenario or other suitable document.

Tester in Charge: The person having overall charge of inspection and testing for the signalling works, and responsible for the planning, organisation and satisfactory completion of the testing and commissioning. They are also responsible for the planning and implementation of an effective, proven, auditable process for testing and commissioning activities associated with verification and validation of the safety integrity of the signalling system, and for the compliance of new or altered signalling with relevant standards when commissioned. (alternate term: Testing Coordinator)

Tester: Person responsible for carrying out independent inspection, testing and certification activities under the control and direction of the Tester In Charge or Lead Tester

Testing (verification): An active verification activity to establish compliance with design and performance requirements. It involves a physical intervention with the operation of the equipment or system, while observing the resulting behaviour of the system. The intervention may 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 minimise impact on the system's operation) Bell testing is a verification test activity.

Testing Strategy: A 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.

Testing Work Instruction: A detailed instruction that lists all test steps that must be carried out to complete a specified testing activity. It is derived from an approved test specification.

Validation: Confirmation that the particular requirements for a specific intended use are fulfilled.

Verification: Testing and evaluation of a product to assure compliance with its specification or other requirements.

Witness: Individual or organisation appointed by the Infrastructure Group, acting on behalf of the Infrastructure Group and RIM to witness testing activities and, if required, to countersign test records for the testing witnessed.

Witnessing: Independent observation of the testing process to ensure compliance with the testing instructions.

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 day-to-day movement of trains is devolved from the operators to the signalling system; the safety of which in turn devolves on the systems designers, installers and maintainers.

Signalling safety and reliability are inter-related, with signalling failures leading to the adoption of less-safe methods of moving trains by regulations.

The safeness of the signalling system depends on –

- (a) correct equipment and system design to standards;
- (b) correct manufacture to the design specifications;
- (c) correct installation to the design and to standard practices;
- (d) correct 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 yields satisfactory results.

Systems designers, installers and maintainers shall be assured that –

- (a) the installation is securely safe in accordance with signalling standards; and
- (b) the installation functions reliably to operating requirements

2.2 Risk management and SFAIRP

In the spectrum covering all forms of transport, rail transport presents very low risk to travellers and operators alike. Nevertheless, there remains a low but finite risk to persons on or about the railway, along with the expectation that efforts will be made to reduce the level of risk.

It is a basic legal requirement on all signalling works (and for any other rail work) that they reduce risk "so far as is reasonably practicable" (SFAIRP)

Any change to the rail infrastructure shall meet the SFAIRP test, by reducing risk SFAIRP. This applies in all cases, irrespective of whether or not the existing level of risk is already tolerably low.

The test of practicability applies to the risk-reducing action, irrespective of the existing level of risk.

"Reasonably practicable" ... means that which is reasonably able to be done in relation to ensuring safety

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 at least 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 at an appropriate level of independence from the construction and implementation process to be verified and validated. The degree and nature of this independence shall be determined by taking into account at least the following factors:

- (a) 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.
- (b) 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.

Competence of organisations has a higher weighting than independence, where independence cannot be achieved other controls should be considered to assure any additional risk due to a lack of independence is controlled.

2.4 Objective of inspection and testing

The objective of the testing and commissioning of new or modified systems is to provide evidence for the verification and validation that the systems satisfy all specified requirements, safe working standards and any application specific requirements

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

Inspections check the finished installation against standards and design, and check that the required safety features have been incorporated.

Tests check that the system has been installed in accordance with the design, and

Testing is performed to prove not only that the installation is as designed, but also that the appropriate standards have been incorporated in the design.

Testing is performed to prove that the signalling apparatus functions in accordance with the design standards and user requirements, and that fail-safe apparatus and control functions will de-energise 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 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 particular vital signalling design drawings;
- (b) compliance with the applicable signalling standards for safety and reliability;
- (c) correct interlocking between conflicting routes; and
- (d) correct control of routes by train detection and point detection equipment; and in the process
- (e) establish correspondence between controls and indications and trackside apparatus

Inspection checks and appropriate tests shall be carried out to and monitored against a testing plan to assure all tasks are planned and all tasks are 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 –

- (a) the equipments, including power supplies, are manufactured correctly to specification;
- (b) the equipments are correctly located and secured in position, correctly labelled and indexed;

- (c) the equipments are correctly interconnected and interlocked and operate correctly (electrical wiring must be exactly as shown in the circuit diagrams);
- (d) the system's discrete functions are correctly isolated and insulated from false operation, secured against improper movement, and protected against interference, damage and deterioration. (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 particular location to ensure that it is built to standard and particular specification requirements, and is correctly designated

Electrical tests comprise earthing tests, insulation tests, bell continuity tests, wire counts and null counts, voltage and current tests, and electrical function tests

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

They include –

- (a) equipment function tests to specification;
- (b) circuit function tests to the wiring diagrams;
- (c) through function tests of completely connected apparatus from the point of control through to the operation of the end function, and through to the point of indication;
- (d) design function tests to control tables and aspect sequence charts;
- (e) design integrity tests to fundamental signalling principles;
- (f) points detection tests; and
- (g) mechanical interlocking tests.

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 –

- (a) simulator testing and certification of CBI application data;
- (b) Factory Acceptance Testing of complete CBI systems (temporarily set up in a factory environment);
- (c) circuit and function testing of pre-wired modules, relay racks and equipment housings.

On-site inspection and testing will comprise the balance of the planned activities and may include –

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

- (b) Staged pre-commissioning of new field equipment items (temporarily operating as part of the existing signalling)
- (c) Controlled partial pre-testing of sections of new wiring (generally in complex interlockings, to minimise scope in the final commissioning period)
- (d) All changeover installation circuit and function testing, through testing and integrity testing associated with the final commissioning period.

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

In such cases, separable completed parts of circuits may initially be energised 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 is subsequently required, with all parts completed and connected and with any and all false feeds and temporary wiring removed.

2.7 Minimum necessary inspection and testing

The intent of any Inspection and Test plan for a signalling system shall be to perform the minimum combination of inspections and tests necessary to provide assurance evidence for the verification and validation that the new system will operate safely, efficiently and reliably, in accordance with user requirements.

The Inspection & Test Plan should require the minimum use of resources (competent personnel and time) necessary to achieve this 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 a standard 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 ensure that design, installation and equipment faults are identified as early as possible, to minimise subsequent rework, and to 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

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

The Tester in Charge shall ensure that all persons conducting inspections and tests with other personnel and communicating inspection or testing messages 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.

Defined methods of identification, terminology and forms of acknowledgement/ repetition shall be used at all times.

- (a) Systems of identification (e.g. personal names, team numbers, call signs) and acknowledgement/ repetition shall be used at all times. Confirmation of the completion of an action must be received before the results of that action are noted.
- (b) Clear, precise and where available standard terminology shall be used.
- (c) Colloquialisms and local common terminology in respect of name and state of equipment and geographical location shall be avoided. Where standard frequently used terminology is not available, the terminology to be used prior to undertaking the testing activity shall be agreed.
- (d) Requests for information (e.g. state of system equipment or function) shall ask for such information to be specifically given.
- (e) Requests leading the receiver to give a particular response shall not be used.

Persons conducting inspections and tests with other personnel shall ensure –

- (a) 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;
- (b) that the identity of persons communicating inspection and testing messages is clearly established on each occasion; and
- (c) that results are not recorded until after clear confirmation is received (do not anticipate).

Recommended communication protocols are detailed in the Code of Practice

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 fully carried out, and that the signalling infrastructure has satisfied all requirements.

2.10 Common documentation

The Infrastructure Controller shall ensure that a common and integrated approach to testing documentation is achieved across the infrastructure.

This 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.

A typical set of testing documentation is provided in the Guidelines to AS 7717

Test records 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 that is 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.

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 (OEM) recommendations;
- (d) safety requirements;
- (e) installation specifications;
- (f) rules and regulations.

The testing requirements so derived shall be documented in the organisation's preferred way.

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 may 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).

It shall be subject to approval by the RIM and verification that the selected specification is appropriate for the specific application it is permissible for a test specification to be:

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

It is permissible to produce checklists 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 an appropriate quality system and shall be controlled using appropriate management techniques.

The organisation applying this Standard shall have in place a Quality System to ensure that the testing and commissioning work is carried out in a planned and systematic way and that there is appropriate documentation as evidence of this.

The quality system should be accredited to AS/NZS ISO 9001 - "Quality Systems for Design/Development, Production, Installation and Servicing", or an equivalent acceptable to the RIM

The relevant elements of AS/NZS ISO 9001 should be tailored into a set of Quality Management Procedures for all signalling testing and commissioning work.

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 arrangements for supervision, quality check and audit shall be documented.

The documentation shall include details of the particular audit and quality checks to be conducted.

In determining the levels of supervision, quality checks and audit, account shall be taken of the—

- (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 Witness

The Infrastructure Group may elect to appoint a witness to audit that the Test Plan or Commissioning Plan and associated procedures are being complied with.

The appointment of a witness shall not relieve the Testing Coordinator / Tester in Charge of any responsibility for the testing and commissioning.

The Witness should witness such testing activities as they deem necessary, and countersign the test records for all testing witnessed, as required by the Infrastructure Group

The Infrastructure Group should require that the witness endorse those items of the Test Plan or Commissioning Plan that have been observed and prepare a report.

The Test and Commissioning Strategy should define the authority of the Witness/Auditor to require corrective actions found necessary during the audit.

2.14 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 particular 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.

Where a testing activity involves a team of persons, the Lead Tester shall be the responsible individual.

2.15 Independence of testing personnel

Independence is a principle that is used to reduce the likelihood of the doer and the checker making the same mistake due to a common cause.

The principle of independent inspection and testing of new and altered work is that no safety critical outcome should rely solely on one person doing and also certifying their own work.

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

Allocation of resources for testing and commissioning activities shall be planned so that the risk of common cause failure is minimised.

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;
- (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 particular 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.

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 authorisation to the required level.

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

New works being implemented in accordance with EN50129 should ensure where practicable that persons undertaking testing validation do not report to the project manager.

Competence of organisations has a higher weighting than independence. Where independence cannot be achieved, other controls should be considered to assure any additional risk due to a lack of independence is controlled

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

2.16 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 design and specifications;
- (c) fail-safe.

Not all fail-safe features are functionally tested and there shall be reliance on the inclusion of these features (e.g. back proving of relays) in the design, as checked and approved, and on associated apparatus inspections, bell continuity tests, wire counts and equipment contact proving tests.

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

The control to an item of trackside apparatus shall operate over the indications of other items of trackside apparatus. Test and certify the interlocking between these controls and indications.

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

The non-vital link to the operator's control console and indicator diagram 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.

Railway organisations and contractors undertaking signalling projects shall ensure that projects are adequately resourced for their respective parts with competent personnel and are able to perform their allocated duties.

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.

It is important that all who are involved with the testing and commissioning process are aware of their responsibilities.

In allocating roles and responsibilities, the enterprise shall ensure that all inspection and testing related activities and needs are 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. Due account shall be taken of any knowledge/skill enhancements required.

Appointees shall be notified of their delegated authorities and responsibilities.

In every signalling project there is a large number of role-players 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 a number of individuals, or conversely one person may perform a number of roles.

Allocation of roles shall take into account the nominated individuals' workload, and be subject to their holding the appropriate licenses and authorisations.

The allocation of roles and responsibilities between the major roles of Signal Project Engineer, Commissioner, and Tester in Charge for the project shall be formally agreed and documented

A suitable format for allocation of responsibilities appears in the Code of Practice

The roles of Project Engineer, Tester in Charge and Commissioner shall continue until all signalling works are complete and the Final Certificate is issued.

Regardless of the nature of the signalling works, the nominated Tester in Charge shall hold overall responsibility for the inspection, testing and certification of the project from concept till completion, and for setting the signalling to work.

3.3 Appointment of testing personnel

The Rail Infrastructure Manager shall devise and implement procedures for formally appointing persons in overall charge of the testing, and for the subsequent appointment of testing personnel.

The Rail Infrastructure Manager shall ensure that for each project one named individual is identified as Tester in Charge, being in overall charge of the testing and commissioning of signalling and control systems.

The Tester in Charge shall be responsible for the –

- (a) organisation, 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 Tester in Charge shall be required to record –

- (a) acceptance of any test plan or schedule affecting safety-related systems; and
- (b) their assurance of the completeness, suitability and satisfactory outcome of the testing

The Tester in Charge shall implement a process of assessment and documentation to ensure that all testing personnel hold the necessary competencies and authorisations for the testing to which they are appointed.

3.4 Roles related to inspection, testing and commissioning

In this Standard, the various inspection, testing and commissioning activities are allocated to generic role titles. The definitions include significant 'outside' roles with which the testing and commissioning activities interface.

The roles are defined in Section 1.6 Definitions, in terms of the various activities to be performed. Where possible, the role titles align with national standards or common industry practice.

Note: The roles and titles are generic. They are not linked to any particular organisation's management structure or procedures, nor are they intended to prescribe how any organisation should allocate or name roles. How the roles are allocated or combined, and the job titles and job descriptions used, are entirely at the choice of each organisation.

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.

For safety related aspects, the inspection and testing shall assure that –

- (a) equipment and materials are correctly manufactured 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 correctly operates, indicates and interlocks in accordance with the design;
- (f) equipment is correctly isolated and insulated from false operation, secured against improper movement, and protected against interference, damage, and deterioration, to specification and standards;
- (g) redundant equipment is made inoperative and removed;
- (h) false feeds, temporary wiring, and any extraneous items are removed.

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

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

- (a) the technology used;
- (b) the complexity;
- (c) the duration;
- (d) the potential risks, e.g. the type of train service.

The selection of the activities required shall take the above issues into consideration.

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

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

- (a) Confirm the correct configuration and operation of all new equipment.
- (b) Confirm the correct configuration of all new and altered circuits.
- (c) Confirm the correct configuration and operation of all existing circuits that may have been inadvertently affected by the alteration works.
- (d) Confirm the disconnection and isolation of all equipment and circuits made redundant by the works.

- (e) Confirm the configuration and operational safety of all intermediate and final stages of the project.
- (f) Confirm the safety and correct operation of temporary wiring provided for stageworks or testing.
- (g) Confirm that design changes made in testing are correctly designed, installed, tested and documented.
- (h) Confirm that the final design record correctly reflects the installed system including all design alterations.

Refer to clause 7.3.1 which shows a staged approach to preparing the inspection and testing plans, including a non-exhaustive list of the required documents and a diagrammatic representation of a sample inspection and testing plan.

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 and include the following:

- (a) Trackside Apparatus:
 - i. Signals and Indicators.
 - ii. Trainstops.
 - iii. Points operating/locking mechanisms and detectors.
 - iv. Track circuits, track insulation and bonding.
 - v. Wheel and vehicle sensors.
 - vi. Axle counters.
 - vii. Balises, beacons & transponders.
 - viii. Traction return bonding and earthing.
 - ix. Ground frames and releasing switches.
 - x. Level crossing lights and booms.
 - xi. Telephones.
 - xii. Notice boards.
 - 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 Base Interlockings.

- iii. Main power supplies.
 - iv. Mechanical interlocking machines.
 - v. Electric lever locks.
 - vi. Mechanical locks and keys.
 - vii. CBI vital data.
 - viii. Control system non-vital data.
- (d) Operator's Control Console and Indicator Diagram:
 - i. Panel processors.
 - ii. Keyboards, pushbuttons, switches, levers.
 - iii. VDUs, lamps, audible alarms, train descriptions.
 - iv. Block instruments.
 - v. Staff instruments.
- (e) Power supplies and connecting local and main cables and/or mechanical rodding and signal wire, remote control and indicating systems.
- (f) Telemetry and data links:
 - i. Non-vital controls & indications links.
 - ii. Control system networks.
 - iii. CBI data links.
 - iv. Diversity links & controllers.
 - v. CBI peer-to-peer networks.
- (g) Monitoring and logging systems:
 - i. Event loggers.
 - ii. Level crossing monitors.
 - iii. Trackside monitoring systems.
- (h) Infrastructure systems and alarms:
 - i. Traction return, bonding & earthing.
 - ii. Electrolysis protection.
 - iii. Power fail alarms – Electrical operating centre.
 - iv. Road traffic signal / level crossing interfaces.

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;