Testing and Commissioning of Signalling and Operational Telecommunication Systems

Synopsis
This document sets out the particular requirements for the testing and commissioning of signalling and operational telecommunications equipment which is to be used as part of Railtrack controlled infrastructure.

Submitted by

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Authorised by

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# Testing and Commissioning of Signalling and Operational Telecommunications Systems

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Part A

Issue Record

This document will be updated when necessary by distribution of a complete replacement.

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<td>Replaces withdrawn Railway Group Standards:</td>
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Technical Content

Approved by:

Francis How, Principal Signalling & Telecommunications Engineer, Railtrack S&SD

Enquires to be directed to the Industry Safety Liaison Dept – Tel: 020 7904 7518

Responsibilities

Railway Group Standards are mandatory on all members of the Railway Group * and apply to all relevant activities that fall into the scope of each individual’s Railway Safety Case. If any of those activities are performed by a contractor, the contractor’s obligation in respect of Railway Group Standards is determined by the terms of the contract between the respective parties. Where a contractor is a duty holder of a Railway Safety Case then Railway Group Standards apply directly to the activities described in the Safety Case.

* The Railway Group comprises Railtrack and the duty holders of the Railway Safety Cases accepted by Railtrack.

Compliance

The provisions of this document are mandatory as from 07 April 2001 in respect of signalling systems and equipment, with the exception of section C4.1. Section C4.1 is mandatory in respect of signalling systems and equipment as from 1 December 2001.

The provisions of this document are mandatory as from 1 December 2002 in respect of telecommunications and equipment.

Prior to the full implementation of this document, testing shall be conducted to a safety level no less than that which is in place at the date of issue of this document.

Any Railway Group member deviating from the requirements set out in this document shall ensure that the situation is regularised in accordance with the requirements of GA/RT6001, GA/RT6004, or GA/RT6006.
Health and Safety Responsibilities

In issuing this document, Railtrack PLC makes no warranties, express or implied, that compliance with all or any documents published by the Safety & Standards Directorate is sufficient on its own to ensure safe systems of work or operation. Each user is reminded of its own responsibilities to ensure health and safety at work and its individual duties under health and safety legislation.

Supply

Controlled and uncontrolled copies of this document may be obtained from the Industry Safety Liaison Dept, Safety and Standards Directorate, Railtrack PLC, Evergreen House, 160 Euston Road, London, NW1 2DX.
Part B  
Introduction and Common Requirements

B1 Purpose

The purpose of this document is to set out the mandatory requirements for the procedures and processes involved in the testing, commissioning and entry (or re-entry) into service of signalling and operational telecommunications systems.

B2 Scope

B2.1 Subject Matter within the Scope of this Document

The overall scope of Railway Group Standards is as specified in Appendix A of GA/RT6001.

This document contains requirements that are applicable to the duty holder of the Infrastructure Controller category of Railway Safety Case:

The Infrastructure Controller is responsible for ensuring all of the following requirements are implemented. Where requirements are identified against other organisations or identified individuals, the Infrastructure Controller has the duty to ensure they are complied with.

Specifically the contents of this document apply to signalling and operational telecommunications testing activities where the work:

a) is taking place on equipment and systems that form part of Railtrack Controlled Infrastructure; or
b) is taking place elsewhere in accordance with application-specific designs (eg factory testing) and the completed work could, when introduced into service, affect the safety of the operational railway.

Work within the scope of this document includes activities during the testing, commissioning, maintenance and abolition phases of the life cycle of systems and equipment.

B2.2 Subject Matter not Within the Scope of this Document

This document does not include within its scope:

a) the testing of train-borne sub-systems (except as specified below);
b) product acceptance testing or trials (see GI/RT7002) unless specifically included as part of the project commissioning;
c) the testing of moving block signalling systems;
d) occupational health and safety requirements relevant to persons who install, test, maintain or operate the systems and equipment.

Train-borne sub-systems are excluded because the application logic contained therein is tested as part of the engineering acceptance process for vehicles (see GM/RT2002).

In some circumstances the trials required for product acceptance include integration (eg track to train) or application testing. Where this is the case, the testing is conducted as part of the testing activities that are mandated by this document (eg section C5.7.1).

Moving block testing requirements are insufficiently advanced to identify any specific safety requirements necessary for the testing of the infrastructure, and are therefore excluded from the scope of the document.
B3 Definitions

A glossary specific to this document is given here. Commonly used signalling terms are defined in GK/RT0002.

Application Logic
Any technology based method that configures a product so as to provide site-specific command and control instructions. Application logic includes:

a) mechanical logic (eg in lever frames);

b) electro-mechanical logic (eg in relay interlocking);

c) electronic switching or code (eg in electronic interlocking, telephone concentrators or cab secure radio);

d) any combination of the above.

Application Requirements
Rules, conditions and constraints relevant to the safety of a product in its proposed application, for example: requirements for the site-specific configuration and interconnection of component parts; methods for installation, testing and commissioning; environmental requirements; methods for maintenance and fault-finding; instructions for use; information regarding modification and decommissioning; health and safety precautions.

Code
Software or data that forms part of the application logic of a system.

Commissioning
The process by which product or application logic is made ready for service (eg the control circuits are changed over; the data is changed; the new is integrated with the existing). Commissioning occurs prior to the new/changed system entering into service (refer to section C6).

Concept Design
A suite of documents that constitute the proposals for how the safety and operational requirements for the signalling or telecommunications part of the project are to be met. The suite provides the basis for the production of the engineering details. Refer to GK/RT0207 for further details in respect of signalling system design.

Engineering Details
A suite of documents that provide the detailed information necessary for the construction/installation of the system. They may also include application logic for the system. Refer to GK/RT0207 for further details in respect of signalling system design.

Like-for-Like Replacement
The removal and restoration of a product in a previously operational system, where the work does not change the configuration or functionality of the system. Engineering details are not provided for the work, and instead the existing infrastructure records are used as the reference documents.

Typically, such work is carried out to replace/repair defective or life-expired products. The work may involve restoring the original item of equipment or replacing it with an operationally equivalent new item (an operationally equivalent item is one that is functionally identical to the item it replaces).

New Work
New work consists of the construction/installation of new or modified products and/or application logic where the work changes, or potentially changes, the configuration or functionality of the system. The work is carried out in accordance with engineering details supplied for the purpose. For the purposes of this document, the definition includes:
a) the installation of totally new systems;

b) the alteration of existing systems; and

c) the abolition (also known as ‘recovery’) of existing systems.

Requirements for the management of construction work in the railway environment are set out in GI/RT7003.

Operational Products
Products that are part of a working signalling or telecommunications system. Where a possession has been arranged for the purposes of carrying out testing then the products that are covered by the possession are regarded as “not operational” for the duration of the possession (ie, they are not within the scope of this definition).

Product
Any of the following within the scope of GK/RT7002: system, sub-system, component or materials (including wiring and cables). For the purposes of this document products are differentiated from application logic.

Project
In the context of this document a project is any group of activities that involves new work to be commissioned on Railtrack controlled infrastructure.

Safety-related Application
The use of a product which, if it fails to conform to the safety requirements pertinent to the application, could increase risk to trains, persons working on the railway or the public.

In this document the term ‘safety-related’ includes the term ‘safety-critical’ (unless specifically differentiated in the text), the appropriate safety integrity being determined by the application.

Safety-related Failure
A failure of a signalling or operational telecommunications system or item of equipment which may result in an increase in risk (see also GK/RT0106).

Safety-related failures are classified as high risk or low risk.

A high risk failure is one where no other part of the system, nor any procedures, provide an acceptable level of safety in the event of a failure.

A low risk failure is one where an acceptable level of safety is maintained by the system or by procedures, even though there is some degradation of safety as a result of the failure.

Safety Requirements
The requirements relevant to safety that have to be achieved by a product in its intended safety-related application. Examples include:

a) the safety functions that the product must perform;

b) the safety integrity requirements (ie how dependable the safety functions must be);

c) design requirements;

d) safety-related characteristics of the product;

e) Reliability, Availability, Maintainability and Safety (RAMS) requirements, where relevant to safety.

The safety requirements can be (or form part of) a Railway Group Standard; an Infrastructure Controller’s specification; a national or international standard; or a specification produced by the supplier of a product.
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Signalling and Operational Telecommunications Systems and Equipment
Systems and equipment within the scope of this document that are used for:

a) authorising and safeguarding the movement of trains (e.g., interlockings; train detection equipment; signals; point operating mechanisms; level crossings; cables; cable-routes; apparatus cases);

b) safety-related communications purposes in the direct operation of the railway (e.g., signal post telephone systems; cab secure radio systems; signalling data communications systems; National Radio Network);

c) protection and warnings for trackside personnel, where such systems form part of the whole signalling system.

The definition includes application-specific software and data, as well as wiring and equipment.

In the context of this document, the definition includes infrastructure-based systems and equipment only, not train-borne equipment.

Simulation Products
Products that are used to simulate the operation of the railway or of parts of the system under test, for the purposes of performing testing activities. Examples of simulation products include, but are not limited to:

a) products or code employed for the express purpose of simulating sub-systems or components not present at the time of testing (e.g., dummy loads, test desks, data generators and any type of simulation product).

b) containers of application logic for the benefit of testing (usually off-site).

c) wire ‘straps’ or wander leads employed for the express purpose of bridging controls in hardwired circuitry.

Sub-systems
Sub-systems comprise a combination of products and application logic. The technology-based sub-systems used for signalling and operational telecommunications systems are mechanical, hydraulic, pneumatic, electrical, electronic or programmable electronic systems. Examples include:

a) man-machine interface;

b) an interlocking;

c) telephone concentrator.

Systems
An organised set of sub-systems, people and procedures capable of providing a service or executing a defined function or group of functions. A system will typically be comprised of:

a) sub-systems;

b) the working practices and procedures associated with the use of the sub-systems;

c) the people who use/operate the systems; and

d) the interfaces and interactions between each of these.

Systematic Fault
A failure that is due to faults in the specification, design, construction or operation of a system or sub-system. It also includes faults in the procedures for installation, commissioning, testing and maintenance.
Tester
An individual assigned to specify and/or perform the tests necessary to ensure that the physical implementation of a design is correct and meets all the specified test and acceptance criteria.

Test Plan
A test plan comprises any document or suite of documents that determines and defines the processes, resources and specifications required for the testing and commissioning of a product at a specific location.

Validation
The activity of demonstration (by test, analysis and audit) that the system meets its specified requirements in all respects.

Validation is generally used to refer to a larger process than verification. In particular, whereas verification will test systems against the engineering details for that system, validation of a system is concerned with whether the operation of the system provides the results needed by the user. Validation therefore involves consideration of whether the specification of a system sufficiently and accurately represents the needs of the intended user.

Verification
Verification is the activity of determination (by test, analysis and audit) that the output of each phase of the design, installation and testing life cycle fulfils the requirements of the previous phase.

The purpose of verification testing is to demonstrate that the system has been installed and configured as intended by the designer.

B4 Introduction

B4.1 General
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.

B4.2 Contents of this Document
The document is split into a number of parts:

Part B – Introduction and Common Requirements
This section covers requirements that are common to all sections of the document.

Part C – Works Testing
This section mandates the requirements where new works are being implemented.

Part D – Maintenance Testing
This section mandates the requirements where like-for-like replacement is taking place. This part also states the requirements for the giving of releases and the testing of temporary designs.

Part E – Action Following System or Product failure
This section mandates the requirements where systems and products have failed. In particular it states the requirements to be implemented if a wrong-side failure is suspected.
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Part F – Safe Systems of Work
This section mandates the requirements for safe systems of work during testing and commissioning. It includes the requirements for disconnections.

Part G – Monitoring and Test Products
This section mandates the requirements where an operational system is to be monitored, or elements of its functionality are to be simulated.

B4.3 Product Testing
Except as noted below this document does not address product testing, which is covered by GI/RT7002.

However, 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 (this applies to some products which were operational prior to the introduction of GI/RT7002).

B4.4 Design and Installation
In this document reference to design assumes that such design is undertaken in accordance with the requirements of GK/RT0207 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 GK/RT0208.

B5 Principles

B5.1 Testing Prior To Entry Into Service
Signalling and operational telecommunications systems shall not be allowed to enter or re-enter service without first being subjected to suitable and sufficient testing which yields satisfactory results.

B5.2 Testing Process
The testing process shall be specified and documented in accordance with an appropriate quality system and shall be controlled using appropriate management techniques.

B5.3 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.

B6 Competence

This section mandates competence requirements that are common to all activities within the scope of this document.

The general requirements for the management of competence, are set out in GK/RT0101 and GO/RT3260.

B6.1 Competency of Organisations
The Infrastructure Controller shall ensure that, to the extent necessary for them to undertake their respective responsibilities, both the Infrastructure Controller’s own organisation, and other organisations undertaking testing and commissioning activities, have personnel assigned to the work who collectively possess:
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a) the necessary competencies in respect of the testing and commissioning processes and procedures (including the use of testing support tools as appropriate); and

b) the knowledge and experience necessary for the particular products and application logic being tested and commissioned.

This requirement applies in respect of the planning, specification and execution of testing activities.

B6.2 Deployment of Personnel
The Infrastructure Controller shall ensure that its own organisation, and the testing organisations, have processes in place for deploying their personnel in a manner which achieves compatibility between the testing they are required to undertake and the competencies that the individuals possess.

B6.3 Safety-Critical Work
The testing of signalling and operational telecommunications systems and equipment is also within the scope of the Railway (Safety Critical Work) Regulations.

B7 Supervision and Audit
This section mandates the supervision and audit requirements that are common to all activities within the scope of this document.

B7.1 Purpose of Supervision, Quality Checks and Audit
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.

B7.2 Documentation of Supervision, Quality Checks and Audit
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.

B7.3 Levels of Supervision, Quality Checks and Audit
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.

B7.4 Avoidance of Undue Pressure During Testing
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.

B8 Common Documentation
The Infrastructure Controller shall ensure that a common and integrated approach to testing documentation (including, but not limited to, the format of test plans; test specifications; records of testing; certificates) is achieved across the infrastructure.
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Part C
Works Testing

C1 Purpose

C1.1 Scope of Works Testing
This part deals with construction works (alterations, additions or recoveries) that are capable of affecting the safe operation of the railway (commonly known as 'works testing'). It describes the processes and practices required to ensure that new or altered systems are introduced to operational service only when they are demonstrably fit for purpose.

All work within the definition of 'new work' (see section B3 of this document) is subject to the testing requirements set out in this Part C.

C1.2 Objectives of Works Testing
The testing process shall demonstrate the following features:

a) correct installation of all products (e.g. correct; adjustment; trackside physical boundaries; product type/version) and application logic;

b) correct implementation of the concept design and engineering details;

c) correct implementation of safety requirements (where these are implemented in the application logic or other engineering details);

d) correct implementation at sub-system and system interfaces;

e) correct implementation of product application requirements (as required by GI/RT7002) so far as these relate to the testing and commissioning of the system;

f) all components of the system operate within their design and application parameters so far as these relate to the testing and commissioning of the system;

g) only the expected change to the system has been made; and

h) the system meets the requirements of the users and is implemented in accordance with the relevant regulations, principles and specifications.

C2 Testing Personnel

C2.1 The Person in Overall Charge of the Testing

C2.1.1 The Infrastructure Controller shall ensure that for each project one named individual is identified in overall charge of the testing and commissioning of signalling and operational telecommunications systems. This person shall be made 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.

C2.1.2 This person 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.

C2.1.3 Throughout the rest of this Part C, reference to the person in overall charge of testing includes any formally appointed deputy or assistant to whom delegated authority is given.

C2.2 Appointment of Testing Personnel
C2.2.1 The Infrastructure Controller shall devise and implement procedures for formally appointing persons in overall charge of the testing, and for the subsequent appointment of testing personnel.

It is permissible for the appointment of testing personnel to be delegated to the person in overall charge of the testing.

Appointees shall be notified of their delegated authorities and responsibilities.

C2.2.2 The 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.

C2.3 Independence of Testing Personnel
C2.3.1 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.

C2.3.2 New works being implemented in accordance with EN50129 shall ensure where practicable that persons undertaking testing validation (see section C5.9) do not report to the project manager.

C3 Test Management and Planning

C3.1 Documenting the Testing Activity
C3.1.1 The planning shall ensure that the entire testing and commissioning process for the project is documented in a robust, clear and timely manner.

C3.1.2 The documentation shall cover the strategy, planning, implementation and review phases of the testing work. It is permissible for the phases to be documented either together or separately depending on the nature and size of the project.

C3.2 Planning
C3.2.1 The testing and commissioning planning shall be integrated with the overall project planning and shall be controlled within the project’s quality and safety management systems.

The project documentation shall include identification of all testing management interfaces that have a safety function, and shall specify the controls required to ensure that risk is not imported at those interfaces. Interfaces include both those
which are internal to the management of the testing, and external interfaces with other project activities.

C3.2.2
The planning of the testing activities shall take due account of all relevant factors, including but not limited to:

a) safety requirements of the products/system;
b) nature of the hazards;
c) risk control measures;
d) types of technology;
e) size and complexity of systems;
f) interfaces between sub-systems;
g) physical distribution of sub-systems and equipment;
h) novelty of design;
i) product acceptance status;
j) possession framework;
k) stagework requirements (including the extent of re-testing required as a consequence of commissioning in stages);
l) interfaces with other engineering and operations disciplines.

C3.2.3
The planning of testing and commissioning shall proceed hand-in-hand with any product testing that is required for product acceptance purposes, to ensure a systematic approach to the commissioning of the systems.

C3.2.4
The testing work associated with a particular set of engineering details shall not be divided into stages such that each is commissioned and brought into service separately. GK/RT0207 mandates that, in the case of signalling systems where commissioning in stages is required, a separate set of engineering details has to be prepared for each stage.

C3.3   Risk Assessment and Mitigation

C3.3.1
The particular hazards associated with the testing and commissioning of signalling and operational telecommunications products and application logic shall be identified, assessed and eliminated or mitigated before work commences. Hazards include, but are not limited to:

a) inadequate protection of the operational railway during testing;
b) hazards arising from equipment that is on site but is not commissioned (or has been decommissioned) after entry into service takes place;
c) hazards arising from the poor condition of existing equipment that may be affected by the testing work.

C3.3.2
The identification, assessment and mitigation of hazards shall also include consideration of situations that could lead to ineffective or insufficient testing. These include, but are not limited to:

a) the masking of certain controls by other controls leaving part untested (e.g. where a safety-critical control is duplicated in a safety-related sub-system or where electric locks might mask mechanical interlocking);
b) logic that is untestable by virtue of the design or product (e.g. untestable locking in a lever frame or internal ‘coils’ in a programmable logic controller);
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c) technology- specific hazards related to the way the safety requirements are implemented (eg track circuit controls being masked by timer back-proving);
d) complex interfaces between sub-systems where timings or other parameters are critical to safe operation;
e) technological and managerial interfaces (systems or contractors);
d) insufficient time to perform testing thoroughly;
e) lack of familiarity of testers with technology under test (particularly novel systems, unusual combinations and ‘heritage’ technology).

C3.3.3
The identified hazards and their proposed control measures shall be documented. Where it is necessary for testing personnel to undertake additional or restricted testing as a result of the risk assessment, the testing documentation shall specify the arrangements.

C3.3.4
The assessment shall be sufficiently rigorous to ensure that all credible risks to the safe operation of the systems are eliminated or controlled to as low a level as is reasonably practicable.

C3.4    The Testing Strategy
C3.4.1
A testing strategy (also known as an outline testing plan) shall be prepared for each project, except as permitted below.

In the case of signalling systems, the testing strategy forms part of the concept design documentation (see GK/RT0207), and is prepared at the design concept stage.

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

Where a telecommunications testing strategy is not prepared, the contents of the test plan (see section C3.5) shall address the relevant strategic issues covered by this section C3.4.

C3.4.2
The testing strategy shall demonstrate the feasibility of the testing works and time scales. It shall:

a) outline the testing and commissioning requirements;
b) develop the objectives of the testing and commissioning;
c) define the deliverables necessary to meet the objectives
d) state how, in overall terms, the deliverables are to be resourced and achieved; and
e) demonstrate that the commissioning can be achieved within the possession pattern and timescales envisaged.

C3.4.3
The testing strategy shall furnish sufficient details to enable the design organisation to take account of any testing or commissioning related constraints.

C3.4.4
The testing strategy shall take account of, and record, the proposals for correlation of the existing systems against the infrastructure records (correlation is normally carried out before detailed design commences).
Where correlation is not practicable, the testing strategy shall specify any additional testing required to mitigate the risks.

When correlation has been carried out in accordance with the proposals, 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 (see section 3.5).

C3.4.5
The Infrastructure Controller shall approve the testing strategy as part of the concept design documentation.

C3.4.6
The testing strategy shall be periodically reviewed throughout the duration of the project, and the requirements and objectives shall be amended as necessary.

C3.5 The Test Plan
C3.5.1
A documented test plan shall be produced which details the complete testing and commissioning requirements up to and including entry into service. The plan shall document the resources and processes required to meet the objectives stated in the testing strategy.

C3.5.2
In respect of the resources and their allocation to tasks and deliverables, the plan shall, as a minimum:

a) define responsibilities and delegated authorities; and

b) define the sequence of the deliverables; and

c) show how the Schedule resources are scheduled to be used; and

d) specify alternative action to cater for reasonably foreseeable problems.

C3.5.3
In respect of the testing processes the plan shall, as a minimum, detail the following:

a) verification and validation requirements, including the individual test specifications to be applied (see sections C4.1 and C3.5.4);

b) configuration control requirements;

c) recording and certification requirements;

d) boundaries of the testing;

e) possession and protection arrangements;

f) test equipment requirements;

g) arrangements for recovery of redundant equipment;

h) arrangements for commissioning (eg connect new inputs, disconnect old) and entry into service;

i) audit and surveillance requirements; and

j) provide for alternative action to cater for reasonably foreseeable problems;

k) any system, integration or application testing specified in the product application requirements (see GI/RT7002); and

l) the documentary evidence required for entry into service (see C6.1.2).
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C3.5.4
In determining the test specifications to be applied (see section C4.1 and section 3.5.3a), consideration shall be given to the consistency, coverage and integration of the test specifications in achieving the objectives of the testing.

C3.5.5
It is permissible for factory testing to be controlled either by a test plan or by the manufacturer's own approved quality system.

C3.5.6
The plan shall be subject to a detailed independent check before being approved.

C3.5.7
The Infrastructure Controller shall approve all test plans before they are issued for implementation.

C3.6 Implementation of Testing
C3.6.1
Implementation of testing shall be in accordance with the approved test plan except as permitted below.

If, due to unforeseen circumstances, the plan has to be amended, such amendments shall not import additional risk. A record of the amendments shall be made.

C3.6.2
A process shall be in place to ensure that persons involved in the implementation of the test plan are both informed in a timely manner, and understand, the content of the plan and their responsibilities.

C3.6.3
It is permissible for the details of the commissioning arrangements (eg resourcing) to be separately documented after the test plan is issued, where this facilitates the management of the testing.

Such documentation (commonly known as a commissioning plan) shall detail the requirements that would otherwise be contained in the testing plan.

C3.6.4
During the testing and commissioning the person in overall charge of testing shall be required to ensure that proper management techniques are applied in order to minimise the safety risk associated with the testing. These shall comprise as a minimum:

a) adequate monitoring of activities;

b) accurate reporting of progress; and

c) reviewing and revising assessments of future risks.

C4 Defining and Recording the Testing Activities

C4.1 Test Specifications
C4.1.1
Each test, or group of tests, shall be documented in the form of test specifications.

The test specification requirements shall be derived from the determining requirements. These determining requirements include, but are not limited to:

a) concept design;
b) engineering details;

c) safety requirements;

d) installation specifications;

e) rules and regulations.

C4.1.2
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) a description of the test activities to be performed; and,

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

C4.1.3
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.

C4.1.4
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.

C4.1.5
The individual test specifications required for the testing phase of the project shall be supplied to the person(s) responsible for performing the testing.

C4.1.6
It is permissible to produce checklists in association with test specifications to aid critical appraisal of aspects of the system.

C4.2 Recording and Certification
C4.2.1
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 (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.
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C4.2.2
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 are to be recorded automatically, the products used for recording shall be subject to the requirements of GI/RT7002.

C4.2.3
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.

C4.2.4
It is permissible for the Infrastructure Controller to authorise 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. Check marks shall be traceable to the person who made them.

C4.2.5
Engineering details, concept design documentation and certification used for testing and/or test recording purposes shall be readily identifiable so as 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.

C4.2.6
Test recording shall be undertaken at the time of each test. Test records shall indicate clearly whether acceptance criteria were met (pass) or not (fail). The person making the test shall be required to certify the record of the test.

C4.2.7
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.

C4.2.8
Test certification shall be generated for each test or group of tests, and shall include the following information as a minimum:

a) title and reference. The reference shall be project specific and unique for each certificate within the project;

b) test specification(s) employed and the equipment/functions under test;

c) results of test;

d) all relevant version or control reference(s) of the product/application logic under test;

e) the name of the person controlling the test;

f) the names of any official witnesses to the test; and

g) the date (and time, if critical) of the test.
C4.2.9
A summary certificate shall be produced in association with the test plan and certification. This summary certificate shall confirm the proper completion of all relevant testing and commissioning against all the required test specifications. Permitted exceptions to this requirement are detailed in section C4.5.

The Infrastructure Controller shall ensure that the person in overall charge of the testing formally accepts the record of testing detailed on the summary certificate prior to entry into service (the general requirement for the approval of construction works is set out in GI/RT7003).

C4.2.10
Where test data or configuration data (e.g., a maintenance record card) is required to be passed to the maintenance organisation, the Infrastructure Controller shall approve the data recording method, and these records shall be made available to the maintenance organisation at time of entry into service.

C4.2.11
GI/RT7001 sets out the requirements for the retention of testing and commissioning records.

C4.3 Configuration Control
C4.3.1
The person in overall charge of the testing shall be required to ensure that the testing is undertaken to specifications, concept design documents, engineering details and data that are complete and of the correct status.

C4.3.2
All testing documentation shall be subject to version control.

C4.3.3
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; or alternatively, sufficient re-testing shall be undertaken to confirm that the integrity of the tested sub-systems has not been compromised.

C4.3.4
The products and application logic under test shall be maintained secure at all times from unauthorised access.

C4.4 Error Reporting
C4.4.1
A methodology shall be defined for the recording of errors identified during testing. This methodology shall be documented in the test plan.

C4.4.2
All errors shall be recorded in a timely manner, be uniquely identifiable to the project and be unambiguous in content. The error records shall be retrievable for inspection and retained with the testing records.

C4.4.3
Each error record shall document:

a) the event that gave rise to the record;

b) the location (geographical and technical);

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

d) why the record is being made.

C4.4.4
All error records shall be reviewed and a formal response given to each one. Responses shall:
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a) be sought from the appropriate authority (usually the design or installation organisations);

b) be traceable to the original error record;

c) give a clear statement of the action required; and

d) reference any associated modification documentation or data.

C4.4.5
The status of each error record shall be recorded and tracked through to close-out.

C4.4.6
The person in overall charge of the testing shall be responsible for the satisfactory close-out of each record, or for the close-out to be accepted by another organisation after commissioning. Agreement on any outstanding or deferred action shall be recorded in accordance with section C4.5 below.

C4.4.7
Error records shall be capable of analysis to show error trends, systematic failure and the integrity level at which the failures occurred. The Infrastructure Controller shall determine the need for, and extent of, such analysis.

C4.5 Outstanding Actions
C4.5.1
The Infrastructure Controller is permitted to accept the works for entry into service provided that any outstanding error records relate to matters that cannot affect the safety of the operational system or, where safety could be affected, suitable and sufficient risk reduction measures are implemented.

C4.5.2
A timescale shall be placed on the resolution of any outstanding error reports and the Infrastructure Controller shall monitor these to close out. This timescale shall be no greater than is commensurate with the risk of leaving the work undone. An upper limit of six months is generally sufficient to cover such work.

C4.5.3
The outstanding error reports shall be closed out on the summary certificate referred to in section C4.2.9 by being transferred to a documented action plan that is formally accepted by the affected organisations.

C5 The Testing Process
C5.1 Extent and Rigour of the Testing Process
C5.1.1
The extent and rigour of the testing process shall be sufficient to control both the risk of technical deficiencies within the system under test and of systematic failure within the testing process itself.

A means of defence against systematic failure within the testing process is the use of over-lapping test activities (for example in signalling systems, to a certain degree the wire count and continuity test overlaps the purpose of the strap and function test).

C5.1.2
The applicability of, and arrangements for compliance with, GI/RT7002 and GI/RT7003 shall be taken into account in determining the extent and rigour of the testing, to ensure that the overall system is fit for purpose before entry into service.
C5.2 Phases of the Testing Process
C5.2.1 Testing shall proceed 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.

C5.2.2 It is permissible for testing processes to 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;

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

C5.3 Handover from Installation
C5.3.1 The Infrastructure Controller shall ensure that the following pre-requisites are met in respect of acceptance by the testing organisation of the system from the installation organisation:

a) New products shall have been finalised except for minor adjustment prior to acceptance for testing;

b) The installation work shall have been carried out to the most up-to-date version of the engineering details; and

c) The appropriate quality assurance certification shall have been completed (or equivalent evidence provided) to indicate that the required standards of workmanship have been achieved.

Where an alteration to existing systems is planned, the extent of completeness of the installation will depend on the extent and intrusiveness of the change. Installation shall be as complete as reasonably practicable, leaving only the minimum work for the commissioning as is determined by the physical constraints of the site.

C5.3.2 Where preparatory testing is to be carried out before a sub-system is fully installed, the subsequent testing process shall be sufficient to ensure complete coverage of the testing objectives set out in section C1.2.

C5.4 Verification Testing
C5.4.1 All products and application logic shall be verified against the relevant test specifications before being permitted to enter into service. Verification comprises static testing (see section C5.5) and dynamic testing (see section C5.7) for both product installation and system integration. Application logic for signalling systems is subject to particular requirements, set out in section C5.6.

C5.4.2 The testing stage of verification shall not commence until the engineering details for construction purposes have been given technical approval (see GK/RT0207 in the case of signalling systems), and GC/RT5101 (for telecommunications systems).

C5.5 Verification - Static Testing
C5.5.1 Static testing shall be applied in order to demonstrate that:

a) products have been installed in accordance with the specifications;
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b) products can be powered and will operate as required; and

c) products 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.

C5.5.2 Examples of the types of tests and checks performed during static testing include, but are not limited to:

a) visual inspection that correct equipment has been installed;
b) security and equipment labelling/identification correct;
c) product configuration correct;
d) wire count and continuity test;
e) rating, regulation and discrimination of power supplies;
f) application logic functionality, eg strap and function test (see also section C5.6 in relation to signalling systems);
g) where duplicated sub-systems exist, each is able to operate with the required level of functionality;
h) diagnostic reporting effectiveness;
i) input/output configuration;
j) failure modes;
k) degraded mode operation;
l) effects of transients;
m) cross-boundary and through testing of circuits and data;
n) alarms operate as specified;
o) correct isolation of independent sub-systems;
p) mechanical or electrical adjustment effected.

C5.6 Verification of the Application Logic in Signalling Systems (the Control Table Test)

C5.6.1 In signalling systems the activity of verifying that the application logic meets the requirements of the control tables (‘control tables’ includes locking tables or any other tabulated definition of the control requirements) is commonly termed the Control Table Test.

C5.6.2 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.

C5.6.3 It is permissible for the application logic to be verified by use of simulation systems. The extent of verification testing by simulation shall be defined in the test plan.
C5.6.4
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 considered in order to determine how the testing is to be carried out.

C5.6.5
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.

C5.6.6
Functions commonly requiring to be tested 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;
m) special controls.

C5.7 Verification - Dynamic Testing
Dynamic testing is applied in order 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 (data rates, protocol, etc).
e) Transmission timings, network delays, and sequencing.

C5.8 Verification of the Integrated System
C5.8.1
When the sub-systems have been fully integrated a verification of the complete system can commence. Testing, analysis and audit shall be performed to
demonstrate that the complete system functions and operates in conformance with the engineering details.

C5.8.2 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.

C5.9 Validation of the Application Logic

C5.9.1 For products designed and implemented in accordance with EN50129 and accepted in accordance with GI/RT7002, the application logic shall be tested in accordance with the requirements of the relevant safety case and product application requirements.

However, in certain systems (eg heritage interlocking systems) the safety and application requirements are not explicitly specified, but the core safety principles are set out in Railway Group Standards or other documents. In such cases validation testing shall be performed so as to demonstrate that the designers of the application logic have correctly interpreted the requirements of the relevant Railway Group Standards and such other documents as define the required functionality. For signalling systems, this phase of testing is known as ‘principles testing’, and the concept design contains details of the relevant standards and other documents (see GK/RT0207).

C5.9.2 The validation activities shall be defined in test specifications and shall be determined by reference to:

a) mandatory safety requirements (eg in Railway Group Standards);

b) concept design documentation;

c) technical constraints; and

d) project-specific risk control measures.

C5.9.4 It is permissible for the application logic to be validated by use of simulation systems.

Caution is required in the application of simulation systems, for example where the simulation could mask the actual operation of the application logic.

C5.9.5 In the case of signalling systems, it is permissible for the principles testing of the application logic to be carried out simultaneously with control table testing, provided that validation is not compromised by so doing.

C5.10 System Validation
Systems within the scope of this document accepted in accordance with GI/RT7002, tested in accordance with this document and compliant with the requirements of GI/RT7003, are deemed to have met the requirements for system validation – see also section C5.1.2.

C5.11 Abolition (Recovery) of Redundant Products

C5.11.1 Products identified for recovery shall be independently confirmed as correctly identified before recovery commences.

C5.11.2 Redundant equipment that cannot be completely recovered shall be identified in the test plan. Recoveries that are found to be inappropriate at time of commissioning shall be subject to error reporting. Any special measures required
to control the risks with leaving redundant equipment in situ shall be in place prior to entry into service.

**C5.11.3**
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.

**C5.11.4**
If any product or application logic is to be left in place it shall not be possible for irregular or confusing indications or information to be given to any operator or other infrastructure personnel, train driver or road user.

### C6 Entry into Service

#### C6.1 Control of Entry into Service

**C6.1.1**
The Infrastructure Controller shall control the entry into service of installed products and application logic. Entry into service shall be permitted only when there is documentary evidence of the proper completion of all of the installation and testing activities associated with the project. See also section C4.5 in respect of outstanding actions.

**C6.1.2**
The Infrastructure Controller shall determine the documentation required for controlling entry into service, and ensure that this is available at time of entry into service. The documentation shall as a minimum consist of the summary certificate of test completion, the as-built design details and a summary list of the error records. Examples of other documentation that might be required include:

- documentary evidence of design verification and approval;
- product acceptance certification (as required by GI/RT7002);
- scheme approvals certification;
- level crossing orders;
- maintenance requirements and arrangements (see GK/RT0210);
- authorisation of any non-compliance;
- asset record data (see GI/RT7001).

**C6.1.3**
Prior to entry into service:

- the system shall be restored to its normal (quiescent) state; and
- any simulation elements or releases provided for testing shall be completely disconnected from the commissioned system, unless subject to the requirements of section G3.2.2.

#### C6.2 Delegation of Authority

It is permissible for the Infrastructure Controller to delegate, to the person in overall charge of the testing, the authorisation of entry to service of a commissioned system. Such delegation shall be formally recorded.

#### C6.3 Monitoring and other Measures

Any monitoring or other measures that are required shall be confirmed as in place and effective before entry into service.
C6.4 Trial Running
Where trial running (eg test trains during the commissioning period or shadow service running) is to be instigated, the Infrastructure Controller (or delegated representative) shall be satisfied that any necessary agreements and protection arrangements are in place before authorising commencement.

C6.5 Security
The site and systems shall be made secure against unauthorised access upon completion of testing work.
C7 Flow Chart for Works Testing

System Requirements
GK/RT0206

Concept Design
GK/RT0207
Or ISO9001

Engineering Details
GK/RT0207
Or ISO9001

Install
GK/RT0208

Verify
(C5.4 – C5.8)

Validate
(C5.9)

Test Specifications
(C4.1)

Test Records
(C4.2)
& Error Records
(C4.4)

Certification
(C4.2)

Entry Into Service
(C6)

Testing Strategy
(C3.4)

Testing Plan
(C3.6.3)

In this flow-chart the relevant Part C section is indicated in parenthesis
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Part D
Maintenance Testing

D1  Purpose
This Part D deals with the testing requirements to support the like-for-like replacement processes permitted by GK/RT0208. Such testing is referred to hereafter as maintenance testing.

D2  Exclusion
This Part D is not applicable where any form of validation of the system design is required. If validation is appropriate then the requirements of Part C of this document apply.

It is not the intention that this Part D be applied where extensive and simultaneous like-for-like replacement or reinstatement is planned, even if such work is performed in accordance with the “as built” infrastructure records. Under such circumstances Part C generally applies. Responsibility for determining what is ‘extensive and simultaneous’ lies with the Infrastructure Controller.

D3  Control of Testing Work

D3.1  Management Control
The Infrastructure Controller shall ensure that:

a) one person is placed in charge of the testing (the maintenance tester);

b) maintenance testing is undertaken only by, or under the supervision of this person;

c) the person in charge of the testing is made responsible for selecting the relevant test specifications.

D3.2  Independence Requirement
D3.2.1
The installation work shall be subject to independent verification by the maintenance tester unless exemption has been authorised by the Infrastructure Controller. The risks arising from exemption shall not impair the safety integrity of the system, and shall be documented.

It is permissible to authorise exemptions only in respect of:

a) the replacement of consumable products used as part of the signalling system, such as lamps. Other plug-in products, and products requiring wiring to be removed and reinstated are not exempt;

b) the replacement/repair of items of telecommunications equipment, but not including equipment where an error in the work could result in a high risk safety related failure (e.g. repairs to bearers used for block circuits between signal boxes).

Even in circumstances where independent verification is not required, it is still necessary to perform maintenance testing in connection with like-for-like replacement, in accordance with the other sections in this Part D.

D3.2.2
Where independence is required, the maintenance tester shall not be permitted to lead or direct the equipment replacement/reinstatement process.

D3.3  Risk Identification and Mitigation
D3.3.1
Risks arising from maintenance testing that could impair the safety integrity of the system shall be assessed and mitigated prior to undertaking the change.
D3.3.2
Particular attention shall be given to the control of risks associated with the testing following:

a) the replacement of missing equipment;

b) replacement by operationally equivalent equipment;

c) loading of data into replacement memory modules

d) inappropriate application of generic test specifications (eg to standard equipment that has been specially modified).

D3.3.3
In assessing risks, due account shall be taken of:

a) any specialised or additional testing required (over and above that in any pre-determined test specification);

b) the competence of the personnel involved;

c) the correlation requirements;

d) the status or content of system documentation; and

e) any special circumstances at the work site (eg poor lighting).

D4  Test Planning

D4.1  Testing Following Maintenance and Renewals

D4.1.1
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.

D4.1.2
Arrangements for the control of deviations from the test plan shall be specified. Changes shall be documented.

D4.1.3
Test plans shall be subject to independent verification by a competent person.

D4.2  Testing Following Faults and Failures

Where testing work following faults or failures is required, a record shall be made of the test specifications that were employed. Except as required by Part E of this document, the production of a test plan following faults and failures is not necessary.

D5  Test Control Requirements

D5.1  Test Specifications

D5.1.1
All maintenance testing shall be carried out in accordance with suitable test specifications.

D5.1.2
Test specifications shall ensure a consistent approach to maintenance testing. It is permissible to use generic/standard test specifications, provided they are applied within the scope of their validity.

D5.1.3
Test specifications shall contain, as a minimum:

a) the objective of the testing;
b) the testing steps necessary to ensure the correct operation of replacement equipment;

c) the sequence of these steps; and

d) details of which steps must be completed before, and which after, the installation work;

e) the acceptance criteria.

D5.1.4 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 (eg in nature, content or environment) shall be assessed and controlled before any such change is implemented.

D5.1.5 Maintenance test specifications shall be made available for use prior to the entry into service of any new product. Railway Group Standard GI/RT7002 specifies the requirements for the assessment of test specifications (referred to as application requirements in that document).

D5.2 Recording and Certification

D5.2.1 The Infrastructure Controller shall specify the requirements for the recording, monitoring and retention of maintenance testing records. The detail recorded shall be sufficient to indicate what testing was undertaken, and to demonstrate the satisfactory completion of the testing and any associated adjustments.

Records shall be retained in accordance with the requirements of GI/RT7001.

D5.2.2 Certification to indicate satisfactory completion of the testing shall be produced. Certification shall require the formal agreement of the maintenance tester in charge. Certification records shall include:

a) the names of personnel undertaking the tests,

b) the date of the work; and

c) equipment and site identity information.

D5.2.3 Where testing work is passed from one team to another for completion, the status of the work shall be clearly recorded and the team taking up the work properly briefed on the condition of the Infrastructure.

D5.3 Infrastructure Records

Railway Group Standard GK/RT0208 specifies the requirements for the use, correlation and, where necessary, the updating of infrastructure records in connection with like-for-like replacement work.

D6 Testing Process

D6.1 Verification Testing

D6.1.1 Testing shall be carried out in accordance with the test plan (where provided – see section D4.1) and test specifications relevant to the work.
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D6.1.2
The testing work shall ensure that the:

a) like-for-like replacement is properly installed;

b) affected product(s) conform to the as-built design, product specifications and relevant standards; and

c) affected systems operate correctly.

If it is possible that application logic would be compromised by the work then the testing shall be undertaken in accordance with Part C.

D6.2 Error Reporting and 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.

D6.3 Re-entry into Service
D6.3.1 Correct correspondence between command and control equipment, and correct operation of the system shall be observed before permitting re-entry into service.

D6.3.2 It is permissible for the Infrastructure Controller to delegate the authority to re-introduce equipment into service to the organisation undertaking the maintenance testing, except where this is prohibited by the provisions of Part E of this document.

D6.3.3 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, unless subject to the requirements of section G3.2.2.

D6.3.4 The site and systems shall be made secure against unauthorised access upon completion of the work.

D7 Minor Changes
D7.1 Introduction
In some circumstances minor changes to systems are necessary following planned maintenance, faults or failures (see also GK/RT0208). 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; replacement of an item by an operationally equivalent item.

D7.2 Requirements
Work within the scope of this section D7 shall be tested in accordance with sections D3, D4, D5 and D6 of this document, taking into account the nature of, and risks associated with, the change being made.

D8 Signalling Releases
D8.1 Introduction
The scope of this section is confined to releases of signalling controls where the arrangements for the release are not designed into the system. Such releases are here described as invasive.

Invasive releases are not permitted where a designed-in means of release is provided (eg sealed releases).
D8.2 Requirements for the Giving of Releases

D8.2.1 Controls within operational signalling systems shall be released only in accordance with the requirements of the Rule Book Section E (refer to D8.3 below).

D8.2.2 So far as is practicable, the technical arrangements for the release shall be subject to independent verification (either on-site, or remotely) before the release is given, to ensure that the intended outcome is achieved and that no unwanted safety-related side effects can occur.

D8.2.3 The release shall be withdrawn and the security of the system restored without delay when the release is no longer required.

D8.2.4 Persons giving a release shall be competent in the technology affected, and knowledgeable in deciding the appropriateness of such actions.

D8.3 Releases Permitted under Section E of the Rule Book

D8.3.1 The giving of releases in accordance with Section E of the Rule Book are permitted to come within the scope of this Part D provided they:

a) are of time-limited nature to facilitate train working;

b) meet the requirements of the Rule Book Section E with respect to the releasing of signalling controls; and

c) do not require any application logic to be redesigned.

D8.3.2 Consideration shall be given to the independent validation of releases that involve an alteration to the configuration of the signalling system (eg physical changes to track dimensions, such as clearance points or overlaps).
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Part E
Action Following System or Product Failure

E1 Purpose
This section mandates the on-site investigative actions to be taken where a signalling or operational telecommunications system has failed.

Other than section E2 (which relates to all types of failures), the requirements of this section relate to safety-related failures only.

The overall requirements for the management of signalling and operational telecommunications failures are set out in GK/RT0106.

E2 Failure Investigation

E2.1 Investigation and Repair of Failures
Reported failures shall be investigated to ascertain the cause, and any necessary repairs shall be tested in accordance with Part D of this document.

All reported safety-related failures shall be treated as having occurred until proven otherwise.

Where there is ambiguity regarding the reported symptoms the failure shall be regarded as safety-related until found not to be so.

E2.2 Low Risk Safety-related Failures
It is permissible for the Infrastructure Controller to exempt specific types of low risk safety-related failures from the requirements of sections E5.1, E5.2 and E6.2. However, exemption can be authorised only in those cases where it is improbable that a high risk safety related failure would be misdiagnosed as a low risk failure.

The Infrastructure Controller shall define and document the specific types of low risk safety-related failures for which exemption is to be granted.

E3 Management of Serious Incidents

E3.1 Requirements for the Investigation of Serious Incidents and Accidents
In the event of a serious accident the requirements of the Rule Book, Section Y, apply.

Railway Group Standards GO/RT3434/2 and GO/RT3434/3 specify the requirements for the investigation of accidents. The investigation of the signalling and operational telecommunications systems shall be under the control of the appointed infrastructure engineer unless otherwise directed.

E4 Management of Safety-related Failures

E4.1 Person in charge of Testing
E4.1.1 Where it is necessary to perform testing to ascertain the cause of a safety-related failure, the Infrastructure Controller shall ensure the following:

a) One person shall be appointed to take overall charge of the testing and to report the results to the appropriate authority(s); and

b) The person in charge of testing shall be made responsible for the production of the test plan and the selection of test specifications (see E6 below).
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E4.1.2
Where the scope of the investigation needs to widen as evidence emerges, there shall be a review of the suitability of the person in charge of testing for undertaking the additional responsibilities.

E4.2 Independence Requirements: Serious Incidents
In the case of a serious incident, the testing personnel shall be free from conflict of interest in the possible cause of the reported failure or incident.

E5 Safety-related Failures: Testing Phases

The requirements of this section are not applicable to failures for which exemption has been granted in accordance with section E2.2.

E5.1 Phases
E5.1.1 The testing shall be divided into a number of phases. The number of phases shall be determined by the technical and managerial competence necessary for informed engineering judgements to be made prior to the closeout of the investigation. There shall usually be at least three phases, as listed below and performed in the order shown:

a) Non-destructive testing (eg non-invasive examination of equipment);

b) Destructive testing (measurements; disconnection of wiring; operation/state change; etc); and

c) Re-entry into service.

It is permissible to omit destructive testing or other intermediate phases if it is evident that the failure has been fully explained by non-destructive testing.

E5.1.2 Each phase shall include sufficient tests to ensure, so far as possible, that all relevant information and data is collected, and all possible causes of the failure are considered.

E5.2 Escalation
E5.2.1 The Infrastructure Controller shall specify the requirements for permitting each phase of testing to commence (usually involving referral (escalation) of the situation and findings of the testing to date to another, or more senior engineer).

Other than for self-evident failures, the person who authorises the progression to the next phase of testing or re-entry into service shall not be one of the personnel engaged in the testing.

E5.2.2 The requirements for escalation/referral shall take account of the severity of the reported failure. Suitable and sufficient tests shall have been satisfactorily completed prior to authorising movement between phases.

E5.2.3 In the case of serious incidents, moving between phases shall usually require the authority of the police representative. (The police also control the recovery and retention of evidence in such circumstances.)

E5.2.4 The Infrastructure Controller shall specify the escalation/referral arrangement to be applied if no fault is found after the final site testing phase.
E6 Control of Testing for Safety-related Failures

E6.1 Commencement of Testing
Testing of safety-related failures shall not commence until arrangements have been implemented to protect the safety of trains. So far as is practicable, the making of such arrangements shall not cause disturbance to possible evidence, nor shall any security seal be broken.

E6.2 Test Plans
In the case of serious incidents, and so far as is practicable in the case of other safety-related failure investigations (but not including failures for which exemption has been granted in accordance with section E2.2), the person in charge of overall testing shall prepare a test plan. The plan shall state the phases and order of the work, and include or reference any test specifications to be used (see section E6.6.2 below).

In the case of serious incidents, the Infrastructure Controller shall approve the test plan.

E6.3 Retrieval of Evidence
Removable component(s) shall be retrieved and secured for further analysis where the correct operation of such component(s) is in question. Immovable evidence shall be as fully recorded as practicable.

In the case of serious incidents, and in the case of other failures where necessary to aid investigation, all available data logs shall be copied or retrieved (depending on the media) and secured for subsequent analysis.

E6.4 Recreation of Reported Failure
Testing which attempts to recreate the reported failure shall not be performed without protection in place sufficient to control the risks of such an endeavour.

E6.5 Facilitation of Train Running
Disconnection, releases or adjustments to a system to permit train running shall be made only on the authority of the Infrastructure Controller or nominated representative, and then only after suitable and sufficient evidence gathering and recording of findings has taken place.

E6.6 Test Specifications
E6.6.1 So far as is reasonably practicable, test specifications shall be produced for the investigation of failures, detailing the tests to be conducted.

E6.6.2 So far as is reasonably practicable, test specifications shall ensure a consistent approach to testing. It is permissible to use generic/standard test specifications, provided they are applied within the scope of their validity.

E6.6.3 All test specifications shall be prepared by competent persons. So far as is reasonably practicable, test specifications relating to products that are safety-critical in application shall be independently verified, and 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.
E7   Records of Safety-related Failure Testing

E7.1   Records of Environmental and Technical Conditions
Written notes shall be made of the environmental, technical and configuration conditions at the time of observation, and of those that were reported as occurring at the time of the incident. Priority shall be given to perishable evidence.

E7.2   Records of Tests
Records shall be kept of all tests conducted, and of the outcome, findings and measurements recorded.

E7.3   Records of Persons Involved in Testing
A record shall be produced of the names of the persons involved in the testing and those authorising the commencement of each testing phase. A record shall be produced of the names, contact details and affiliation of any known witnesses.

E7.4   Report of Testing
The records shall be collated into a suitable report, reviewed and retained as determined by the Infrastructure Controller or Inquiry representative. Original records, made at the time of testing, shall be retained if they might be required for a formal inquiry.

E7.5   Specification of Recording Arrangements
Where a test plan is produced, it shall specify the recording arrangements for the testing work.

E8   Re-entry into Service after Safety-related Failures

E8.1   Permission for Re-entry Into Service
E8.1.1
The decision to permit re-entry into service shall be taken by the Infrastructure Controller or a competent person authorised to make such decisions on the Infrastructure Controller’s behalf.

The key determining factors in the decision to permit re-entry into service shall be the completeness, satisfactory outcome and authoritativeness of the recorded testing.

E8.1.2
Permission for re-entry into service shall be given at a level not lower than that of those to whom the investigation has been escalated during the investigation.
Part F
Safe Systems of Work

F1 Introduction
This section deals with the requirements for safe systems of work when any type of testing is to be carried out. It deals with methods of disconnection and protection relevant to the testing of operational products.

A safe system of work, in this context, refers to the arrangements to be applied during testing to ensure the safety of trains, and the public at level crossings. It does not include the safety of personnel engaged in the testing work.

F2 Safe Systems of Work

F2.1 Planning Safe Systems of Work
The testing documentation shall mandate the arrangements required for safe systems of work, invoking the application of the Rule Book as necessary and detailing the disconnections required where this can be planned in advance.

When planning the arrangements for the passage of trains through areas affected by the testing work, the proposed method and intensity of train working shall be taken into account.

F2.2 Integrity of Operational Products
F2.2.1 Testing work shall not interfere with the integrity, operation or use of existing operational products, except where measures have been implemented to ensure that safety is not jeopardised.

F2.2.2 In the case of level crossings the road user shall be protected in accordance with the appropriate highway regulations.

F2.2.3 Operational products shall also be protected at all times from the potentially unsafe effects of un-commissioned products or application logic such as:

a) wiring;

b) code;

c) electromagnetic interference.

F2.2.4 The demarcation between operational and non-operational products shall be defined so far as is reasonably practicable. The demarcation shall be documented or otherwise identified for the benefit of any personnel likely to be misled by the current status of products.

F2.3 Situations where Equipment cannot be Restored To Service
If an item of equipment cannot be safely restored to service, the provisions of the Rule Book for failed equipment apply.

F2.4 Protection against Unsafe Indications and Information
During testing work there shall be protection in place to ensure that, so far as is reasonably practicable, no irregular, misleading or confusing indication or information is given to any operator or other personnel, train driver or road user.

Where it is not reasonably practicable to provide such protection, arrangements shall be in place to ensure those operators or other personnel, train drivers or road users are not misled or confused by such indications.
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F2.5 Communications Protocols
A high standard of 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.

The Rule Book, Section A, specifies the requirements for messages concerning safety.

F3 Disconnections

F3.1 Application of Rule Book
Any disconnection that affects the use of operational products within the scope of this document shall be made in accordance with the Rule Book Section E.

F3.2 Principles for Disconnections
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 (eg 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.

F3.3 Identification of Disconnections
Disconnections shall be clearly identified to prevent inadvertent reconnection.

F3.4 Verification of Disconnections
The effectiveness of disconnections shall be verified before being relied upon.
Part G
Use of Monitoring and Test Products

G1 Introduction
This section deals with the arrangements for the insertion and recovery of monitoring and test equipment into operational signalling and communications systems, together with the control requirements for the use of simulation Products. The requirements apply to all test and monitoring instrumentation that is connected to safety-related operational products.

G2 The connection of Test or Monitoring Products

G2.1 Integrity of Operational Products
Under no circumstances shall the connection or use of test or monitoring equipment jeopardise the safe working of operational products.

G2.2 Integrity of Connection Arrangements
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 and therefore be tested in accordance with Part D7 of this document where the connection arrangements are straightforward and low risk. In other circumstances the testing shall be conducted in accordance with Part C of this document.

G2.3 Records of Arrangements
An appropriate record of the temporary alterations shall be provided on site; this shall include distinct identification of temporary instrumentation and associated equipment (eg wiring, relays).

G2.4 Limitations on Duration of Arrangements
The work shall not remain in place for an extended period (typically no more than one month) without consideration of the additional risks involved, and action taken to mitigate any unacceptable risk.

G2.5 Removal of Equipment
At the conclusion of the monitoring period the instrumentation shall be recovered in a controlled manner and the site restored to its original configuration. The system shall be verified as having been returned to its original configuration.

G3 Simulation Products

G3.1 Integrity of Operational Products
G3.1.1 Under no circumstances shall the connection or use of simulation products jeopardise the safe working of operational products.

G3.1.2 Simulation products shall never be connected to operational products unless a detailed risk assessment is undertaken and the risks suitably controlled.

G3.2 Control of Use of Simulation Products
G3.2.1 The Infrastructure Controller shall ensure that the use of simulation products is controlled by a suitable management system under the control of the person in charge of the testing. Procedures for the use of such products shall control the risks arising from their use.

G3.2.2 Physical equipment shall be distinctive in appearance and bear individual identifier markings that are unique to the organisation undertaking the testing.
G3.2.3
Software-based products and code shall be:

a) subject to an appropriate configuration control system; and

b) used only for those applications for which their product acceptance is valid.

G3.3 Effectiveness of Simulation
The extent, effectiveness, and reliance placed upon the results of, of any applied simulation shall be determined prior to undertaking the test for which it is provided, taking into account the integrity of the simulation product and the manner of its use.

G3.4 Unattended Simulation Products
The Infrastructure Controller shall ensure that the application of simulation products that are left unattended on site is designed, installed and tested by competent personnel. Such work shall be tested in accordance with Part C of this document.

Upon the removal of such products the system shall be verified as having been returned to its proper configuration.
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References

Railway Group Standards

GA/RT6001  Railway Group Standards Change Procedures
GA/RT6004  Temporary Non-Compliance with Railway Group Standards
GA/RT6006  Derogations from Railway Group Standards
GC/RT5101  Technical Approval Requirements for Changes to the Infrastructure
GI/RT7001  Management of Safety Related Records of Elements of the Infrastructure
GI/RT7002  Acceptance of Systems, Equipment and Materials for use in Railtrack Controlled Infrastructure
GK/RT0002  Glossary of Signalling Terms
GK/RT0101  Competence Standards for Signalling & Telecommunications Staff
GK/RT0106  Management of Safety Related Failures of Signalling and Operational Telecommunications Systems
GK/RT0206  Signalling and Operational Telecommunications Design: Safety Requirements
GK/RT0207  Signalling Design Production
GK/RT0208  Installation of Signalling and Operational Telecommunications Equipment
GM/RT2002  Acceptance Testing of Rail Vehicles
GO/RT3000  The Rule Book
GO/RT3260  Competence Management for Safety-Critical Work
GO/RT3434/2  Accident Management
GO/RT3434/3  Accident Investigation and Formal Inquiries


Other References

EN 50129  Railway Applications: Safety Related Electronic Systems for Signalling
          Railway (Safety Critical Work) Regulations
ISO 9001  Quality Management Systems