

Category 2 Standard

S2524

(Formerly E75 I I)

Testing of Signalling Installations

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1 Purpose

- 1.1 The purpose of this Standard is to define mandatory requirements for the testing of vital signalling systems (which may include elements of trainborne sub-systems, up to a defined interface for each type of rolling stock), prior to entry (or re-entry) into operational service.

2 Scope

- 2.1 This standard applies to pre-commissioning, commissioning, maintenance (both preventative and corrective), and incident investigation. It also applies to decommissioning and removal from service (whether temporary or permanent), in relation to its potential impact on the integrity of the remaining system.
- 2.2 This standard shall apply to in-situ signal testing on the system for which London Underground is the Infrastructure Manager, and also to site-specific testing taking place away from the railway (e.g. pre-wired racks or location cases, or data-driven interlockings).
- 2.3 This standard replaces E7511 A1, S2524 A1 and TLL-ENG-S7272-A1, which are withdrawn.

3 Requirements

3.1 Testing to be carried out

- 3.1.1 The testing objectives detailed in 5.4.1 shall be fully understood.
- 3.1.2 Testing shall be carried out:
- a) before a signalling system is first brought into use (see 3.1.4);
 - b) following any subsequent interference with the signalling system (see 3.1.5);
 - c) where necessary to monitor potential degradation of signalling system components (see 3.1.6);
 - d) following any reported abnormal behaviour of the signalling system (see 3.1.7);
 - e) when the correctness of the 'as built' design record needs to be verified (see 3.1.8).
- 3.1.3 Testing shall be sufficient and appropriate, having regard to all of the circumstances, and taken together with other assurance processes, to ensure that the subsequent risk from any potentially unsafe mode of operation of the total signalling installation is ALARP.

Note:

1. The purpose of testing is to contribute to the assurance that the safety and operational performance of the vital signalling meets the relevant standards and specifications. However, the phrase 'taken together with other assurance processes' recognises that this overall assurance often cannot be achieved by testing alone. Testing forms one part of the total process of verification and validation, and must always operate in association with other assured processes such as design approval and configuration management.
2. Establishing that the risk remains ALARP in any case may require formal or informal risk assessment, as appropriate to the circumstances.

3.1.4 Before a new signalling system is first brought into use, sufficient and appropriate testing shall be carried out to satisfactorily achieve all of the testing objectives in 5.4.1.1, and, where applicable, the additional objective in 5.4.1.2.

3.1.5 Following any interference with the commissioned signalling system, either actual or potential, it shall be satisfactorily re-tested prior to its re-entry into service.

Notes: Examples of 'potential' interference might include the risk of disturbance to the signalling:

- a) from a procedure that is not intentionally intrusive, but where it is impractical to apply a sufficient degree of control to guarantee that intrusion will not occur, or
- b) during a prolonged period when the signalling is out of use, such as the extended closure of a section of line for major structural works.

3.1.6 S1199 (Signalling and Signalling Control – Operation and Maintenance) requires that signalling system components shall be analysed to identify degradation modes with the potential to reduce system safety, and that defences against them shall be specified within the maintenance regime. Where the specified defences involve testing to monitor the onset or development of such degradation then a programme of planned testing shall be established and carried out.

3.1.7 S1199 requires that any report of abnormal behaviour of the signalling system which may indicate a potentially unsafe failure shall be investigated. The evidence underlying the report shall be collected and used to pinpoint the particular abnormal behaviour as closely as possible. Potential causes of the abnormal behaviour shall then be identified, and testing carried out to either refute or confirm each potential cause.

3.1.8 Before planned work is carried out where the safety assurance relies on the accuracy of the 'as built' signalling records, the relevant parts of the signalling shall be tested to identify any significant discrepancies between the installation and the records, and the records amended to match the installed signalling. This process is known as 'correlation', and its scope, extent and timing shall be such that the safety risk that might arise from any remaining discrepancies is ALARP.

Note:

1. Where the planned work involves a design change, the required scope and extent of correlation will be determined by the Design Authority, as it will be governed by the nature of the proposed design change (this is mandated by S1200 (Signalling and Signalling Control – Alterations to Systems). Defining the required scope and extent requires an assessment of the potential threats to the safety and operability of the signalling that a discrepancy in the records might pose. Such threats will generally be to either:
 - a) the execution of the proposed modification (generally arising from a discrepancy within the immediate sub-system being altered, e.g. an affected circuit) such that the modification might be incorrectly carried out and will not actually be what the design shows; or b) the validity of the modified design (which may arise from a discrepancy beyond the immediately affected sub-system), due to the designer being misled into false assumptions about the principles or details of the existing signalling.
2. Where the planned work is of a like-for-like nature, the required scope and extent of correlation will generally be determined by the competent person (as defined by S1203, (Competence of Personnel Working on Signalling and Control Systems) who will be responsible for carrying out the planned work itself.

3.2 Management system requirements

- 3.2.1 The testing process, including the objective, procedure and acceptance criteria for each testing activity, shall be specified and documented in accordance with an appropriate quality management system. This shall embody a continuous improvement process, and include appropriate procedures to:
- a) respond to reports of identified testing deficiencies, from whatever source;
 - b) establish the root cause of any deficiency and revise the testing process as necessary;
 - c) ensure that the testing process is informed by industry best practice.

3.2.2 The competence of testers shall be managed in accordance with S1203.

3.3 Supervision and audit

- 3.3.1 In determining the levels of supervision, quality checks and audit, account shall be taken by the supplier of:
- a) the complexity of the work and the extent to which it is unusual or unique;
 - b) the competency of the testing personnel in relation to the work being performed;
 - c) the likelihood of errors being made; and d) the consequences of such errors.

3.4 Avoidance of undue pressure during testing

- 3.4.1 Suppliers shall ensure that testers are permitted sufficient time to plan and conduct testing thoroughly, and are not subject to undue interference or pressure by other persons in management, supervisory or other capacities, either to finish before their test regimes are completed, or to accept situations where clearly defined acceptance criteria are not met.

3.5 Works Testing

3.5.1 Purpose

3.5.1.1 Scope of Works Testing

- 3.5.1.1.1 The processes and practices described in this sub-section, commonly known as 'works testing', shall be applied to:

- a) planned alterations to the signalling system within the scope of S1200;
- b) planned alterations to trainborne sub-systems forming part of the signalling system, as defined in this standard.

They may also be applied, in whole or in part, when emergency changes are made to the signalling system in accordance with S1199. The extent of their applicability in such cases will be determined through the escalation procedures defined within S1199.

Note: S1200 contains much of relevance to works testing and should be read in association with this standard. Note however that S1200 excludes trainborne elements of the signalling system, while this standard (E7511) includes them.

3.5.1.2 Objectives of Works Testing

- 3.5.1.2.1 Works testing shall meet all of the applicable testing objectives in 5.2.1.1, and where appropriate the additional objective in 5.2.1.2. In the context of works testing, these objectives shall be interpreted as including confirmation, so far as reasonably practical, that:

- a) the change has not brought about any unintended effects;
- b) correct logical operation and acceptable performance is sustained when the system is stressed to maximum capacity;
- c) where appropriate, degraded performance under relevant fault conditions is as intended.

3.5.2 Testing personnel

3.5.2.1 The Tester in Charge (TiC)

- 3.5.2.1.1 Whenever a new signalling system is to be brought into commission for the first time, or any modification or partial decommissioning of an operational system is to take place, a TiC shall be appointed. The TiC shall take overall responsibility for ensuring that, at the time of entry or re-entry into service, the resulting system

has been brought to a safe and operable condition, and is fit for purpose. This responsibility shall include:

- 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, including the acceptance of any test plan or schedule affecting vital systems;
- d) recording and reporting of the testing activities, including assurance of the completeness, suitability and satisfactory outcome of the testing.
- e) receipt of assurance that interfaces to signalling systems, including control systems, have been addressed.

Note:

1. Further details of the role of the TiC are given in S1200.
2. S2523 (Commissioning of signalling systems) requires that a Commissioning Engineer should independently review and confirm that the system acceptance criteria are appropriate and complete, and that they are met. In appropriate cases, having regard to the scale and nature of the works, the roles of TiC and Commissioning Engineer may be fulfilled by the same person. In larger or more complex projects a separate Commissioning Engineer might be appointed.
3. In addition, for major projects involving a large number of separate but interrelated commissionings, a separate Test and Commissioning Manager may be appointed to manage the overall strategy and approach to the testing.
4. Irrespective of such arrangements, it remains the case that every individual commissioning shall have an appointed TiC, whose responsibilities as defined in this standard and in S1200, are not diminished.

3.5.2.2 Independence of works testers

- a) S1200 requires that validation testing of site-specific vital signalling systems (otherwise known as 'principles testing') shall be carried out by testers who are independent of the designers and design validators of the installation being tested.
- b) There shall be an appropriate reporting line for testers to assist in meeting the requirements of 3.4.
- c) There shall be sufficient independence between installation and testing personnel that deficiencies in the process of installation do not compromise the requirements of 3.1.3 and 3.5.5.2 a).

3.5.3 Test management and planning

3.5.3.1 Documenting the testing activity

- a) The entire testing and commissioning process shall be documented.

- b) 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.

Note: S1200 contains certain specific documentation requirements, and reference should also be made to S1217, Integration of Human Factors into System Development.

3.5.3.2 Risk assessment and mitigation

- a) Testing may encounter or give rise to various hazards which can threaten either the immediate safety of the railway, or the integrity or operability of the resulting system. Such hazards typically arise from:
 - 1) the nature and condition of the signalling systems to be tested;
 - 2) the processes by which the testing is carried out (including situations that could lead to ineffective or insufficient testing);
 - 3) the environment in which the testing takes place.

Such hazards shall be identified and shall be addressed within the testing strategy.

- b) The assessment and mitigation of such hazards shall be sufficiently rigorous to ensure that all credible risks to the safe operation of the signalling arising from or associated with the testing and commissioning process are either eliminated or controlled to a level that is ALARP.

Note: Examples of hazards are given in clause 5.4.2.

- c) When an alteration is to be made to a signalling installation, any non-compliance with current signalling standards and practice that the Design Authority proposes to retain as part of the modified system shall be identified and documented as part of the modification design process. The proposed retentions shall be independently reviewed by a competent person. The TiC shall ensure that this review has been carried out.

3.5.3.3 The testing strategy

- a) A testing strategy or outline testing plan shall be prepared at the early stages of each project, which shall:
 - 1) outline the testing and commissioning requirements;
 - 2) develop the testing objectives in relation to the specific project concerned;
 - 3) define the deliverables necessary to meet the objectives;
 - 4) state in overall terms how the deliverables are to be resourced and achieved;
 - 5) demonstrate that the commissioning can be achieved within the possession pattern and timescales envisaged.

- b) The testing strategy shall furnish sufficient details to enable the design organisation to take account of any testing or commissioning related constraints.
- c) The testing strategy shall be periodically reviewed throughout the duration of the project, and the requirements and objectives shall be amended as necessary.
- d) The testing strategy, including any amendments, shall be approved by the TiC and by the accredited Asset Engineer. The Asset Engineer may, at his discretion, delegate such approval to another competent person.

Note:

1. The testing strategy should take due account of all relevant factors, including but not limited to:
 - a) the physical distribution of sub-systems and equipment;
 - b) the inclusion of any new or novel features within the design;
 - c) the acceptance status of equipment to be used;
 - d) the access and possession arrangements;
 - e) the impact of any stageworking requirements (including the extent of re-testing);
 - f) the effect of interfaces with other engineering disciplines, other operating administrations, and between sub-systems.
2. The Design Authority's arrangements for carrying out correlation of the existing 'as built' records before issuing the modification drawings (as required by S1200) will normally be documented separately. However, responsibility for ensuring that the correlation is valid when site work affecting commissioned assets is carried out rests with the TiC, and any testing for this purpose should be covered by the testing strategy.

3.5.3.4 The test plan

- a) A documented test plan or series of test plans shall be produced, following logically from the testing strategy. Each test plan shall detail the complete testing and commissioning requirements from pre-testing up to and including entry into service. Test plans shall document the resources and processes required to meet the objectives stated in the testing strategy.
- b) Where it is a requirement that testing takes place in phases, with certified completion of one phase before proceeding, this shall be made clear in the test plan.
- c) Test plans shall be approved by the TiC and by the accredited Asset Engineer before testing starts. The Asset Engineer may, at his discretion, delegate such approval to another competent person.

Note: A summary extract of the test plan relating to the testing to be carried out during the commissioning itself may be incorporated in the CQP (specified in S2529, Signalling and Control Systems safety critical processes, and required by S1200). Where appropriate (e.g. for minor works with little or no pre-testing), at the discretion of the Asset Engineer, the CQP may incorporate all the requirements of the test plan and a separate document is then not required.

3.5.3.5 Implementation of testing

- a) Implementation of testing shall be in accordance with the approved test plan. Any departures from the plan that may be proposed by the TiC due to unforeseen circumstances shall be documented and, where practicable, agreed with the Asset Engineer.
- b) Throughout the testing (from pre-testing to commissioning) the TiC shall take appropriate steps to ensure that the hazards identified from 3.5.3.2 are effectively mitigated, and that any unforeseen hazards which arise are assessed and the risk reduced to a level that is ALARP.

3.5.4 Defining and recording the testing activities

3.5.4.1 Test specifications

- a) The supplier shall develop test specifications for works testing. Where systems and test requirements are common across more than one Supplier a common test specification shall be agreed between the Suppliers concerned.
- b) Test specifications shall contain, as a minimum:
 - 1) the objectives of the test, both general and specific;
 - 2) details of the initial or final conditions where these may influence the result;
 - 3) a description of the test activities to be performed;
 - 4) the expected results and the acceptance criteria;
 - 5) credible threats to the effectiveness of the test, and required defences.

3.5.4.2 Recording and certification

- a) A system of test recording and certification shall be defined or referenced in each test plan. All tests shall be recorded. Recording by exception is not permitted.