

Category 1 Standard

S1198 Signalling and Signalling Control - Installation, Testing, Commissioning and Handover

Issue No.: A3

Issue date: November 2011
Review date: November 2016

MAYOR OF LONDON

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Contents

1	Purpose	3
2	Scope	3
3	Requirements	4
3.1	General	4
3.2	Installation	6
3.3	Testing - General	12
3.4	Works testing	15
3.5	Commissioning	23
3.6	Handover	25
3.7	Management of rusty or contaminated rails	25
3.8	Evidence of Compliance	25
4	Responsibilities	25
5	Supporting information	27
5.1	Background	27
6	Informative references	27
6.1	Documentary references	27
6.2	Abbreviations	28
6.3	Definitions	28
6.4	Technical content manager	30
6.5	Document history	30
7	Attachments	31
7.1	Attachment 1 - Wire counting	31
7.2	Attachment 2 - Contents of Commissioning Quality Plans	34
7.3	Attachment 3 - Management of rusty rails	37



1 Purpose

The purpose of this Standard is to define the Signalling and Signalling Control Installation, Testing, Commissioning and Handover Requirements which are mandatory to Signalling and Signalling Control Systems used anywhere on the London Underground throughout the whole life-cycle of the system.

2 Scope

- 2.1 This Standard applies to mainline and depot sections of the London Underground Railway which are signalled using conventional or transmission based technology. It is applicable to safety and safety-related parts of the signalling system.
- 2.2 This Standard focuses on requirements for the third stage of the lifecycle, Installation, Testing, Commissioning and Handover. However, the totality of requirements contained within the complete suite of Signalling and Signalling Control Standards, see 5.1.2, must be complied with for these systems.
- 2.3 This standard applies to the pre-commissioning and commissioning of signalling systems. 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.
- 2.4 This standard applies to in-situ testing on the system and also to site-specific testing taking place away from the railway (for example pre-wired racks or location cases, or data-driven interlockings).
- 2.5 For clauses 3.1.4.2, 3.4.3.3.1, 3.4.3.3.6, 3.4.3.4.1, 3.4.4.1.1, Attachment 1 Paragraph 6, and Attachment 3 Paragraphs 1.1 and 1.2.:
- a) Suppliers may offer an alternative providing that the option is in accordance with Good Industry Practice, BS and ENs and that risks are always managed ALARP.
 - b) Suppliers shall declare the option and provide evidence of meeting both the criteria described above and their own standards where applicable.
- 2.6 This issue of the standard replaces 1-198 A3
- 2.7 This Standard supports the following LU Policy:

Note: The identification of the Policy shown below shall have no material impact upon Suppliers beyond the obligations already contained in this Category 1 Standard. It is provided for LU reference purposes only.

Number	Title
1-01102-001	LU Policy: Health, Safety & Environment



3 Requirements

3.1 General

3.1.1 Objectives

3.1.1.1 Signalling systems on LU shall be installed, tested and commissioned in such a way that they meet the following objectives:-

- a) to provide assurance of safety for customers and staff at all times;
- b) to cause minimum disruption to the normal running of the railway;
- c) to formally verify or validate or both that the immediate design aims of the system have been achieved;
- d) to permit efficient and effective maintenance of the completed system.

Note: Immediate design aims are those aspects of the design that can be assured at the time. By contrast, practical demonstration of some other design aims such as service capacity may not be possible at the time the system is first put to use.

3.1.2 Competency of staff

All staff involved with any activities deriving from this Standard shall be competent to undertake their role with respect to the particular environments, procedures and types of system, in accordance with Standard S1203, Competence of personnel working on signal and signal control systems.

3.1.3 Safe methods of working

3.1.3.1 When carrying out any form of installation, testing or commissioning work the most important aspect of the work is safety. Due regard shall be given to all aspects of safety, and in particular:-

- a) Operational Safety - The safe operation of the Railway system during and after the work; and
- b) Occupational Safety - The health and safety of employees and others likely to be affected, e.g. the public and customers, whilst the work is being carried out.

Note: The consequences of possible hazards (collisions and derailment) are obviously very severe, and signalling systems are therefore designed with numerous safeguards against them. However, any work that disturbs the installed signalling arrangements - if not carried out to very strict rules - introduces the risk that the protective features of the design may be compromised.

3.1.3.2 Operational safety

3.1.3.2.1 The integrity of any existing systems shall not be compromised by full or partial completion of the works.

3.1.3.2.2 Where the work is carried out on or near to a commissioned installation it is essential that the following conditions are met:-

- a) the working of the signalling equipment during Traffic Hours shall remain safe in every respect;



- b) except where a specific agreement has been reached with LU Operations and published in the Traffic Circular, work shall be planned so that the railway operations are not disrupted in any way.

3.1.3.2.3 When these conditions cannot be met then the work shall be carried out during Engineering Hours or a Possession.

3.1.3.3 Identification and mitigation of hazards

3.1.3.3.1 All hazards which could affect the safety of the railway shall be identified and managed so that the associated risk is As Low As Reasonably Practicable (ALARP).

3.1.3.3.2 Hazard identification and risk management shall continue throughout the life of the system installation, testing and commissioning stages.

3.1.3.3.3 Safe systems of work shall be devised and followed for all installation, testing and commissioning activities, taking account of identified hazards.

Note: Hazards may arise from factors outside the LU environment, such as from the traction system of adjacent railways.

3.1.3.4 Process controls

3.1.3.4.1 Individual tasks involving a disturbance to the function of an asset shall be sanctioned prior to the works, and certified on completion, through the issue of an Authority to Work Certificate (AWC) in accordance with the AWC procedure defined in Standard S1201, Signalling and Signalling Control - Approvals.

3.1.3.5 Stageworks

Note: During a major project it may be necessary to introduce the signalling system in a number of stages, termed 'Stageworks'.

3.1.3.5.1 The full pre-testing and commissioning testing requirements shall be applied at each stage, and full system integrity and reliability maintained throughout all interim stages where train services are operated.

3.1.3.5.2 Any subsequent tasks relating to the removal of temporary connection points, such as plate-racks, used in the interest of efficient commissioning practice, as well as any other system modifications, shall also be subject to testing.

3.1.4 Traceability of signalling system assets

Note: Traceability is critical to the safe and reliable operation of LU assets and is required when installing or replacing signalling system assets.

There is an obligation for all persons responsible for the design, installation and replacement of signalling system assets to ensure traceability is achieved throughout the life cycle.

3.1.4.1 Suppliers shall establish a means to record and maintain traceability data for all signalling and signalling control system assets, except where it can be shown that their performance is not critical to safety or reliability, or that to do so is not reasonably practicable.

3.1.4.2 Traceability data shall be recorded at the time of installation and include:

- a) for Electronic and Electrical Components (line replaceable units):
 - i) manufacturer;



- ii) type and Serial number;
 - iii) version or modification status.
- b) for Cables and Wire:
 - i) manufacturer;
 - ii) type;
 - iii) drum number;
 - iv) batch number.
- c) for all items:
 - i) asset number on supply or after overhaul, where applicable;
 - ii) location where stored or installed following manufacture or overhaul;
 - iii) date item or batch approved for use;
 - iv) date and time of installation;
 - v) test results from time of installation or commissioning, where appropriate.

3.1.4.3 An asset register shall be maintained and shall include the following mandatory elements of Standard 1-041, Provision of Asset Information, and the additional elements required by this standard:-

- a) asset identity:
 - i) type;
 - ii) identification number;
 - iii) line;
 - iv) location and BRS code;
 - v) detailed description;
 - vi) serial number.
- b) asset history:
 - i) incident records;
 - ii) preventative and corrective maintenance history;
 - iii) failure root causes (including workshop repair findings);
 - iv) annual certified test records;
 - v) Authority to Work Certificate records;
 - vi) defined critical parameters that are to be measured and recorded (such as insulation of safety multicore cables or track circuit set-up);
 - vii) records of signals passed at danger due to technical reasons.

3.2 Installation

3.2.1 General installation requirements

3.2.1.1 Installation works (including like-for-like and removal of redundant equipment) shall be carried out in accordance with approved designs issued by the Design Authority (authorised 'modification' drawings or equivalent documents for software) and installation standards for the system concerned.



Note:	The totality of the installation requirements may comprise:
a)	application specific design drawings;
b)	specifications;
c)	manuals;
d)	installation standards;
e)	any other relevant information (for like-for-like, this could be the approved book-wiring drawing).

3.2.1.2 Where the existing signalling system is to be modified, this shall be achieved in accordance with Standard S1200, Signalling and Signalling Control - Alterations to Systems.

3.2.1.3 Access and security arrangements at installation sites shall be maintained at the same level as required for commissioned installations.

3.2.1.4 All tools (including gauges) used shall be fit for purpose.

3.2.2 Installation planning and control

3.2.2.1 Suppliers shall produce an installation plan which shall define the tasks to be carried out, and how they will be executed safely and effectively. The independence of the test and installation organisations shall be defined as part of the plan.

3.2.2.2 Third parties shall be identified and notified of the intended work and approvals gained as necessary.

3.2.2.3 There shall be formal configuration control of the equipment to be installed.

3.2.2.4 There shall be a formal process for the control of change during the installation activities. This shall provide traceability for all items of note and allow a log of outstanding issues to be maintained.

3.2.2.5 A checking process shall be instigated, which uses hold points to monitor quality.

3.2.2.6 If installation requires a deviation from the issued design, then approval shall be sought from the Design Authority.

3.2.2.7 The approach to verification shall be specified in advance of installation. This shall include communication channels, and definition of testing boundaries and responsibilities.

3.2.2.8 Any errors and discrepancies shall be recorded through a logging and tracking process.

3.2.2.9 If a verification stage fails, then the level of re-verification shall be agreed with the Installation Engineer and recorded.

3.2.2.10 Installation works shall be left in a safe and secure state at the end of each shift.

3.2.2.11 Suitable protection shall be provided for partially installed equipment.

Note:	Suitable protection includes covers, ramps, doors, panels, etc. that should be in place before resumption of traffic.
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3.2.3 Installation standards

3.2.3.1 Positioning of trackside equipment

3.2.3.1.1 All equipment shall be erected to meet the requirements of Standard 1-156, Gauging and Clearances.

3.2.3.1.2 Installation of equipment in public areas shall be in accordance with Standard 1-356, Sightlines, visual clutter and visual space planning.

3.2.3.1.3 No equipment shall be positioned such that it needs to be removed in order to gain access to other equipment.

3.2.3.1.4 Equipment shall be positioned such that it does not obstruct walkways or other areas of safety or sighting.

Note: The Tester in Charge (TiC) is reminded that compliance with the issued design, the Design and Installation Standards and the requirements of the Signal Sighting Committee should all be addressed.

3.2.3.2 Signals not in use

All signals not in use shall be covered with an opaque black cover to prevent the train operator from seeing the signal and associated name plate. The signal shall have its light source disabled. In addition, for outdoor signals a white diagonal cross shall be placed on the front of the signal head to indicate that the signal is not in use.

Note: This applies to all signals, signs and indicators that are not commissioned for use.

3.2.3.3 Connections to the Rail

Attachment of signalling equipment to the rail shall be carried out to an approved method and by a competent person to prevent any deterioration in the performance or condition of the rail which could result in a subsequent failure of the rail in service.

3.2.3.4 Electrical wiring - general

3.2.3.4.1 Installations shall be earthed in accordance with Standard 1-106, Earthing and Bonding of LU Electrical Networks.

3.2.3.4.2 Signalling equipment room power outlets and associated wiring shall be labelled to indicate their supply voltage and particular circuit.

3.2.3.4.3 The installation method for cabling and wiring shall avoid damage that might affect the mechanical or electrical properties of the wires.

Note: This should include consideration of minimum radius, mounting and securing arrangements and friction damage during the installation.

3.2.3.5 Pre-energisation checks

3.2.3.5.1 Prior to energisation of any new equipment, the Installation Engineer shall establish that the new installation does not contain a threat to the integrity of existing systems, in terms of mechanical, electrical, Electro Magnetic Compatibility issues or other physical parameters (e.g. thermal effects).

3.2.3.5.2 The Installation Engineer shall confirm that the relevant power load has been approved in accordance with Standard 1-100, Load Change Application Requirements for Electrical, Compressed Air and other Services.



3.2.3.5.3 Where a non-standard arrangement for power supply is used it shall be subjected to a 'signalling principles' check by a Principles Tester.

3.2.3.6 External cabling

3.2.3.6.1 Cable installation shall take account of the suppliers recommendations.

Note: This should include minimum bending radius and the maximum unsupported length for each type of cable.

3.2.3.6.2 Spare cores shall not be cut back. All cable cores, whether main cables, tail cables or multicores shall be terminated.

3.2.3.6.3 Cables that cross the track bed for local connection shall be protected from damage. They shall be installed such that they do not present a tripping hazard, as far as is practicable.

Note: Protection against damage may be integral to the cable sheath, such as 10 core cables.

3.2.3.6.4 Cables shall be given an appropriate supporting structure that will maintain the cable integrity.

3.2.3.6.5 Installation shall preserve the design intent of segregation between cables to minimise undesirable interactions between different systems.

Note: Segregation of critical cables should consider the effect of damage to a cable run. For example, to minimise this effect diversity could be provided by running cables in runs on opposite sides of the track. Other reasons for considering segregation include EMC, and electrolytic corrosion and also dissimilar insulation material that may cause chemical reaction.

3.2.3.7 Cable joints

The number of joints in cables between terminations shall be kept as low as reasonably practicable. There shall be no joints or splices in safety multicore cables during initial installation.

3.2.3.8 Internal wiring

Installation shall preserve the design intent of any specified segregation between wiring.

3.2.3.9 Termination and protection of wiring and cabling in safety signalling installations

Note: Wiring - individual circuit conductors whose insulation and sheathing is designed for installation only in protected environments, such as equipment rooms or cases.

Cabling - circuit conductors whose insulation and sheathing is designed for installation where they may be exposed to harsh environments e.g. Lineside cabling.

3.2.3.9.1 All wiring in commissioned signalling installations shall have the wire ends properly secured and protected.

3.2.3.9.2 There shall be no exposed unterminated wire ends of any kind (vital or non-vital) in any equipment room, kiosk or case, of an installation containing commissioned vital signalling equipment, unless being actually worked on under controlled conditions.



3.2.3.9.3 Un-terminated wires that form preparation for a modification shall be capped, secured and clearly labelled with the installation date and modification reference. If no such label exists or the date on the label is more than six months old, the wire shall be investigated as if redundant.

3.2.3.9.4 A redundant wire or cable shall be removed unless its removal is likely to entail significant risk to the existing wiring arrangements. In this case a risk assessment shall be carried out to determine the comparative risk of removing it or leaving it in situ. The Asset Engineer's approval shall be obtained for the redundant wire or cable to be left in situ.

Note: Where the redundant cable sheath forms part of the earth return path, consideration should be given to retaining an adequate cross section for the earth conductor.

3.2.3.9.5 An unterminated redundant wire that cannot be removed shall be:

- a) cut back and secured so there is no credible risk of the wiring coming into contact with any conductive surface and;
- b) capped with an approved protective device.

Note: Where possible an approved wiring tie should be placed over the cap to secure it in place to a wiring tree or to the framework of the rack or strapping. The distance from the cable tie to the cap should not exceed 50mm. Un-terminated cores of multicore cables should be capped and secured to the same standard. It is permissible to use a large protective cap to insulate more than one core.

3.2.4 Proving of controlled wiring alterations

3.2.4.1 General

Note: The proving of controlled wiring alterations is applicable to both outside and inside safety and safety-related Signalling wiring, including cables, either commissioned or that has been subjected to pre-commissioning testing.

3.2.4.1.1 The proving of wiring prior to its connection or removal shall:-

- a) ensure proof of identity of each end of a single length of wire;
- b) assist in determining that as-built or as-installed wiring corresponds with issued design documentation.

3.2.4.2 Precautions to be taken

3.2.4.2.1 Before wiring is disconnected or re-connected, appropriate techniques for the correlation of wiring to the as-built drawings shall be applied.

Note: Wire counting by itself does not necessarily provide adequate assurance of correlation and other techniques may need to be employed, as appropriate.

3.2.4.2.2 Before making connections or removals, appropriate steps shall be taken to securely isolate the power to the affected wiring.

Note: Staff shall be alert to the possibility of abnormal voltages, due to fault conditions, such as 600V DC. Where dangerous voltages exist, appropriate steps shall be taken to identify and isolate them.

3.2.4.2.3 Appropriate test methods and equipment shall be selected for the testing required.



3.2.4.2.4 Where it is not practicable to physically remove disconnected wiring, the ends shall be cut back, capped and secured, in accordance with section 3.2.3.9 of this Standard.

3.2.4.2.5 Wires disconnected temporarily to permit tests shall be suitably labelled to aid replacement.

3.2.4.3 Method

3.2.4.3.1 Wiring alterations shall only be carried out when authorised by an AWC in accordance with the AWCs for task authorisation and certification process defined in Standard S1201, Signalling and Signalling Control - Approvals.

3.2.4.3.2 All connections or removals shall be controlled and recorded against the appropriate amendment drawings. In addition to the person controlling the wiring changes, a second competent person shall independently monitor the changes as they are carried out, using a separate schedule of wiring changes prepared and checked either by the Design Authority or by competent persons other than by the person actually controlling the changes.

Note: The purpose of the monitoring is to minimise the risk of installation error, and the use of a separate schedule in particular is to minimise the risk of misinterpretation of the amendment drawings. This benefit is maximised if the schedule is prepared by the Design Authority directly, rather than by a third party interpreting the amendment drawing.

3.2.4.3.3 Both the controlling and the independent monitoring of wiring changes shall be carried out by competent persons, one of whom shall be the AWC holder unless this is not reasonably practicable. In the event that it is not reasonably practicable, for either to be the AWC holder, then the roles shall be fulfilled by persons appointed by the AWC holder, and their names shall be recorded on the AWC.

3.2.4.3.4 If it is possible to observe the entire length of a wire, this visual examination shall suffice to prove the identity of both ends of the wire (but will not ensure electrical continuity).

3.2.4.3.5 The identity of wires to be connected or disconnected shall be positively established at the time of connection or disconnection. This shall be carried out despite any system of labelling that may have been provided.

3.2.4.3.6 Where it is not practical to observe the whole length of a wire, the wiring shall be hand traced and a test for continuity made.

3.2.4.3.7 Where 3.2.4.3.4, 3.2.4.3.5 and 3.2.4.3.6, above, are not practicable, then the wiring shall be proved by testing in accordance with a method statement agreed by the Asset Engineer or his Accredited representative.

3.2.4.3.8 Removal of wiring that is not recorded in the 'as built' drawings shall be carried out in accordance with a method statement agreed by the Asset Engineer or his Accredited representative. Wiring temporarily disconnected shall be labelled, capped and secured.

3.2.5 Installation records

3.2.5.1 A record of all design and installation changes made during installation shall be maintained by the Installation Engineer, from the initial receipt of the design until hand over to the Tester in Charge.



- 3.2.5.2 The Installation Engineer shall keep an error log of all discrepancies and the corrective action taken to achieve resolution.
- 3.2.5.3 Installation records shall include all error logging records and their sign-off.
- 3.2.5.4 Installation records shall be archived and retained for the life of the installation.

3.2.6 Handover for Testing

- 3.2.6.1 The design drawings shall be updated to incorporate any alterations that have been found necessary during the installation process.
- 3.2.6.2 The TiC shall obtain assurance that the installation work has been carried out to the necessary quality and installation standards, in accordance with the approved design.

Note: Where the installation has been undertaken by a separate group this may take the form of a Certificate of Conformity.

- 3.2.6.3 A Test Copy of the design shall be provided to the TiC prior to the start of testing.
- 3.2.6.4 The record of changes and error log shall be reviewed as part of the formal handover between the Installation Engineer and the TiC.

3.3 Testing - General

Note: Testing of signalling systems, whether for the introduction of new works or the maintenance of existing arrangements, is critical for ensuring that the installed signalling arrangements function safely and in accordance with their design.

3.3.1 Testing objectives

- 3.3.1.1 Testing shall have defined objectives which include:-
 - a) verifying physical correspondence between a system and its authorised design, including that the authorised version of a component or data set has been installed;

Note: Physical check of conformance to design should include but is not limited to:

- a) a 100% check of as-built dimensions which are critical to safety or performance;
- b) verification that the correct equipment has been installed;
- c) a wire count of all terminations;
- d) a terminal-to-terminal continuity test, carried out after the wires have been terminated;
- e) verification of satisfactory earthing and other circuit protection arrangements.

- a) verifying the logical operation of a system in accordance with its authorised design;
- b) verifying the correct adjustment of a component or sub-system;
- c) validating the application design principles embodied in a system;
- d) in some instances, verifying (or validating, or both) the critical characteristics or parameters of a component or sub-system.